AMERICAN JOURNAL OF PHARMTECH RESEARCH
Journal home page: http://www.ajptr.com/

Survival Analysis of SARS-COV-2 in Infected Population of Karnataka State of India

Suhas Bhat[1*], Surekha B. Munoli[1], Rohan Kolla[2]
1. Department of Statistics, Karnatak University, Dharwad-580003, India.
2. Senior Medical Advisor, Novo Nordisk India Private Ltd, Bangalore India.

ABSTRACT

Survival probabilities of SARS-COV-2 virus causing COVID-19 in the infectee are tracked using the duration of recovery times of patients in Karnataka state of India. Influence of age, gender, and other symptoms and illness on recovery time is studied. The death of COVID-19 patients and the infectees still under treatment are censored.

Keywords: SARS-COV-2, Survival probability, Kaplan-Meier curve, Nelson-Aalen Curve, Median time of recovery.

*Corresponding Author Email: suhasbhat2@gmail.com
Received 14 July 2020, Accepted 01 August 2020

Please cite this article as: Bhat S *et al*., Survival Analysis of SARS-COV-2 in Infected Population of Karnataka State of India. American Journal of PharmTech Research 2020.

INTRODUCTION

The coronavirus started from Wuhan city of China and setoff as a global pandemic. While there are several strains of coronaviruses, the novel coronavirus strain SARS-COV-2, thought to have a zoonotic origin, causes the infectious disease COVID-19. People infected with COVID-19 experience respiratory illness with common symptoms including fever, cough, shortness of breath & loss of sense of smell. COVID-19 affects different people in different ways with older people and those with underling medical problems like cardiovascular diseases, chronic respiratory diseases, diabetes, and cancer more likely to develop serious illnesses or death. The prognosis for Influenza-like illness (ILI) and Sever Acute Respiratory Illness (SARI) patients who are infected with COVID-19 is distressing. As of June 15, 2020, globally 8,108,667 people are infected which has resulted in 438,596 reported deaths. India has reported 343,026 positive cases with 9915 deaths; out of which Karnataka has 7213 cases with 88 deaths reported.

Every effort is being made by governments, private organizations, NGOs, and social organizations to control the spread of COVID-19. At an individual level, practicing respiratory etiquettes, washing hands, avoiding touching one's face and contaminated surfaces, social distancing controls the transition of humans from susceptible to infected. At the government level, imposition of lockdowns, isolation and sealing containment areas are some of the measures taken to control the spread of virus at the community level.

From scientific perspective, studies relating to life, life span of coronavirus, how long it remains intact on different surfaces, density of virus particles, influence of environmental conditions such as temperature and sunlight are made. Researchers from different fields are scrambling to understand the epidemiology of the disease and how best to tackle it.

People of all ages are at risk of getting infected with COVID-19. The severity of the disease and recovery from the disease varies with respect to age, gender, and other health parameters. The question to be answered is how long the virus stays alive inside a body (viral persistence). The knowledge of COVID-19 persistence may help to determine how long someone is contagious and how long the infected should stay in isolation. Given the novelty of COVID-19, the need of the hour is to investigate about recovery times of COVID-19 patients.

Some contributions to the study on recovery time, median time of recovery, influence of age, gender on virus persistency, etc. for various populations are due to Mishra *et al.* (2020), Thai (2020), Wang (2020), Rees (2020)[1-4]. Several tools to carry out analysis of the event of interest are available in literature when count data is available. The popular ones are: Kaplan- Meier (K-M) estimator of survival function [5] and Nelson-Aalen (N-A) estimator of cumulative hazard function [6].

Using the data of date of diagnosis of COVID-19 and the date of discharge from the COVID-19 hospitals for each infected individual of Karnataka state of India, the probabilities of a person being in infected condition as the days elapse are calculated using K-M estimator of survival function and Nelson-Aalen estimator of cumulative hazard function. In other words, the survival probabilities of coronavirus in the infectee are tracked using the duration of recovery of COVID-19 patients of Karnataka.

This study endeavors to track and analyse the recovery times of COVID-19 patients. In this study K-M estimators of survival probabilities and estimators of survival probabilities using Nelson-Aalen estimator of cumulative hazard function are obtained for the populations of Karnataka. Difference in virus persistency among male and female infected populations is studied. Recovery times of infected population of age greater than 60 are analyzed gender wise. Also the recovery times of COVID-19 asymptomatic, ILI, and SARI patients are tracked.

MATERIALS AND METHOD

For the present study, a publicly available secondary data is obtained from COVID-19 INFORMATION PORTAL, GOVT. OF KARNATAKA [7]media bulletins up to June 15, 2020. As the study used the data that are available for general public, no ethical approval was sought. The authors also refrain from reporting any sensitive information related to COVID-19 pandemic in Karnataka state of India

A database is created for each infected case which includes the date of diagnosis, the date of recovery from infection, age, gender, travel history, initial symptoms, detected district, Recovered/Deceased, and treatment duration. The event of interest is a complete recovery from COVID-19 as per WHO specifications (three successive test results of COVID-19 infection should be negative). In calculations of survival probabilities, the deaths of infected due to COVID-19, deaths of infected due to reasons other than COVID-19, the COVID-19 patients who are under treatment are considered as censored observations. During the study, about 60 patients who were tested positive for COVID-19 and discharged within two days of hospitalization (these were the asymptomatic and on testing second and third time, the test reports were negative). Such cases may be false positive test results for COVID-19. Such observations are considered as truncated observations. Table 1 presents distribution of COVID-19 patients as per age and gender.

Table 1: Total number of infected individuals

Age Interval	Male	Female	Total
0-10	333	291	624
10-20	578	411	989
20-30	1097	669	1766

30-40	1084	655	1739
40-50	758	293	1051
50-60	367	188	555
60-70	185	130	315
70-80	51	36	87
80-90	9	15	24
90-100	2	1	3

From the table, it is clear that more number of COVID-19 infected belong to the age intervals (20-30) years and (30-40) years and also the numbers of male infected are greater for all the age groups (except for the interval 80-90). This may be attributed to socio-economic reasons. Using "survival" package of R-software, the survival probabilities of COVID-19 causing virus SARS-COV-2 in an infectee are computed with K-M and N-A methods for total infected population of Karnataka are plotted in Figure 1.

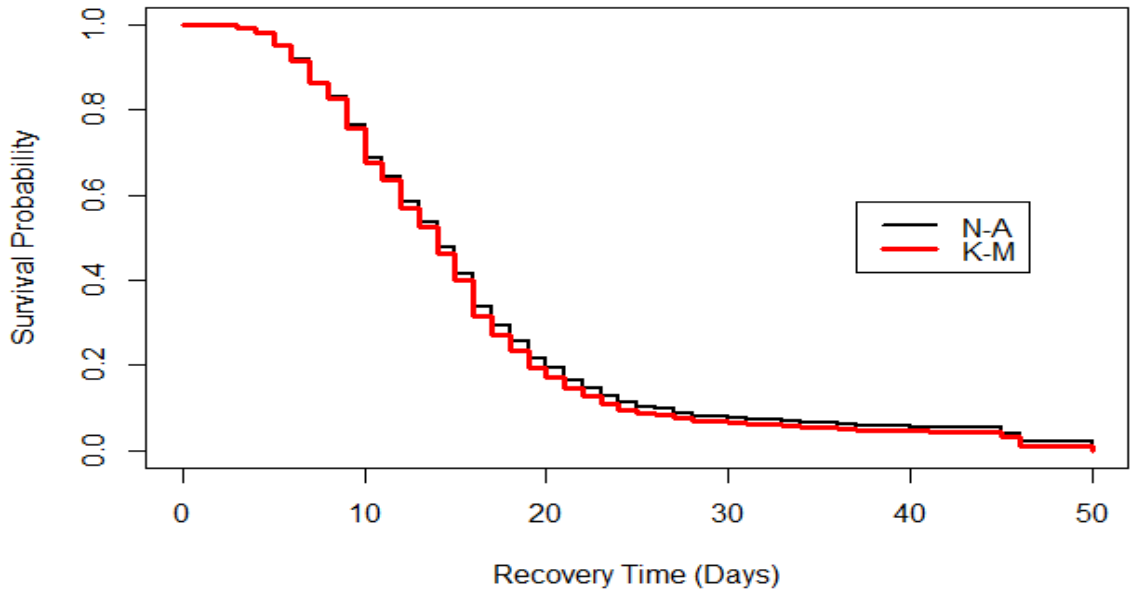

Figure 1: Nelson- Aalen and Kaplan- Meier Curve of infected population

K-M estimators of survival probabilities of virus among male and female infected populations are tracked in Figure 2.

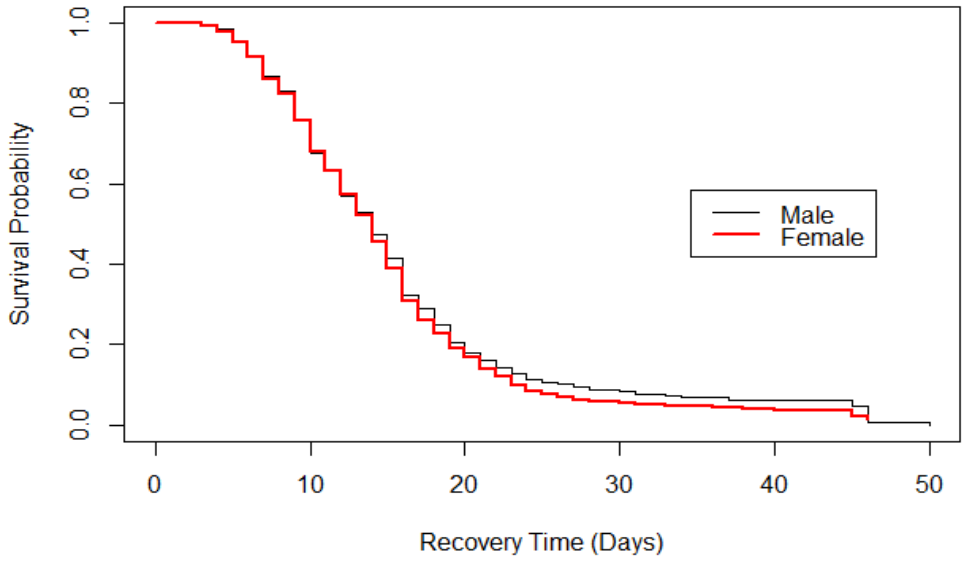

Figure 2: Kaplan- Meier curve of male and female infected population

In individuals older than 60 years, other co-morbid conditions such as hypertension, diabetes, respiratory conditions and other chronic illnesses contribute to their overall health. Study of COVID-19 pandemic belonging to this part of the population deserves a separate consideration. K-M estimators of survival probabilities of SARS-COV-2 virus in male and female infected people aged 60 and more are plotted in Figure 3.

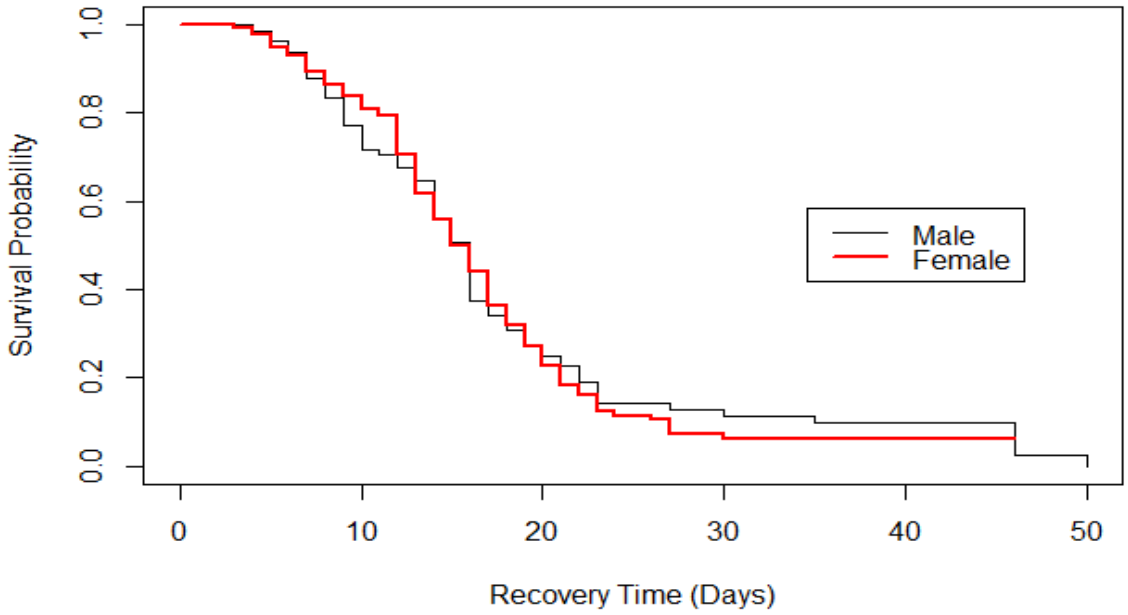

Figure 3: K-M estimator for age 60 and more

Also, the survival analysis of the virus using recovery times of COVID-19 patients who were asymptomatic, with ILI and with SARI in made Figure 4.

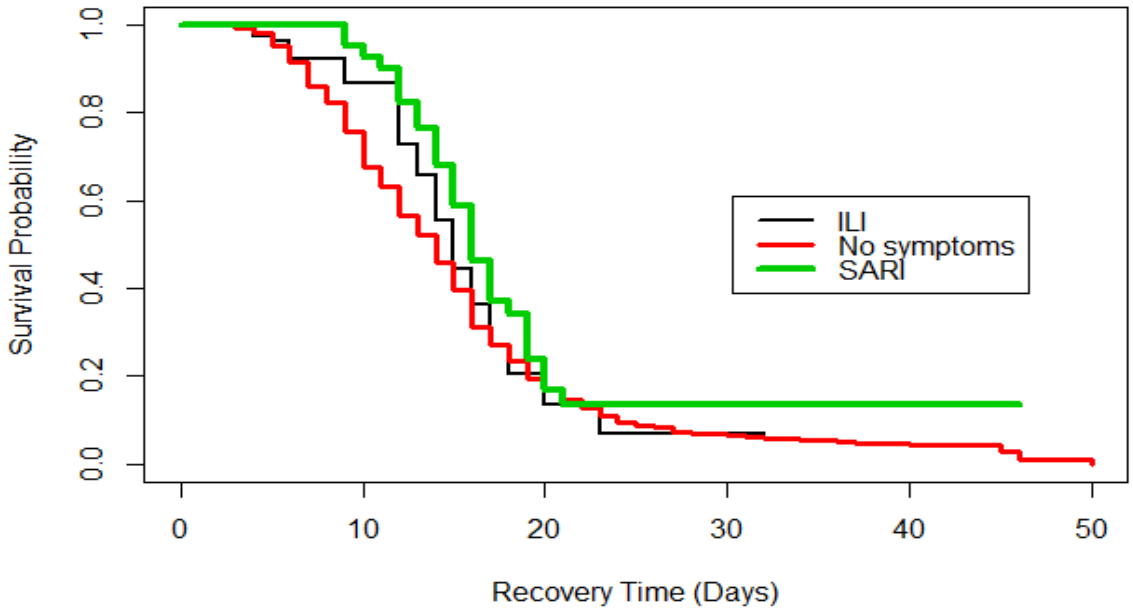

Figure 4: K-M estimator of patients with initial symptoms

Table 2 presents the numbers of recovered and median times of recovery along with 95% confidence intervals (CI) for total infected, male, female, infected aged ≥60, infected males aged ≥60 and infected females aged ≥60. Similar figures for COVID-19 patients who have no symptoms, with SARI and ILI are given in Table 3.

Table 2: Median Recovery Time of Infected Population

	Total Infected	**Total Recovered**	**Median Time (95% CI) in days**
Total infected	7153	3969	14 (14-14)
Male	4464	2522	14 (14-14)
Female	2689	1447	14 (14-14)
Total infected age ≥60	429	208	16 (14-16)
Male infected age ≥60	247	116	15 (14-17)
Female infected age ≥60	182	92	16 (14-16)

Table 3: Median Recovery Time of asymptomatic, SARI and ILI patients

Initial Symptoms	**Total Infected**	**Total Recovered**	**Median Time (95% CI) in days**
Asymptomatic	6898	3914	14 (14-14)
SARI	99	29	16(15-19)
ILI	156	26	15 (14-18)

DISCUSSION

From Figure 1, it can be seen that the difference of survival probabilities using two methods are negligible during early days of infection. But for later days of infection, N-A estimators have smaller standard errors, of course, there will be very few cases with greater recovery times. From

Figure 2, it can be concluded that females are recovering faster than males and to confirm this, further investigation is required with the consideration of other factors. Recovery times of all infected aged 60 and more, males and females is found to be more both with respect to survival probability and median recovery times. Also, the recovery times of patients admitted with ILI is more than compared to patients tested positive and the recovery times of SARI patients is the highest.

CONCLUSION

With this study one can conclude that aged people have longer durations of recovery times. Recovery times of ILI and SARI patients are more. Median times of recovery vary for different populations. The difference may be explained by the differences of number of infected, severity of infection, health parameter, climatic conditions, time gap between infected and hospitalization. Tracking the virus survival with consideration of these factors might give correct insight into analysis of median time of recovery. The inferences drawn from this study are factual as the analysis is carried with the truncation of outlier variables (recovery times less than 2 days) and censoring of impertinent cases like deaths of COVID-19 patients, and also the patients under treatment.

ACKNOWLEDGMENT

The first author is thankful to Department of Science and Technology-Innovation in Science Pursuit for Inspired Research (DST-INSPIRE) for financial support.

REFERENCES

1. Mishra V, Burma AD, Das SK, Parivallal MB, Amudhan S, Rao GN. COVID-19-Hospitalized Patients in Karnataka: Survival and Stay Characteristics. Indian Journal of Public Health. 2020 Jun 1;64(6):221.
2. Thai PQ, Dinh TS, Van Hoang TH, Luu NM, Hung LX, Luu NH, Duong HL, Luong NK, Nguyen TK, Le TH. Factors associated with the duration of hospitalization among COVID-19 patients in Vietnam: A survival analysis. Epidemiology & Infection. 2020 Jun 10:1-20.
3. Ji JS, Liu Y, Liu R, Zha Y, Chang X, Zhang L, Zhang Y, Zeng J, Dong T, Xu X, Zhou L. Survival analysis of hospital length of stay of novel coronavirus (COVID-19) pneumonia patients in Sichuan, China. medRxiv. 2020 Jan 1.
4. Rees EM, Nightingale ES, Jafari Y, Waterlow NR, Clifford S, Pearson CA, Jombart T, Procter SR, Knight GM, CMMID Working Group. COVID-19 length of hospital stay: a systematic review and data synthesis.

5. Kaplan EL, Meier P. Nonparametric estimation from incomplete observations. Journal of the American statistical association. 1958 Jun 1; 53(282):457-81.
6. Aalen O. Nonparametric inference for a family of counting processes. The Annals of Statistics. 1978 Jul 1:701-26.
7. COVID-19 Information Portal, Govt. of Karnataka (https://covid19.karnataka.gov.in/) [Last Accessed June 15, 2020]