Literature on Stochastic Modeling of Heart and Kidney: A Review

Meenaxi[1] , Dalip Singh[2], Narender Singh[3]
[1]Research Scholar,[2]Professor,[3]Asst.Professor
[1]Department of mathematics, M.D. University, Rohtak-124001

Abstract

The reliability of human beings and human activities are rendered more important by the complexity of life, work and medicine development. Human heart is powerful muscular pump whose work is to supply oxygenated blood to the body. Kidneys are the main functional unit of excretory system. Excretory system helps to remove harmful waste products through urine. This study is focused on the review of various stochastic models for heart and kidney, which provide the basis for the most clinically applied methods for Heart and Kidney mechanism analysis.

Keywords **:- Reliability, survival analysis, heart failure, Kidney disease, Stochastic processes**

Introduction

In the study of medical science and Reliability theory, prevention of either disease in men or loss of machines is given a lot of importance because it will prevent the loss of life for production. The reliability is the property to fulfill the required tasks within the given period for the given working conditions. Reliability theory contains reliability engineering disciplines, human and social reliability etc. Similarly to the engineering reliability, the human reliability can be defined as well as the probability that an individual will perform a certain activity during a given period of time. It is very important to solve the reliability problems even in the healthcare system. Our heart is responsible for continuous supply of oxygenated blood all around the body. Human kidneys filter the waste products in form of urine. It helps to control blood pressure by regulating water and salt level. Recent researches has detected that cardiovascular failure is an important risk factor for kidney disease. When human heart does not pumping efficiently, this blood is accumulated, which produces pressure in the main nerve connected to the kidney, and blood gets deposited in the kidneys. Therefore kidney is also affected by lack of oxygenated blood. Hence this review focused on the various stochastic models for heart and kidney.

Literature Review

- The literature on stochastic modeling within the health area is broad. Barlow and Proschan [1] studied Statistical Theory of Reliability and Life Testing in 1975. In 1977 Ramanarayanan [2] analyzed a model in which 1-out of 2: F system exposed to cumulative damage processes. A study which is based on diabetes and cardiovascular risk factor was presented by Kannell and McGee [3] in 1979. In 1998, Hauskrecht and Fraser [4] discussed a markov decision process related to treatment therapy of Ischemic Heart disease. In this paper by using POMDP framework, a model was discussed which helps to solve the problem of the management of the patients with Ischemic heart disease (IHD) demonstrate the modeling advantages of the framework over standard decision formalism. In 2003, Kuusela [6] etal, discussed stochastic model for Heart rate fluctuation. Jackson [5] et al. discussed Multistate Markov models of successive diseases with classification error. In 2005, Tsiatis [8] et al. worked on analysis of survival data. In 2005, Macdonald [7] et al. constructed a model for coronary heart disease. The whole paper is divided into two parts. In part 1, a model has been made for coronary heart disease which is either included in corporate or underwriting for critical illness, through the main risk factor of interest. In part 2, model has been developed in such a way that it also includes critical illness like cancer, kidney failure. Sandercock [9] et al. studied Reliability of short term measurements of heart rate variability in 2005. Bosquet [10] et al. worked on Reliability of post exercise heart rate recovery in 2008. In 2009 Chadben [11] et al. discussed the cost effectiveness of increasing kidney transplantation and home made dialysis. In 2011, Orlando [12] et al. presented a chronic kidney disease model. The objective of this model is to guide the decision makers. This paper examined the natural history and treatment of CKD by Monte Carlo Simulation. The CKD model is a general purpose model that aims to improve the CKD care and use it as a resource to inform policy decisions. In 2011, Zaitseva [13] et al. worked on Reliability analysis of healthcare system. In 2011, Al Haddad [14] et al. worked on Reliability of Resting and Post exercise Heart rate Measures. Arduini [15] et al. in 2011 discussed Reliability evaluation of different models for improving heart rate recovery after sub maximal bicycle exercise. Depuy [16] et al. studied Reliability evaluation of heart rate measures used to assess post- exercise Parasympathetic reactivation in 2012. In 2012, Sinescu [17] et al. studied Human reliability and Heart failure model. In this paper, they focused on the detail analysis of survival with practical examples for the heart failure. The researches have been carried out on a sample of 101 patients diagnosed with heart failure. The Kaplan-Meier estimator is obtained from the life-time data. A multivariate analysis was developed using the COX model. In 2014, Anwar [18] et al. presented a stochastic model for the succession of chronic

kidney disease. The objective of these studies is to proposed a stochastic model which delineate the development of chronic kidney disease, estimate the mean time spent in each stage of disease stages that precedes developing end stage renal failure and to estimate the life expectancy of a CKD patient.. Using kolmogorov forward differential method, explicit expressions of transition probability functions were derived. Besides the mean sojourn time, the state probability distribution, life expectancy of CKD patients in each state of the system was presented in the study. . In 2014 Muthaiyan [19] et al. studied stochastic model to find the prognostic ability of NT pro-BNP in advanced Heart failure patients using Gamma distribution. In 2016, a stochastic model was presented by E.B. nkemnole [20] etal., a study was discussed by them related to some Endemic infections which is based on medical records of Gbagada general hospital, Nigeria. In 2018, a study was presented by S. Subramanian [21] etal, which were based on stochastic models applied in chronic kidney disease. In 2019, son jeongeun [22] etal discussed a stochastic modeling and analysed the cardiovascular with rotary left ventricular assist devices.

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