

Estimation of Survival Probability of Patients with COVID-19 Based on Information of Patients

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INTRODUCTION

The coronavirus, responsible for COVID-19, belongs to a large family of viruses ranging from those causing the common cold to those responsible for SARS (1). COVID-19 typically results in cold-like symptoms and, in some cases, acute respiratory syndrome (2-3). Symptoms in humans include fever, cough, shortness of breath, and loss of smell and taste (2-3). The most severe form of this disease is pneumonia, with affected patients typically experiencing shortness of breath around five days after symptom onset,

Background: In medical science, the probability of survival is a crucial index used to assess patient outcomes. This study aims to estimate the survival probability of patients diagnosed with COVID-19.

Materials and Methods: In a historical cohort study, the Kaplan-Meier method was used to assess the survival probability of 4,372 COVID-19 patients treated at Dr. Masih Daneshvari Hospital in Tehran during the pandemic.

Results: The study results indicated that 199 patients (4.6%) died during the treatment, while 4,173 patients (95.4%) were censored. The daily survival probability estimation for COVID-19 patients revealed that the highest and lowest survival probabilities within 100 days from disease onset were 96% and 55%, respectively. Additionally, the survival probabilities on the 20th, 50th, 70th, and 90th days from the onset of disease and treatment were 92%, 70%, 63%, and 61%, respectively.

Conclusion: Estimating the survival probability of COVID-19 patients offers clinicians valuable insights into mortality rates and the effectiveness of common therapeutic strategies in treating the disease.

Keywords: COVID-19 disease; Probability of survival; Mortality rate; Kaplan-Meier method

and 4% developing acute respiratory syndrome (3-4). Generally, about 85% of COVID-19 patients experience mild to moderate symptoms, while approximately 15% develop severe symptoms (4-5). Numerous uncertainties remain regarding COVID-19, with many aspects still unclear to researchers (4, 6). Despite the development of various medications and treatment methods since the outbreak began in China and its subsequent global spread, none have yet been established as definitive treatments for COVID-19 (7- 10). Lack of effective treatments has

contributed to an increase in mortality rates (11-12). Although there have been conflicting reports about COVID-19 mortality rates since the pandemic's onset, many studies indicate that the death rate exceeds 10%, with thousands of deaths occurring daily worldwide (11, 13). Understanding patient survival is crucial given the challenges in treating COVID-19 patients and the rising global mortality rates (14-15).

The survival rate or probability is a key metric for estimating the chances of survival for patients with diseases like COVID-19. This metric reflects the effectiveness of treatment methods in improving patient outcomes and serves as a criterion for evaluating the success of COVID-19 therapies. Estimating the survival probability from various perspectives provides clinicians with valuable insights into mortality and the efficacy of common treatment strategies for COVID-19. Despite all the advantages of assessing the survival probability of COVID-19 patients, most studies have predominantly focused on infection and mortality rates. Consequently, there is a scarcity of research on patient survival (6, 14-17).

To evaluate the effectiveness of treatment methods in improving patient outcomes and reducing mortality, it is essential to focus on the event of death and the survival time of these patients. Therefore, this study aims to estimate the survival probability of COVID-19 patients using data from those referred to Dr. Masih Daneshvari Hospital in Tehran.

MATERIALS AND METHODS

In this retrospective cohort study, we analyzed data from 4,372 COVID-19 patients who were treated at Dr. Masih Daneshvari Hospital during the pandemic. The study period began at diagnosis and treatment initiation, with death as the primary event. Patient follow-up involved collecting time-to-death data from clinical records, and for those discharged without a death record, follow-up was conducted via phone call. Patients who were alive at the study's end with no further information were considered censored. The Kaplan-Meier method was employed to estimate survival probability, with a

significance level of 5%. All analyses were performed using STATA version 14 software.

RESULTS

The study results indicated that out of 4,372 COVID-19 patients, 199 (4.6%) died during treatment, while 4,173 (95.4%) were censored. The daily survival probability estimation revealed that the highest and lowest probabilities within 100 days from disease onset were 0.96 and 0.55, respectively. In other words, 96% of patients survived 10 days from disease onset, and 55% survived 100 days (Table 1).

Table 1. Estimating the Survival Probability of COVID-19 Patients referred to Dr. Masih Daneshvari Hospital in Tehran

Time (days)	Estimating the Survival Probability of COVID-19 Patients	95% Confidence Interval
10	0.96	0.95-0.97
20	0.92	0.91-0.93
30	0.88	0.86-0.90
40	0.82	0.76-0.84
50	0.71	0.65-0.75
60	0.65	0.59-0.71
70	0.63	0.56-0.69
80	0.62	0.53-0.67
90	0.61	0.49-0.64
100	0.55	0.42-0.59

The estimated survival probabilities for COVID-19 patients on the 20th, 50th, 70th, and 90th days from disease onset and treatment are 92%, 70%, 63%, and 61%, respectively. Consequently, as time progresses, the survival probability decreases while the mortality probability increases. The mortality probabilities on the 10th, 30th, 50th, 70th, and 90th days are 4%, 12%, 30%, 37%, and 39%, respectively. Ultimately, within 100 days from disease onset and treatment, the mortality probability is approximately 45%. In addition to estimating patient survival probabilities, this study graphically presents the survival trends of COVID-19 patients in Figure 1. This graph illustrates a decreasing trend in survival probability over 100 days from disease onset and treatment initiation. This decline is steep until around 50 days, after which the

rate of decrease slows. On average, the survival probability decreases by 0.45% per day, reaching approximately 55% within 100 days (Figure 1).

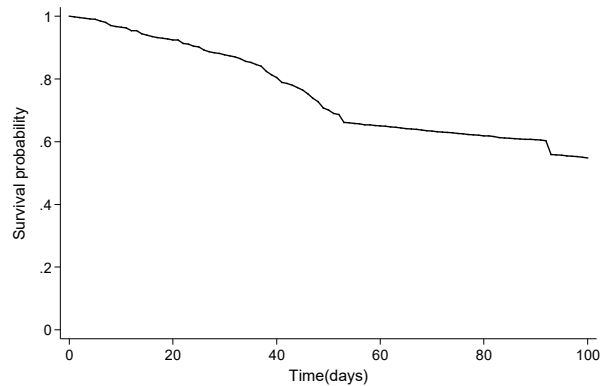


Figure 1. Survival Probability of COVID-19 Patients at Dr. Masih Daneshvari Hospital in Tehran Using the Kaplan-Meier Method

DISCUSSION

With the global spread of COVID-19, numerous indicators related to the disease have garnered attention (18). Infection and mortality rates have been widely reported and recommended for monitoring the status of COVID-19 in various countries (16, 18). However, the absence of effective treatments and the rising mortality rates have underscored the importance of patient survival (14-15). Efforts to treat the disease, develop vaccines, and implement extensive social restrictions have primarily aimed to control the disease burden, reduce mortality, and ultimately enhance patient survival (3, 9 -10, 19). Despite the critical importance of patient survival in COVID-19, few studies have been conducted to estimate this index (14-15). Most research has focused on patient mortality and the case-fatality rate of this disease (12-13, 20). At first glance, mortality indicators like the case-fatality of COVID-19 may seem more significant than survival indicators such as the probability of survival. However, studying and estimating patient survival offers distinct advantages. Firstly, estimating the survival probability allows for the straightforward calculation of the death probability due to COVID-19. Secondly, while the case-fatality index provides a snapshot of the death probability at a single point in time, survival studies enable the estimation of survival

probability over the entire study period. Thus, it is possible to study the survival probability of COVID-19 patients during the disease and treatment. Additionally, the survival probability index can provide valuable insights into the effectiveness of treatment methods and serve as a criterion for evaluating COVID-19 treatment strategies.

Given the importance of patient survival, this study estimated the survival probability of patients treated at Dr. Masih Daneshvari Hospital in Tehran using the Kaplan-Meier method. The study results indicated that the survival probability of COVID-19 patients was 96% at 10 days and 55% at 100 days from disease onset and treatment initiation. The estimated survival probabilities at 20, 50, 70, and 90 days were 92%, 70%, 63%, and 61%, respectively. Similar estimates have been reported in other studies on COVID-19 patient survival (14-15, 21). These studies have examined the survival probability of patients over a period of approximately 35 to 50 days. According to their results, the survival probability of COVID-19 patients at 15 and 30 days from disease onset and treatment is estimated to be around 89% and 78%, respectively.

The lowest survival probabilities reported for 35 and 50 days are approximately 75% and 60%, respectively (14-15). Our study found that the survival probability of COVID-19 patients decreases by 0.45% daily over 100 days from disease onset, and by 0.70% daily over the first 50 days. Other studies report an average daily decrease of 0.80% in survival probability over 50 days (14, 21). Comparing our results with these studies, the survival probability of patients at Dr. Masih Daneshvari Hospital in Tehran is similar to that of other patients globally. This suggests that the treatment protocols and strategies employed at our hospital are as effective in improving patient survival as those used in other medical centers worldwide.

CONCLUSION

In conclusion, studying the survival of COVID-19 patients offers comprehensive insights for treatment and mortality reduction. It serves as a valuable indicator for

evaluating the effectiveness of COVID-19 treatment strategies.

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