Survival Analysis of Kidney Disease Patients on Dialysis

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ABSTRACT - Kidney diseases (KD) are one of the major global public health problems with an increasing prevalence. In this study, Kaplan Meier model was used to estimate the survival time and the survival probability of the four significant diseases: hypertension, severe malaria, kidney Disease and acute renal function. A retrospective study was done on a sample of 467 Kidney diseases. The overall median survival time was 39.83. In the followed up period 224 (48.0%) patient died and 178 (38.1%) were censored, 61(13.1%) patients were lost to follow up and 4 (0.9%) were transplanted. The results indicate that hypertension, severe malaria, acute kidney infection and acute renal function increases hazard rate of the kidney disease patients on dialysis were statistically significantly, since their respectively P-values of 0.742, 0.099, 0.729, and 0.879 were greater than alpha-value of 0.05. The probability of survival of the hypertension, severe malaria, acute kidney infection and acute renal suggested a good survival.

Keywords: Survival, Kidney Disease, hazard function, Kaplan Meier.

1. INTRODUCTION

Survival analysis is generally defined as a set of methods for analyzing data where the outcome variable is the time until the occurrence of an event of interest and the event can be death, occurrence of a disease, marriage, divorce, etc. It is a set of statistical methods for examining not only event occurrence but also the timing of events. (Williams and Durham, *2008*). It can also be seen as corresponding to a set of statistical approaches used to investigate the time it takes for an event of interest to occur. It is also known as lifetime data analysis. It involves the consideration of the time between a fixed starting point (e.g. diagnosis of cancer) and a terminating event (e.g death). (Lee *et al* 1997., Clark *et al*, 2003). The kidney is an important organ of the body which maintaining internal balance among other functions. When the kidney failed, the function is impaired and resulting in retention of waste products of metabolism.

Several researchers like (Boyi, *et al* 2020., Bikbov, *et al* 2020., Dada, *et al*. 2019., Mohammed, *et al* 2017., Verbeme, *et al* 2016., Santos, *et al* 2015., Chandrashekar, *et al*., 2014., Olurotimi *et al*., 2012., Prinja, 2010., Langova, 2008., Berwick, 2004., and Altman, 1992, have worked on a comparative analysis of survival of patients on dialysis and after kidney transplantation .

2. MATERIALS AND METHODOLOGY

The study used a retrospective study, all the events and exposure had already occurred in the past and reviewed the patients' card and information sheets. The data were collected from the Renal Center Unit, of a certain Hospital in Sokoto, North West Nigeria. It covered the period of 2010 to 2019. The models used for the study was Kaplan-Meier (KM). The survival models were used to quantify the effect of one or more explanatory variables on failure time, Hussein *et al* (2017).

2.1 Survival Function and Hazard Function

The survival function S (t) is then given by:

$$S(t) = \Pr(T \geq t) = 1 - \Pr(T < t) \qquad (2.1)$$

Cumulative distribution function F(t) is given as:

Hypertension.	Chi-Square	Df	Sig.
Log Rank (Mantel-Cox)	.108	1	.742
Breslow (Generalized Wilcoxon)	.440	1	.507
Tarone-Ware	.0341l8	1	.854
Diabetes	Chi-Square	Df	Sig.
Log Rank (Mantel-Cox)	2.723	1	.099
Breslow (Generalized Wilcoxon)	1.688	1	.194
Tarone-Ware	2.098	1	.147
Acute Kidney Infection	Chi-Square	Df	Sig.
Log Rank (Mantel-Cox)	.120	1	.729
Breslow (Generalized Wilcoxon)	.005	1	.942
Tarone-Ware	.003	1	.958
Severe Malaria	Chi-Square	Df	Sig.
Log Rank (Mantel-Cox)	.023	1	.879
Breslow (Generalized Wilcoxon)	.070	1	.792
Tarone-Ware	.007	1	.931

$F(t) = \Pr(T \le t)$, then the survival function

$$S(t) = \mathrm{P}(T > t) = \int_t^{\infty} f(u)\,du \tag{2.2}$$

$$= 1 - F(t) \tag{2.3}$$

Hazard function h(t) is given by the following;

$$h(t) = \mathrm{P}(T = t \mid T \ge t) \tag{2.4}$$

$$= \frac{\mathrm{P}(T = t)}{\mathrm{P}(T \ge t)} = \frac{f(t)}{s(t)} \tag{2.5}$$

2.2 Kaplan-Meier (KM)Model

The model for Kaplan-Meier estimator of survival function at time t is given as:

$$S_{km}(t) = \left(1 - \frac{d_{(1)}}{N_{(1)}}\right)\left(1 - \frac{d_{(2)}}{N_{(2)}}\right)\ldots\left(1 - \frac{d_{(j-1)}}{N_{(j-1)}}\right) \tag{2.6}$$

$$= \prod_{t(j)<t}^{k}\left(1 - \frac{d_{(j)}}{N_{(j)}}\right) \quad for \quad t_{(k)} \le t < t_{(k+1)}, k = 1,2,3,\ldots,m \tag{2.7}$$

When t = 0, S(0) = 1, this means that all subjects alive at time 0.

The variance of the Kaplan-Meier estimator of the survival function which is known as the greenwood formula is given as:

$$\hat{\mathrm{var}}(S(t)) = \left[\hat{S}(t)\right]^2 \sum_{t_{(i)st}} \frac{d_i}{n_i(n_i - d_i)} \tag{2.8}$$

The (1-g) X 100% confidence interval for the survival function (Skm (t)) at time t is:

$$\hat{S}_{km}(t) \pm Z_{\frac{\alpha}{2}} s.e\left(S_{km}(t)\right) \tag{2.9}$$

3 RESULTS AND DISCUSSIONS

Table 1: Test of equality of survival distributions for the different levels of Hypertension, Diabetes, Acute Kidney Infection, Severe Malaria

The log rank test from the table 1 above shows that the two curves are not statistically significantly different since the P-values (0.742, 0.099, 0.729, 0.879) of Hypertension, Diabetes, Acute Kidney Infection and Severe Malaria respectively were greater than alpha-value (0.05). It shows the level of significance and the test of equality of survival distributions for the different levels of Hypertension, Diabetes, Acute Kidney Infection and Severe Malaria.

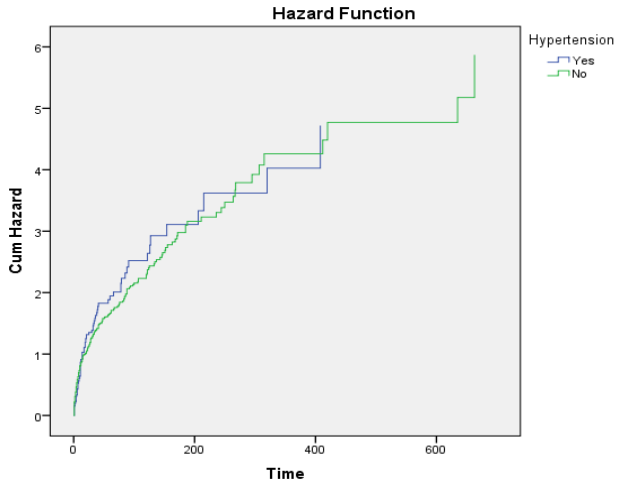

Fig1. : Plot of hazard functions for hypertension.

The graph fig. 1 shows the estimated hazard function of hypertension patients on dialysis.

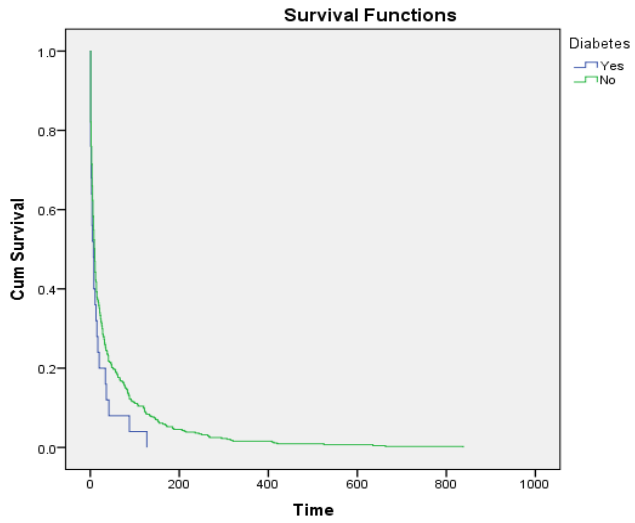

Fig. 2: Plot of survival functions for Diabetes.

From the graph in Figure 2, the lines represent survival curves of the two groups (Yes and No) of diabetes. The vertical tick marks (blue and green) on the curves mean that a patient was censored at this time. Thus, at time zero, the survival probability is 1.0 (or 100% of the patients are alive). suggesting a good survival.

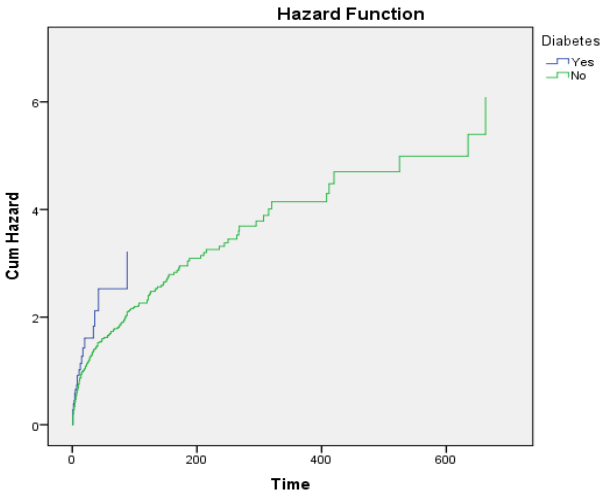

Fig. 3: Plot of hazard functions for Diabetes.

The graph fig. 3 show the estimated hazard function of diabetes patients on dialysis.

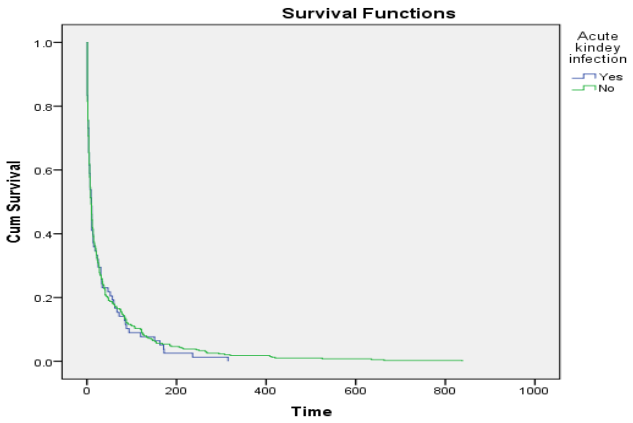

Fig. 4: Plot of survival functions for Acute Kidney Infection.

The graph above shows that at time zero, the survival probability is 1.0 (or 100% of the patients are alive).

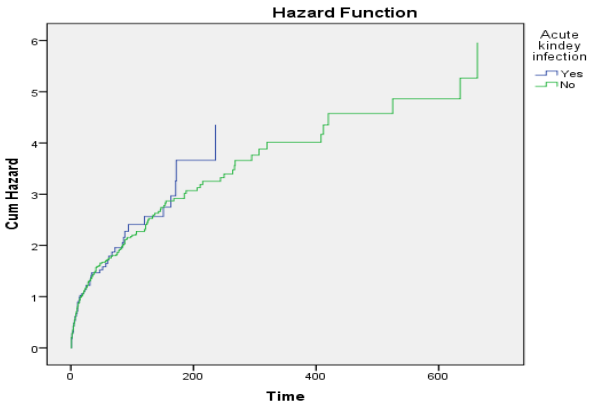

Fig. 5: Plot of hazard functions for Acute Kidney Infection.

The graph fig. 5 show the estimated hazard function of acute kidney infection patients on dialysis.

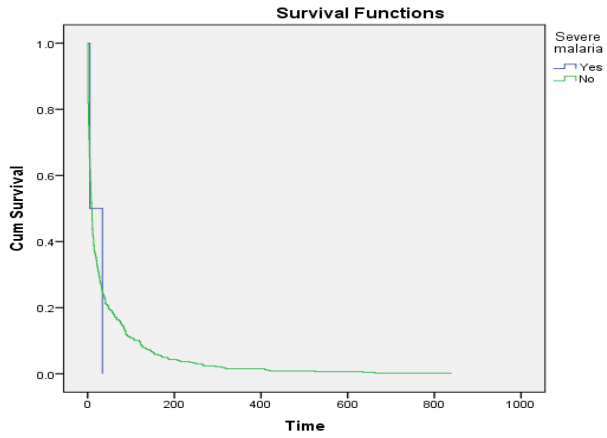

Fig. 5: Plot of survival functions for Severe Malaria.

From the graph above, the survival probability is 1.0 (or 100% of the patients are alive) at time zero,

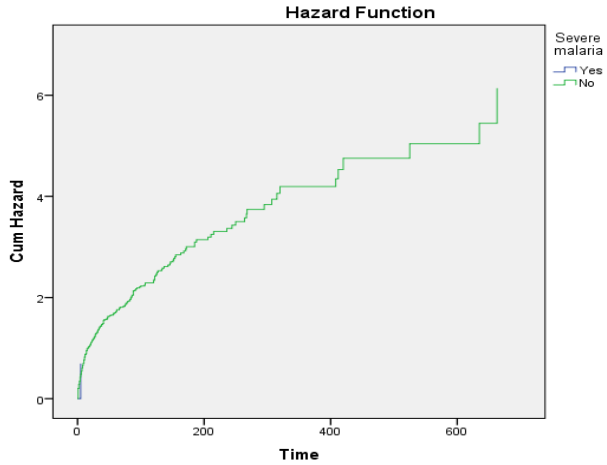

Fig. 6: Plot of hazard functions for Severe Malaria.

5. CONCLUSION

On fitting the proportional hazard model on the kidney disease data, the results indicated that hypertension, severe malaria, acute kidney infection and acute renal function increases hazard rate of the kidney disease patients on dialysis were statistically significantly. The survival probability suggested a good survival. Therefore, the results show that, the explanatory variables are not contributing relevant prognostic factors to survival or hazard of kidney disease patients on dialysis. This study provided a detailed investigation of the survival rate of dialysis patients.

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