Caspian J Intern Med 2020; 11(Suppl1): S512-519
DOI: 10.22088/cjim.11.0.512

Original Article

COVID-19 and ICU admission associated predictive factors in Iranian patients

Amir Sadeghi (MD) [1]
Pegah Eslami (MD) [1]
Arash Dooghaie Moghadam (MD) [1]
Ali Pirsalehi (MD) [1]
Sajad Shojaee (MD) [2]
Mohammad Vahidi (MD) [1]
Amirali Soheili (MD) [1]
Faezeh Ghanimat (MD) [1]
Yasaman Keshmiri (MD) [1]
Saeed Abdi (MD) [1]
Mohammad Reza Zali (MD) [1 *]

1. Gastroenterology and Liver Diseases Research Center, Research Institute for Gastroenterology and Liver Diseases, Shahid Beheshti University of Medical Sciences, Tehran, Iran
2. Basic and Molecular Epidemiology of Gastrointestinal Disorders Research Center, Research Institute for Gastroenterology and Liver Diseases, Shahid Beheshti University of Medical Sciences, Tehran, Iran

*** Correspondence:**
Mohammad Reza Zali,
Gastroenterology and Liver Diseases Research Center, Research Institute for Gastroenterology and Liver Diseases, Shahid Beheshti University of Medical Sciences, Tehran, Iran

E-mail: nnzali@hotmail.com
Tel: 0098 2122663593
Fax: 0098 2122663593

Received: 30 May 2020
Revised: 20 July 2020
Accepted: 15 Aug 2020

Abstract

Background: The pandemic situation created an overwhelmed needs for ICU facilities, according to this problem, the need of accurate management of facilities represents boldness. In this study, prognostic risk factors for ICU admission among COVID-19 hospitalized patients were evaluated.

Methods: From 22 February to April 20, 2020. A total of 214 COVID-19 patients participated in this study. The included patients were between 18- 80 years old, and the patients who previously admitted for COVID-19 were excluded. The comorbid medical conditions, admission laboratory, demographic data, and first manifestations were analyzed between two groups, including ICU and non-ICU admitted patients. The statistical analysis, univariate and multivariate analysis were afforded. The value of the predictors in the risk assessment of ICU admission was estimated.

Results: 55(25.7%) patients were admitted in ICU. The ICU admitted patient's mortality rate was about 68%. The age was significantly higher among ICU admission group (P=0.03). Admission O2 saturation was significantly lower among ICU admitted patients (P=0.00). The kidney disease and malignancy history were more frequent in ICU-admitted patients (P=0.04, P=0.00). Myalgia was the clinical manifestation that significantly presented more frequent in ICU-admitted patients. INR, CRP, ESR, HB, and lymphocyte were significantly different between two groups. After multivariable analysis, admission O2 saturation, hematocrit, CRP and myalgia could significantly predict the risk of ICU admission. Furthermore, the value of predictors was estimated in our study.

Conclusion: Based on our results, the admission O2 saturation, HCT, CRP levels at first admission and myalgia presentation could be considered as the valuable predictors of ICU admission.

Keywords: ICU admission, COVID-19, Prognostic factors.

Citation:
Sadeghi A, Dooghaie Moghadam A, Eslami P, et al. COVID-19 and ICU admission associated predictive factors in Iranian patients. Caspian J Intern Med 2020; 11(Suppl 1): S512-519.

The world is experiencing the new respiratory viral disease associated with the 7th member of the coronavirus family, is which known today as COVID-19 (1, 2). In December 2019, local hospitals in Wuhan City, China, reported several cases of new unknown pneumonia. New cases of COVID-19 continued to exponentially rise and this disease spread all around the world and created a new pandemic (2-4). As of July 9, 2020, more than 11,870,000 confirmed cases and approximately 550,000 deaths were recorded worldwide according to the 171th report of WHO(5) . Moreover, studies have shown that the infection fatality ratio is about 0.66% in COVID-19 (6). While the majority of COVID-19 patients had a self-limited type of disease, 1 in 5 COVID-19 patients over 80 years old required hospital care (6). Also, hospital care requirements in other age categories varied from 0.04% to 16.6% in 10-years-old and 70-years-old people, respectively (6). Thus, according to the

severe contagious nature of this disease, increasing demand for hospital beds and care is not unexpected (7).

The requirement of intensive care among COVID-19 hospitalized patients varies between countries from 5% to 32% (8). In some studies, it has been reported that many factors including age, sex, and comorbidities are associated with the severity of disease and ICU admission (8, 9). According to these studies, severe disease is accompanied by acute kidney injury, acute respiratory distress syndrome (ARDS), myocarditis shock cardiac, and septic shock. Hence, ICU admission plays a crucial role in the care of COVID-19 patients and also is effective in decreasing the mortality rate (8-10).

Currently, our ICU resources are limited and typically more than 50% of its capacity is full under normal conditions (11). Therefore, in emergency conditions such as the COVID-19 pandemic, we encountered a lack of capacity (7). Under this condition, we have to focus more on distinguishing critical patients to save more ICU capacity and classify ICU-needed from non-ICU-needed patients (7). To achieve this goal, it is vital to identify the factors related to ICU admission and those that are significantly different between ICU and non-ICU admitted COVID-19 patients. Previously, the first admission day laboratory data were commonly used in the case of other diseases, forecasting would need ICU admission and more care during hospitalization (12). To the best of our knowledge, the factors associated with ICU admission in COVID-19 patients have only been discussed in few studies until now.

Hence, the present study was conducted to investigate COVID-19 admitted patients in Taleghani hospital to identify the first admission day laboratory data and other associated factors that have a relationship with ICU admission and help classify patients from the first admission day.

Methods

Design and subjects: This observational, retrospective, single study was carried out in Taleghani Hospital, a territory center in Tehran, affiliated by Shahid Beheshti University of Medical Sciences, Tehran, Iran, from 22nd of February to the 20th of April, 2020. A total of 214 COVID-19 positive patients participated in this work. In this study, COVID-19 positive patients were recognized based on SARS-COV-2 nucleic acid RT-PCR using the oropharyngeal sputum and swab samples. Patients who were less than 18 years old or more than 80 years were excluded. Also, patients who were previously admitted to other hospitals for COVID-19 were excluded from the study. The data collection was based on the patients' electronic medical records. All patients were followed-up in detail until 20 April by trained researchers. The patients participated in two groups of ICU admission and non ICU admission. In this study, written informed consent was obtained from all the subjects. The study was approved by the Ethics Committee of Shahid Beheshti Medical University (Code:IR.SBMU.RETECH.REC.1399.114) based on the World Medical Association's Declaration of Helsinki regarding human studies.

Data collection and definitions: The chest computerized tomography (CT), comorbid medical conditions, laboratory, demographic data, and first signs and symptoms of all participants were gathered. All those tests were performed on the first day of admission. The first-day admission was determined as day 0. All laboratory samples were examined with the same standards. Our laboratory panel included complete blood cell counts, blood coagulation function, blood biochemistry including liver functional tests, C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR). The patients were followed up from admission to discharge. Moreover, the occurrence of death or survival and the requirement of treatment in ICU during the hospitalization were recorded for all patients. All data collections were compared between two groups of ICU admitted and non-ICU admitted patients.

Statistical Analysis: Categorical variables were reported as percentages and continuous variables with mean±SD. To identify risk factors for ICU admission, univariate logistic regression was used. Also, multivariate analyses were carried out after selecting the best model by AIC criteria, using the following parameters: the comorbid medical conditions, admission laboratory, demographic data, and first manifestations of all participants. The accuracy of significant risk factors for predicting ICU admission was evaluated based on ROC curves. The area under the ROC curve (AUROC) was calculated with 95% confidence intervals (CI). SPSS, version 23.0 and R, version 3.6.3 were conducted for statistical analysis.

Results

From 22 February to 20 April, 214 patients with the suspicious manifestations of COVID-19 and positive CT-scan or PCR-test were admitted. Among these patients, 159 (74.30%) were only admitted in emergency rooms or ward, and about 55 (25.70%) of them had the ICU admission experience during their hospitalization. The mean age of our patients was 58.14±16.99 years, and 55% of hospitalized patients were males.

Cardiovascular diseases and hypertension were the most frequent underlying disorder among our patients (26% and 22%, respectively). Dyspnea, fever, and coughs were the most common signs and symptoms among the admitted patients (45.73%, 44.8%, and 41.25%, respectively). Other laboratory data, co-morbidities, and signs and symptoms are reported in table 1. Finally, the mortality rate in all study population was about 23.83%. The mortality rate in ICU admission group was 68%.

Demographic and laboratory data in non-ICU admitted group and ICU-admitted group: The mortality rate in the ICU-admitted and non-ICU patients was about 69.09 and 10.69%, respectively. The mean age of the patients in the non-ICU admission group and ICU admission group was 56.70±17.14 and 62.33±15.99 years, respectively. About 41.50% and 54.54% of the patients in the non-ICU and ICU admission groups were males. Also, 12.5% of non-ICU admission cases and 3.63% of ICU admission patients were smokers. The mean admission O2 saturation in the non-ICU and ICU admission groups was 90.41±6.27 and 86.08±9.79, respectively.

The mean heart rate and respiratory rate among non-ICU admitted groups were respectively 86.63±13.92 and 2.84±0.24 beats/per minute. In ICU admitted patients, these values were respectively 91.17±17.94 and 3.37±0.49 beats/ per minute. Diabetes, as a co-morbidity was detected in 25.45% of ICU admitted patients; however, 15.47% of non-ICU admission groups represented DM. About 12.72% and 7.73% in ICU admission and non-ICU admission groups reported previous underlying pulmonary disorder, respectively.

Moreover, 23.63% and 8.92% of ICU admission and non-ICU admission patients confirmed a positive history of cancer, respectively.

Myalgia prevalence in non-ICU admission and ICU admission groups were 41.07% and 12.72%, respectively. The mean range of INR in non-ICU admission and ICU admission groups were 1.28±0.51 and 1.60±0.95, respectively. The mean CRP in the ICU admission group and non-ICU cases was 56±54.88 and 39.90±43.09 respectively. The complete prevalence of other parameters is presented in table 2 for each group.

Table 1. Characteristics of patients with COVID-19 infection admitted to the hospital.

characteristics	
Age	58.14±16.99
Sex(male)	55%
smoking	10.3%
Admission O2 saturation	89.28±7.56
Heart rate (beats per minute)	87.79±15.13
Respiratory rate (breaths per minute)	18.13±2.98
Admission SBP 1 (mmhg)	122.83±21.29
Admission DBP 2(mmhg)	76.24±11.55
kidney disease (any)	9.4%
Pulmonary disease (any)	9%
Cardiovascular disease	26%
Diabetes	17.9%
Positive history of cancer	12.6%
Hypertension	22%
Fever	44.8%
Myalgia	34.08%
dyspnea	45.73%
Cough	41.25%
Chest pain	15.69%
Diarrhea	17%
Blood Urea Nitrogen (BUN) (mg/dl)	24±22.54
sodium(mmol/L)	138.39±3.50
potassium(mmol/L)	4.12±0.54
Troponin (ng/mL)	0.79±5.27
CK-MB3(IU/L)	33.33±69.14
LDH4 (units/L)	654.89±420.04
INR5	1.37±0.67
PT6(sec)	14.17±3.92
PTT7(sec)	37.12±15.31
Creatinine (mg/dL)	33.00±1.66
CRP8 (mg/L)	44.40±47.09
ESR9(mm/hr)	36.31±24.43
Hemoglobin (g/dl)	10.99±2.57
HCO3 (mmol/L)	23.99±5.65
Hematocrit	33.61±7.38
White blood cells count (*10^9 cells/L)	7.21±4.07
Lymphocyte count (*10^9 cells/L)	1.28±0.87
Monocyte count (*10^9 cells/L)	0.43±0.37
Neutrophil count (*10^9 cells/L)	5.42±3.46
Platelet (x 109 cells/L)	200.47±101.64
Red blood cell count (million/mm3)	4.39±6.21
Influenza vaccination	5.4%

[1] admission systolic blood pressure, [2] admission diastolic blood pressure, [3] Creatine kinase-MB [4] Lactate Dehydrogenase, [5] International Normalized Ratio (for blood clotting time), [6] prothrombin time, [7] Partial thromboplastin time, [8] C-reactive protein, [9] erythrocyte sedimentation rate

Table 2. Factors related to ICU admission, univariate analysis.

characteristics	No ICU admission(N=159)	ICU admission (N=55)	OR	95% CI	P value
Age	56.70±17.14	62.33±15.99	1.02	1.00-1.04	0.03
Sex(male)	41.50%	54.54%	0.59	0.31-1.09	0.09
smoking	12.5%	3.63%	0.26	0.06-1.16	0.07
Admission O2 saturation	90.41±6.27	86.08±9.79	0.93	0.89-0.97	0.00
Heart rate (beats per minute)	86.63±13.92	91.17±17.94	1.02	0.99-1.04	0.06
Respiratory rate(breaths per minute)	2.84±0.24	3.37±0.49	1.01	0.90-1.13	0.82
Admission SBP1 (mmhg)	123.58±16.30	120.73±31.54	0.99	0.97-1.00	0.39
Admission DBP2(mmhg)	10.19±0.81	15.02±2.08	1.00	0.97-1.02	0.99
kidney disease (any)	7.14%	16.36%	2.54	1.00-6.41	0.04
Pulmonary disease (any)	7.73%	12.72%	1.73	0.65-4.60	0.26
Cardiovascular disease	25%	29.09%	1.23	0.62-2.42	0.54
Diabetes	15.47%	25.45%	1.86	0.89-3.89	0.09
Positive history of cancer	8.92%	23.63%	3.15	1.39-7.15	0.00
Hypertension	19.04%	30.90%	1.90	0.95-3.78	0.06
Fever	45.83%	41.81%	0.84	0.45-1.57	0.60
Myalgia	41.07%	12.72%	0.20	0.08-0.49	0.00
dyspnea	44.04%	50.90%	1.31	0.71-2.42	0.37
Cough	40.47%	45.45%	1.13	0.61-2.10	0.68
Chest pain	18.45%	7.27%	0.34	0.11-1.03	0.05
Diarrhea	18.45%	12.72%	0.64	0.26-1.55	0.33
Blood Urea Nitrogen (BUN) (mg/dl)	22.80±22.34	30.17±22.43	1.013	1.00-1.026	0.04
Sodium (mmol/L)	138.55±3.65	137.92±2.98	0.95	0.86-1.04	0.27
Potassium (mmol/L)	4.10±0.57	4.19±0.45	1.39	0.75-2.54	0.28
Troponin (ng/mL)	0.81±5.75	0.74±4.05	0.99	0.95	0.92-1.07
CK-MB3 (IU/L)	81.16±8.70	14.92±2.52	0.99	0.98-1.00	0.40
LDH4 (units/L)	623.26±383.10	726.85±491.71	1.00	1.00-1.001	0.20
INR5	1.28±0.51	1.60±0.95	1.91	1.12-3.26	0.01
PT6(sec)	13.81±3.13	15.12±5.41	1.07	0.99-1.16	0.06
PTT7(sec)	36.06±12.30	39.92±21.20	1.01	0.99-1.03	0.15
Creatinine (mg/dL)	1.70±3.27	1.55±1.08	0.98	0.86-1.11	0.75
CRP8(mg/L)	39.90±43.09	56±54.88	1.00	1.00-1.01	0.04
ESR9(mm/hr)	24.19±2.09	24.18±3.45	1.01	1.00-1.02	0.03
Hemoglobin (g/dl)	11.34±2.44	9.22±2.65	0.80	0.71-0.91	0.00
HCO3(mmol /L)	24.06±5.10	23.79±6.95	0.99	0.93-1.05	0.77
Hematocrit	34.72±6.86	30.26±7.91	0.92	0.88-0.96	0.00
White blood cells count (* 10^9 cells/L)	7.18±3.90	7.34±4.60	1.00	0.97-1.03	0.91
Lymphocyte count (* 10^9 cells/L)	1.28±0.66	1.26±1.42	0.95	0.91-0.99	0.02
Monocyte count (* 10^9 cells/L)	0.41±0.26	0.55±0.69	1.06	0.98-1.16	0.13
Neutrophil count (* 10^9 cells/L)	5.12±3.20	6.47±4.10	1.02	0.99-1.05	0.11
Platelet (* 109 cells/L)	205.50±95.24	185.48±118.45	0.99	0.99-1.001	0.22
Red blood cell count (million/mm3)	4.66±7.13	3.58±1.05	0.57	0.40-0.80	0.00
Influenza vaccination	5.95%	3.63%	0.59	0.12-2.80	0.51

[1]admission systolic blood pressure, [2] admission diastolic blood pressure, [3] Creatine kinase-MB, [4] Lactate Dehydrogenase, [5] International Normalized Ratio (for blood clotting time), [6] prothrombin time, [7] Partial thromboplastin time, [8] C-reactive protein, [9] erythrocyte sedimentation rate

Univariate analysis of risk factors: The univariate analysis was performed for several parameters. Among the demographic items, age was significantly associated with the incidence of ICU admission (P=0.03, OR=1.02, 95% Cl=1.00-1.04). Among the vital signs, admission O2 saturation significantly had an association with the need for ICU admission (P=0.00, OR=0.93, 95%Cl=0.89-0.97). In terms of the co-morbidities, according to our univariate analysis, the history of kidney disease or suffering from cancer could increase the prevalence of ICU admission among COVID-19 infected patients (P=0.04, OR=2.54, 95% Cl=1.00-6.41; P=0.00, OR=3.15, 95%Cl=1.39-7.15; respectively). Among the several signs and symptoms, only myalgia and chest pain significantly were associated with ICU admission rate in our study (P=0.00, OR=0.20, 95%Cl=0.08-0.49; P=0.05, OR=0.34, 95%Cl=0.11-1.03; respectively). Furthermore, we evaluated the admission laboratory data to prognosticate the risk of ICU admission among our patients. The admission level of CRP and ESR could be associated with risk of ICU admission (P=0.04, OR=1.00, 95%Cl=1.00-1.01; P=0.03, OR=1.01, 95% Cl=1.00-1.02). Among the coagulation factors, INR was significantly associated with ICU admission (P=0.01, OR=1.91, 95% Cl=1.12-3.26). In CBC test, hemoglobin, HCT, lymphocyte, and RBC had statistically significant association with increased chance of ICU admission (P=0.00, OR=0.80, 95%Cl=0.71-0.91; P=0.00, OR=0.92, 95% Cl=0.88-0.96; P=0.02, OR=0.95, 95% Cl=0.91-0.99; P=0.00, OR=0.57, 95% Cl=0.40-0.80; respectively).

Multivariate analysis of risk factors related to the increased risk of ICU admission: Among the demographic factors, age was an independent factor for increasing the risk of ICU admission in patients infected with COVID-19 (P=0.04). Also, O2 saturation was the only vital sign that could be numbered as an independent predictor for ICU admission in COVID-19 infection (P=0.00). CRP as a biomarker of acute inflammatory phase could independently predict the risk of ICU admission among our patients (P=0.00). In admission CBC test items, HCT was considered as an independent factor for ICU admission (P=0.03). Among the several manifestations of COVID-19 infection, myalgia was the only independent predictor in the risk assessment of ICU admission (P=0.01)

Analysis of the efficiency of prognostic factors in the prediction the risk of ICU admission among COVID-19 patients: Table 4 showed the value of the independent factors in predicting the risk of ICU admission among COVID-19 infected patients. The ROC curve was authorized to report the efficacy of predictors in risk assessment of ICU admission. The area under the curve (AUC) of admission O2 saturation is 0.635 (95% Cl (0.54–0.72); P=0.00); the AUC of HCT is 0.66 (95%Cl (0.58-0.75); P=0.00); the AUC of neutrophil count is 0.64 (95%Cl (0.53-0.75); P=0.00); the AUC of ESR is 0.614 (95%Cl (0.52-0.70); P=0.01); the AUC of myalgia is 0.64 (95% Cl (0.56-0.72); P=0.00).

Table 3. Factors related to ICU admission, multivariate analysis

Characteristics	Odd Ratio (OR)	Cl 95%	P value
Sex	0.36	0.13-0.96	0.04
Admission O2 saturation	0.88	0.82-0.96	0.00
Hematocrit	0.92	0.86-0.99	0.03
White blood cell count	0.95	0.89-1.01	0.15
Neutrophil count	1.01	0.99-1.04	0.08
Monocyte count	0.85	0.73-1.00	0.05
CK-MB	0.98	0.97-1.00	0.18
CRP1	0.98	0.95-1.00	0.00
ESR2	1.02	1.01-1.03	0.09
Myalgia	0.06	0.01-0.30	0.01

[1] C-reactive protein, [2] erythrocyte sedimentation rate,

Table 4. The value of predictors of ICU admission

Prognostic factors	AUC (95%Cl)	Sensitivity	Specificity	P value

Admission O2 saturation	0.61	51%	29%	0.01
Hematocrit	0.66	59%	30%	0.00
Neutrophil count	0.64	60%	68.4%	0.00
ESR (Erythrocyte sedimentation rate)	0.61	71%	56%	0.01
Myalgia	0.642	87.2%	58%	0.00

Discussion

In the current study, 214 confirmed cases of COVID-19 hospitalized in our center were reported. Among them, 55 with severe and critical diseases were admitted in the ICU. The current study determinates the assumed risk factors for ICU admission. All studies either in COVID-19 or other respiratory infections confirmed the high rate of morbidity and mortality among ICU admitted patients(13). The mortality rates among ICU admission cases in different studies are diverse and range from 16% to 67% (14). The majority of mortality in our study was between the ICU admission group, which was 69% while 10% of non-ICU admitted patients died. There is a growing need for ICU admission worldwide (15).

Finding the predictor items related to patients could help better manage these requirements of ICU beds. Furthermore, identification of the correctable predictors could help improve the outcome of patients and decrease the need for ICU admission (16). Contrarily, evidence like the current study could be of great assistance for health and government officials to policy decision-making based on available facilities. In the current study, the association of several assumed items with the risk of ICU admission was evaluated. These items include demographic characteristics, underlying diseases, duration of hospitalization, admission manifestations, admission laboratory tests, and vital signs. Although several of these factors (e.g., age, gender, and kidney diseases) or some of the laboratory items are associated with the incidence of ICU admission, limiting factors could be considered as independent predictors. Among the demographic characteristics, sex was an independent factor. Male gender in the current study could independently predict the admission of COVID-19 infected patients in ICU. Several previous studies have revealed the association between male gender with the rate of ICU admission (16). However, there was no evidence confirming the sex as an independent predictor for ICU admission. Previous studies have reported that the majority of patients admitted to ICU were old men (16). According to our study, although the older age is associated with more rate of ICU admission, it could not alone be considered as a predictor for ICU admission. This result is consistent with previous evidence (16).

In the present study, 6 different co-morbidities were detected among the study population; i.e., hypertension, CVD, different types of kidney diseases, and respiratory diseases, positive history of malignancy, and diabetes. The patients who had a positive history of kidney disease, hypertension, and malignancy represented a more severe form of COVID-19 and needed intensive care. Nevertheless, none of them could independently cause ICU-admission. Several previous studies evaluated the role of underlying diseases in the severity of COVID-19 infection. Nevertheless, the results were highly conflicting among studies. A new meta-analysis figured out the results of 30 original articles about the impact of HTN in the outcome of patients infected with COVID-19. They reported that hypertension is significantly associated with the severity of infection, ARDS, and ICU admission in the population (17). However, this association was not independent of other factors, especially gender and cardiovascular diseases and diabetes (17). So, it seems that none of the underlying disorders could independently affect the prognosis of infection. The other important characteristic evaluated in the present study was their sign and symptoms. Some of the signs and symptoms had a strong association with the incidence of ICU admission. These factors may have led the patients to more intensive care and caused critical ill situation for infected patients. Chest pain and myalgia were significantly associated with ICU admission among our patients.

Chest pain appears due to its life threatening differential diagnosis that usually categorized in cardiac accidents leading to more ICU admissions. Surprisingly, the frequency of myalgia complaint was significantly high among ICU admitted patients. Furthermore, the multivariate analysis revealed myalgia as an independent predictor of ICU admission in COVID-19 infected patients. An explanation for this high ratio of myalgia could be the damage of muscle cells by SARS-COV2 (14). The previous studies described a high rate of hyper-coagulopathy during the first days of admission among patients infected with COVID-19. But, it seems that

this phase of hypercoagulation is not persisting. However, the second hyperfibrinolysis phase following hypercoagulation is rare among COVID-19 patients. The most important issue about the coagulopathies in COVID-19 is its accompaniment with sepsis during the development of COVID-19. The COVID-19 could strongly cause septic shock in critically ill patients (14).

Nevertheless, recent studies have revealed that the common paraclinical tests including PT, PTT, and INR could not significantly distinguish the hypercoagulopathy due to sepsis in primary stages (18). While the COVID-19 infection is complicated with severe forms of hypercoagulation such as DIC, these factors significantly elevated (18). In the present study, a significant association was found between a high level of CRP and ESR as the predictors of the inflammatory phase due to sepsis and ICU admission. Simultaneously, the INR level was significantly higher in ICU-admitted patients. These results indicate the inflammatory reactions as one of the main pathophysiology of COVID-19 infection in critically-ill infected patients. Moreover, according to our findings, CRP could be considered as an independent factor of ICU admission (18). The WBC count and especially lymphocyte counts served as remarkable predictors for mortality and could reflect the severity of COVID-19 infection (19). Based on previous evidence, lymphopenia in critical cases could significantly lead to co-infection and increases the risk of septic shock (14). The suggested pathophysiology of lymphocyte reduction includes the attack of the SARS-COV2 virus to lymphocyte that causes the lymphocyte damage (19). Moreover, the increase in the number of lymphocytes indicated the recovery period of COVI-19 (19).

This study, in comparison to previous studies, includes a larger population that helps to achieve more trustable results. In the current study, among laboratory data, admission levels of hemoglobin, lymphocytes, and RBC counts significantly decreased in critically-ill patients who were admitted to the hospital. However, upon their recovery, these numbers returned to normal levels. Also, admission monocyte counts could independently predict ICU admission. Overall, the associated factors among different studies are similar, but it seems there is still a big conflict about the predictors for severity in different studies. The predictive factors helped better manage the health care sources and achieve a better outcome in our patients. Hence, the future similar investigations could lead to trustable and confirmed results. Despite the advantages of the present study, it had some limitations, as well. The number of our population is small and the duration of the study was short. Also, due to the limited ICU or ward beds in our centers, some critical patients could not access to the ICU.

In conclusion, several admission characteristics are associated with the need for ICU admission. According to our study, the male gender, myalgia, admission monocyte counts, CRP level in the first day of hospitalization, and O2 saturation independently could predict the need for intensive care in COVID-19 infected patients. Furthermore, dynamic monitoring with high frequency from admission date in terms of the recommended predictors seems necessary. However, our study has several limitations, unfortunately the study population was limited and all the evaluation was afforded in a single center, we could not achieve accurate mortality determination, at all.

In conclusion because of the limited available facilities of Intensive Care Unit (ICU), worldwide, their accurate management for appropriate patients is vital. Therefore, the determination of ICU admission risk factors is necessary. Our study revealed the high mortality among ICU admitted patients. Furthermore, sex, admission O2 saturation, HCT, myalgia and CRP were considered as the valuable predictors of the risk assessment of ICU admission.

Acknowledgments

We would like to thank our colleagues from Taleghani Hospital and Gastroenterology and Liver Diseases Research Center for their contribution.

Funding: This study was financially supported by Gastroenterology and Liver Diseases Research Center of Shahid Beheshti University of Medical Sciences

Conflict of interest: The authors declare that there is no conflict of interest.

References

1. Wang H, Li X, Li T, et al. The genetic sequence, origin, and diagnosis of SARS-CoV-2. Eur J Clin Microbiol Infect Dis 2020; 39: 1629-35.
2. Lee A. Wuhan novel coronavirus (COVID-19): why global control is challenging? Public Health 2020; 179: A1-2.

3. Moazzami B, Razavi-Khorasani N, Dooghaie Moghadam A, Farokhi E, Rezaei N. COVID-19 and telemedicine: Immediate action required for maintaining healthcare providers well-being. J Clin Virol 2020; 126: 104345.
4. Torkian P, Ramezani N, Kiani P, Bax MR, Akhlaghpoor S. Common CT findings of novel coronavirus disease 2019 (COVID-19): A Case Series. Cureus 2020; 12: e7434.
5. World Health Organization. Coronavirus disease (COVID-19) Situation Report–171. WHO 2020. Available at: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200709-covid-19-sitrep-171.pdf?sfvrsn=9aba7ec7_2.
6. Mahase E. Covid-19: death rate is 0.66% and increases with age, study estimates. BMJ 2020; 369:m1327.
7. Moghadas SM, Shoukat A, Fitzpatrick MC, et al. Projecting hospital utilization during the COVID-19 outbreaks in the United States. Pro Natl Acad Sci 2020; 117: 9122-6.
8. Halacli B, Kaya A, Topeli A. Critically-ill COVID-19 patient. Turkish J Med Sci 2020; 50: 585-91.
9. 9.Phua J, Weng L, Ling L, et al. Intensive care management of coronavirus disease 2019 (COVID-19): challenges and recommendations. Lancet Respir Med 2020; 8: 506-17.
10. Fatima Rajani H, Alshaikh FA, Anushiravani A. SARS-CoV-2; What We Know so far. Arch Iran Med 2020; 23: 498-502.
11. Halpern NA, Goldman DA, Tan KS, Pastores SM. Trends in critical care beds and use among population groups and medicare and medicaid beneficiaries in the United States: 2000-2010. Crit Care Med 2016; 44: 1490-9.
12. Beumer MC, Koch RM, van Beuningen D, et al. Influenza virus and factors that are associated with ICU admission, pulmonary co-infections and ICU mortality. J Crit Care 2019; 50: 59-65.
13. Dooghaie Moghadam A, Eslami P, Razavi-Khorasani N, et al. The impacts of the COVID-19 pandemic on liver transplant patients; time to change the priorities. Arch Iran Med 2020; 23: 507-8.
14. Yu Y, Xu D, Fu S, et al. Patients with COVID-19 in 19 ICUs in Wuhan, China: a cross-sectional study. Crit Care 2020; 24: 219.
15. Aggarwal S, Garcia-Telles N, Aggarwal G, et al. Clinical features, laboratory characteristics, and outcomes of patients hospitalized with coronavirus disease 2019 (COVID-19): Early report from the United States. Diagnosis (Berl) 2020; 7: 91-6.
16. Grasselli G, Zangrillo A, Zanella A, et al. Baseline characteristics and outcomes of 1591 patients infected with SARS-CoV-2 admitted to ICUs of the Lombardy Region, Italy. JAMA 2020; 323: 1574-81.
17. Pranata R, Lim MA, Huang I, Raharjo SB, Lukito AA. Hypertension is associated with increased mortality and severity of disease in COVID-19 pneumonia: A systematic review, meta-analysis and meta-regression. J Renin Angiotensin Aldosterone Syst 2020; 21: 1470320320926899.
18. Pavoni V, Gianesello L, Pazzi M, Stera C, Meconi T, Frigieri FC. Evaluation of coagulation function by rotation thromboelastometry in critically ill patients with severe COVID-19 pneumonia. J Thromb Thrombolysis 2020; 50: 281-6.
19. Zheng Y, Sun LJ, Xu M, et al. Clinical characteristics of 34 COVID-19 patients admitted to intensive care unit in Hangzhou, China. J Zhejiang Univ Sci B 2020; 21: 378-87.