Faculty of Commerce
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# Statistical Model Proposed to Predict Survival Rate among Patients Performed Liver Transplantation Operation in Egypt

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A thesis submitted in partial fulfillment of the requirements for the Master Degree in Applied Statistics

**2016**


Faculty of Commerce
Ain shams University

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**Academic Degree:** M.Sc. in Applied Statistics

**Name of Student:** Sally Hossam ElDin Ahmed Zakria

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**Date of Dissertation Defense / / 2016** **Approval date / / 2016**

*Dedicated To*

*My Parents,*

*My Husband*

*And My Son*

# Acknowledgements

First and foremost, praise and thanks must be to ALLAH who guides me throughout my life and gave me the power and determination to accomplish this research work.

I would like to thank and express my deepest appreciation to **Prof. Dr. Mostafa Galal Mostafa** for all what I learnt from him throughout my academic years. Also I would like to thank him for agreeing to be a member of this committee and his valuable time and advices which added a great value to the study.

I sincerely would like to express my deepest gratitude and thanks to my supervisor Prof**. Dr. Medhat Mohamed Abdel Aal,** for his careful supervision, continuous encouragement, and great support throughout the work. He was always willing to give his time without any delay. Thanks for his generous support and sincere guidance, supervision and advices.

I am really deeply grateful to **Prof. Dr. Mohamed Amin Sakr** for his great help in the medical aspects for this work, and his assistance and efforts for getting the medical data.

I strongly acknowledge the contribution of **Prof. Dr. Abdulla Abd El - Ghaly** for his valuable time, patience and professionalism which added a great value to the study.

Finally, I am most grateful to my parents, sister and brothers they have gave me all the help and support I could possibly ask for. And very special thanks to my beloved husband, and my little baby Omar, who have always loved me and supported my dreams. I am really thankful to everyone who took part in exhibiting this work to light.

# Abstract

**Sally Hossam El din Ahmed Zakria Zaki**

**Statistical Model Proposed to Predict Survival Rate among Patients Performed Liver Transplantation Operation in Egypt**

**Master Degree in Applied Statistics**
**Ain Shams University, Faculty of Commerce**
**Statistics, Mathematics & Insurance Department**
**2016.**

Survival analysis refers to the general set of statistical methods developed specifically to model the timing of events. This thesis concerns a subset of those methods that deals with non informative right censored data.

The main objective of the current study is to construct statistical model that estimate the survival function of Egyptian patients performed liver transplantation operation and to determine the risk factors affecting the outcome of liver transplantation operation by using different statistical methods represented in non parametric, semi parametric and parametric methods. Also the study aimed to construct the feed-forward neural network and use it as a classifier to distinguish between censored and uncensored patients.

The study showed that the probability of 1 year survival after living donor liver transplantation was 85.76% with mean survival time 10.504 months however the probability of 2 year survival after living donor liver transplantation was 81.45% with mean survival time 20.584 months.

Also the Cox proportional hazard regression model showed that: the variables Recipient age, $MELD_3$ , Ln_Creatinine, and GRWR are

statistically significant and selected as significant factors for risk of death after liver transplantation operation .

The Cox proportional hazard model displayed lack of fit in this study, since the variable Recipient age violates the proportional-hazards assumption. The stratified Cox model with interaction and with no interaction was applied and showed that the no-interaction model is acceptable at 0.05 level of significance and the variables $MELD_3$ , Ln_Creatinine are statistically significant and selected as significant factors for risk of death after liver transplantation operation.

In contrast of the proportional hazard model, the Accelerated Failure Time model (AFT) provides an adequate description of this data. The family of the AFT models including the exponential AFT model, Weibull AFT model, log-logistic AFT model, log-normal AFT model, was applied to this dataset. And it was concluded that the lognormal AFT model is the best model fitting and showed that the variables: Recipient age, $MELD_3$ , and GRWR are statistically significant and selected as significant factors for risk of death after liver transplantation operation .

Also the Piecewise Constant Exponential model showed that the hazard is not constant over the time, and the pattern of the coefficient estimates is not monotonic.

Moreover the feed forward neural network were developed and trained using MS Excel it showed that the best network is achieved when the minimum mean square error for training data was 0.0378, and for testing data is 0.2233. It was concluded for the *training data set* the percent of correct classification was 95.0%. Also for *testing data set* the percent of correct classification was 75.80%.

***Keywords:*** Survival analysis, Censoring, Kaplan–Meier estimate, Cox PH regression model, Stratified Cox regression model, Accelerated failure time model, Piecewise Constant Exponential model , Feed forward neural network, Multilayer perceptron, Back propagation algorithm.

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| AFT | Accelerated Failure Time Model. |
| AIC | Akaike Information Criterion. |
| ANN | Artificial Neural Network. |
| BMI | Body Mass Index. |
| CTP | Child Turcotte Pough. |
| ESLD | End Stage Liver Disease. |
| FFNN | Feed Forward Neural Network. |
| GLM | Generalized Linear Regression Model. |
| GRWR | Graft-Recipient Body weight Ratio. |
| HBV | Hepatitis B Virus. |
| HCC | Hepato-cellular Carcinoma. |
| HCV | Hepatitis C Virus. |
| INR | International Normalized Ratio. |
| K-M | Kaplan-Meier. |
| LDLT | Living Donor Liver Transplantation |
| LT | Liver Transplantation |
| MELD | Model for End Stage Liver Disease. |
| NN | Neural Network. |
| OPTN | Organ Procurement Transplantation Network. |
| PAT | Parenteral Antischistosomiasis Therapy . |
| PCE | The Piecewise-Constant Exponential Model. |
| PH | Proportional Hazard. |
| PO | Proportional Odds. |
| UNOS | United Nation for Organ Sharing. |
| WHO | World Health Organization |