



## Predictors of ICU Length of Stay in Patients with COVID-19: A Retrospective Study

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### Abstract

**Background.** The available evidence has made the long-term accompaniment of COVID-19 and its other variants with human life predictable. Different studies have proposed different and, in some cases, contradictory findings as factors determining the duration of hospitalization of patients with COVID-19. The present study aimed to identify the factors related to the duration of ICU length in patients with COVID-19.

**Methods.** The present study retrospectively analyzed the data related to patients aged 1 to 97 years with COVID-19 registered in Isfahan's COVID-19 registration system. The data of those patients with COVID-19 who were alive at the time of discharge (n=453) were analyzed in the present study. Information related to laboratory findings, clinical data, and co-morbidities were collected. T-test, correlation, and analysis of variance tests were used in crude analysis. The linear regression model was used to determine the factors related to the ICU length and their importance.

**Results.** The mean (SD) of intensive care unit days was 0.64 (2.39). Higher than normal values of INR, hemoglobin, and creatinine increased the average length of stay in ICU by 2.45 (p=0.001), 3.82 (p <0.001), and 0.72 (p <0.001) days, respectively. Among underlying co-morbidities, the presence of other respiratory diseases significantly increased the average length of stay in the ICU by 1.5 days (p=0.024). Standardized regression coefficients also showed that higher-than-normal hemoglobin and increased WBC values were the most important variables predicting ICU hospitalization length.

**Conclusion.** The higher-than-normal values of hemoglobin and increased WBC values are the most important predictors of the length of hospitalization in the ICU. The findings of the present study can be helpful in the decision-making of specialists to reduce the duration of hospitalization in the ICU and to help diagnose more critical cases.

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## Extended Abstract

### Background

The health, economic, and social consequences of the coronavirus (COVID-19) pandemic were considerable worldwide. So far, more than 6,900,000 deaths caused by COVID-19 and its variants have been confirmed.

Hospitalization of COVID-19 patients in the intensive care unit (ICU) can impose a significant psychological and economic burden on patients, families, and the health system. However, several patients need hospitalization in the ICU, and their treatment may include long-term use of ventilators, corticosteroids, and neuromuscular blockers. Literature has proposed various co-morbidities as factors that increase the probability of hospitalization in these patients.

Identifying the factors associated with the ICU hospitalization length in COVID-19 patients can help decision-making and diagnose more critical cases. This study aimed to identify the factors related to the length of ICU stay in COVID patients.

### Methods

The present study retrospectively analyzed the data related to patients registered in I-CORE in Isfahan until May 2021. The study design, sampling method, and data collection details have been published in another article. The study was approved by the Research Ethics Committee of Isfahan University of Medical Sciences (IR.MUI.MED.REC.1398.733).

### Study Population

The present study analyzed the data of COVID-19 patients who were discharged while still alive. Discharge conditions were as follows:

- 1) three-day normalization of body temperature
- 2) lung imaging showing reduced inflammation
- 3) significant respiratory symptom improvement

### Data Collection

#### Laboratory Findings

Information on routine blood tests, including complete blood count, lymphocyte percentage, neutrophil percentage, blood glucose, blood urea

nitrogen (BUN), total bilirubin, activated partial thromboplastin time (aPTT), prothrombin time (PT), alanine aminotransferase (ALT), aspartate aminotransferase (AST), international normalized ratio (INR), creatinine, C-reactive protein (CRP), hematocrit, hemoglobin (HB), sodium, K, lactic acid dehydrogenase, platelets, and WBC were collected. The AST/ALT ratio and the categories for all the above blood indices (normal, <normal, and >normal values) were calculated using the available information.

### Clinical Data

Clinical data were collected at the time of admission to the hospital. Clinical signs and symptoms were recorded, including cough, fever, muscle pain, decreased consciousness, and respiratory distress. Data on co-morbidities such as diabetes, cardiovascular disease, neurological disorder, asthma, cancer, HIV/AIDS, chronic blood disease, chronic liver disease, chronic kidney disease (CKD), other lung diseases, and immunodeficiency were collected. Fever was defined as axillary temperature  $>37^{\circ}\text{C}$  or oral temperature  $>37.5^{\circ}\text{C}$  using digital thermometers.

### Analysis

Quantitative variables were reported as mean and standard deviation and qualitative variables were reported as frequency and percentage. The distribution of quantitative variables was investigated using normality tests. The study conducted a bivariate analysis to investigate the raw relationship between the variables and the duration of ICU hospitalization. The linear regression model was used to investigate the relationship between the study variables and the ICU hospitalization duration. VIF test was used to check the multicollinearity of predictor variables. A significant level of 5% was considered. All the tests were done using Stata software version 14.

### Results

The present investigation assessed 453 individuals discharged after recovering from COVID-19. The mean (SD) age was 57.1 (16.9) years. The mean (SD) number

of ICU hospitalization days was 0.64 (2.39). 57.62% of patients were male. In the crude analysis among the clinical variables, the history of other lung diseases ( $p=0.004$ ) along with the presence of respiratory distress ( $p<0.001$ ) significantly increased the average number of days hospitalized in the ICU by 2 and 0.77 days, respectively (Table 1).

As shown in Table 2, values higher than normal INR ( $p<0.001$ ), ALT ( $p=0.024$ ), AST ( $p<0.001$ ), neutrophil ( $p<0.001$ ), lymphocytes ( $p<0.001$ ), BUN ( $p<0.001$ ), creatinine ( $p<0.001$ ), WBC ( $p<0.001$ ), blood sugar ( $p=0.05$ ) and PT ( $p=0.047$ ) showed a statistically significant relationship with the number of days hospitalized in ICU.

Table 3 shows the adjusted associations between the variables and the ICU hospitalization duration after considering the role of other potential confounding variables. This table also presents the standardized values of the regression coefficient. As shown, among the laboratory variables, higher-than-normal values of INR, hemoglobin, and creatinine increased the average duration of ICU hospitalization by 2.45 days ( $p=0.001$ ), 3.82 days ( $p<0.001$ ), and 0.72 days, respectively ( $p<0.001$ ). Among the primary signs and symptoms, respiratory distress significantly increased the average

length of ICU stay. Among underlying patients, other respiratory diseases significantly increased the average length of stay in the ICU by 1.5 days ( $p=0.024$ ). Standardized regression coefficients also showed that higher-than-normal hemoglobin and WBC values were the most important variables predicting the ICU hospitalization duration.

## Conclusion

Higher-than-normal hemoglobin and WBC values are the most important variables predicting the ICU hospitalization duration. The findings of the present study can be helpful in the decision-making to reduce the duration of hospitalization in the ICU and to help diagnose more critical cases. While the existing literature has not directly addressed the relationship between INR, hemoglobin, and ICU length of stay for COVID-19 patients, the present study adds valuable information to the existing body of knowledge in this area. Further research is needed to confirm and extend the present findings and investigate the potential mechanisms underlying the observed association between these laboratory variables and ICU length of stay for COVID-19 patients.