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Research Paper

Clinical Parameters and Mortality in COVID-19 Patients Admitted to an Intensive Care Unit (ICU) in Qazvin City

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ABSTRACT

Background: The initial reports of an outbreak of SARS-CoV-2 pneumonia suggest that COVID-19 is a severe disease.

Objective: We aimed to investigate the clinical parameters and mortality of patients with SARS-CoV-2 pneumonia admitted to the intensive care unit (ICU) of Velayat Hospital in Qazvin, Iran.

Methods: In this single-centered, cross-sectional, and retrospective study, we enrolled all adult patients with COVID-19 admitted to the intensive care unit (ICU) of Velayat Hospital from March 20 to April 30, 2020. Sociodemographic data, laboratory values, and disease outcomes of the patients were collected. Then, the obtained data were compared between survivors and non-survivors.

Results: Of 1100 patients with SARS-CoV-2 pneumonia, 74 adult patients were included in this study. The Mean±SD age of the 52 patients was 60.1±16.46 years. All patients had underlying diseases. The Mean±SD time from admission to discharge from the ICU was 12.39±6.48 days. The logistic regression test indicated that the amount of blood urea nitrogen (BUN) during hospitalization in the ICU was associated with increased mortality risk (OR=1.081, 95% CI=1.024-1.141; P=0.005). Moreover, the same test showed that platelet count (OR: 0.991, 95% CI: 0.985-0.997; P=0.002) and hemoglobin concentration (OR: 0.691, 95% CI: 0.502-0.951; P=0.023) were associated with a decreased mortality risk in ICU patients; this means that patients with higher hemoglobin concentration and platelet counts had a lower mortality risk in ICU.

Conclusion: The mortality rate of patients with SARS-CoV-2 pneumonia is high. The BUN level was a predictor of mortality in patients with COVID-19. Therefore, it is recommended that BUN be measured during initial referral, and based on that, timely and appropriate corrective actions be conducted.

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1. Introduction

Regarding the initial reports of an outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pneumonia, it was first estimated that approximately 5% of patients would require intensive care based on the severity and extent of the disease [1]. However, the need for admission to the intensive care unit was reported by 12% of positive cases and 16% of all admitted patients in some countries, such as Italy [2]. Nevertheless, considering the prevalence and extent of the disease, it is expected that in the SARS-CoV-2, like the previous severe cases (e.g., SARS, MERS, avian influenza, and influenza [H1N1A]), intensive care will be an integral part of the global response to this emerging infection [1].

Wang reported that out of 138 patients admitted with coronavirus disease pneumonia in Wuhan, 40% required intensive care and intensive care unit (ICU) admission [3]. The most documented reason for patients requiring intensive care is the need for ventilators since two-thirds of the patients admitted to these wards have the criteria of acute respiratory distress syndrome (ARDS) [3]. It should be noted that the mortality rate of patients under ventilation is also very high. In a study by Fei Zhou et al. in two medical centers in China, 97% of the patients undergoing ventilation died [4].

It should be noted that the treatment of respiratory failure and hemodynamic status has key significance. ICU specialists, physicians, and the government should equip the ICUs to admit significantly more patients by emphasizing the existing infrastructure, condition, management, and provision of medical staff [5]. Moreover, with the increase in the number of critically-ill patients, there will be a need to plan the potentially increased resources of special wards and provision of access to lifesaving measures such as ICU beds, ventilators, extracorporeal membrane oxygenation, and so on [6]. Risk factor analysis for disease severity and death and identifying patients who are critically ill and those who are likely to require intensive care are important. Given that it is very important to know the clinical parameters and death rate of patients who are candidates for hospitalization in the ICU, the current study aimed to evaluate the clinical course and mortality of critically-ill patients admitted to the ICU of Velayat Hospital in Qazvin, Iran.

2. Material and Methods

This cross-sectional and retrospective study was conducted in a single center. We investigated all adult patients with COVID-19 who were admitted to the ICU of Velayat Hospital from March 20 to April 30, 2020.

The inclusion criteria included patients admitted to the ICU with at least 60% of Oxygen saturation were considered critically ill cases [7]. These patients require intubation and ventilation.

The collected information consisted of demographic information, history of chronic diseases (diabetes, hypertension, coronary heart disease, malignancy, respiratory diseases, etc.), and vital and clinical signs of the patient at the time of admission (fever, cough, myalgia, headache, etc.). The laboratory values (hemoglobin concentration, lymphocyte and platelet count, peripheral oxygen pressure, blood urea nitrogen [BUN], creatinine, etc.) were recorded at the time of admission and on the seventh day of admission in the ICU; the findings of lung CT scan at the time of admission and reports of treatment (oxygen therapy, antiviral drugs, antibacterial medicines, corticosteroids, etc.) were also collected. In the present study, the mortality rate after admission to the ICU was also considered.

All information about critically-ill cases was obtained from medical records and other care resources in the hospital. All information was approved by two physicians in charge of treating patients in the ICU.

The obtained data were analyzed using SPSS software version 24. Moreover, descriptive results were obtained by calculating the frequency, Mean±SD based on the variable type. We used the logistic regression analysis to predict the outcomes of death or survival of patients. A significance level of less than 0.05 was considered.

3. Results

A total of 1100 patients with confirmed COVID-19 (SARS-COv2) were admitted to Velayat Hospital in Qazvin from March 20 to April 30, 2020. Of them, 74 critically-ill cases (6.72%) were admitted to the ICU and treated. All patients lived in the city and suburbs of Qazvin. The Mean±SD age of these patients was 60.1±16.46 (range: 32-92 y) years; there was no statistically significant difference between the two sexes. All patients had underlying diseases; the most prevalent underlying diseases in hospitalized patients were

Table 1. Demographics and baseline characteristics of critical patients with COVID-19 disease at the intensive care unit

Variables		No. (%)			P
		Survivors (n=29)	Non-survivors (n=45)	All Patients (n=74)	
Age (y)	30-39	8(27.6)	39(6.7)	11(14.9)	0.139
	40-49	6(20.7)	7(15.6)	13(17.6)	
	50-59	2(6.9)	7(15.6)	9(12.2)	
	60-69	6(20.7)	10(22.2)	16(21.6)	
	70-79	5(17.2)	10(22.2)	15(20.3)	
	≥80	2(6.9)	8(17.8)	10(13.5)	
Sex	Female	11(37.9)	11(24.4)	22(29.7)	0.298
	Male	18(62.1)	34(75.6)	52(70.35)	
History of disease	Hypertension	10(34.5)	18(37.8)	28(37.8)	0.410
	Ischemic heart disease	6(20.7)	13(28.9)	19(25.7)	0.587
	HLP	3(10.3)	7(15.6)	10(13.5)	0.731
	Diabetes	8(27.6)	13(28.9)	21(28.4)	1.000
	Acute & chronic Kidney diseases & end-stage renal disease	0	4(8.9)	4(5.4)	0.150
	Chronic obstructive pulmonary disease	2(6.9)	3(6.7)	5(6.8)	1.000
	Neurologic disease	2(6.9)	9(20)	11(14.9)	0.183
	Hypothyroidism	1(3.4)	0	1(1.4)	0.392
	Malignancy	0	4(8.9)	4(5.4)	0.150
Admission chest CT Scan findings	Ground-glass opacities	20(69)	32(71.1)	52(70.3)	1.000
	Focal consolidation	12(41.4)	18(40)	30(40.5)	1.000
	Pleural effusion	2(6.9)	8(17.8)	10(13.5)	0.298
	Crazy paving	10(34.5)	16(35.6)	26(35.1)	1.000
	Fibrotic	0	1(2.2)	1(1.4)	1.000
	Mosaic pattern	0	1(2.2)	1(1.4)	1.000
	Atelectasis	0	1(2.2)	1(1.4)	1.000
Lobar affected in CT Scan	Multi	23(39)	36(61)	59(98)	0.400
	Mono	1(4.2)	0(0)	1(1.7)	
PCR test	Positive	17(39.5)	26(60.5)	43(58.1)	1.000
	Negative	12(38.7)	19(61.3)	31(41.9)	
-	Need for Intubation	5(22.7)	27(69.2)	32(52.5)	0.001

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Table 2. Intensive care measures and vital signs and laboratory tests results of survivors and non-survivors of severe COVID-19 disease

Variables		Mean±SD		P*
-	Symptoms When Admitted to ICU	Survivors (n=29)	Non-survivors (n=45)	
-	Heart rate (beats/min)	97.44±17.23	93.57±15.58	0.32
-	Respiratory rate (breaths/min)	21.20±5.02	21.06±6.05	0.918
-	Temperature (°C)	37.18±0.79	37.10±0.84	0.675
-	Systolic blood pressure (mmHg)	132.75±24.06	128.37±18.61	0.382
-	Systolic blood pressure (mmHg)	82.86±15.17	79.44±12.09	0.287
-	$SatO_2$ without O_2	89.71±8.14	87.31±11.21	0.014*
	$SatO_2$ with O_2	89.71±8.14	73.74±17.55	NS
	Last $SatO_2$	93.24±4.56	85.43±14.60	0.002*
-	Saturation before intubation	56.33±25.38	63.07±19.25	NS
Hemoglobin concentration (g/L)	1st day	14.12±2.22	12.30±2.03	0.001*
	7th day	12.82±1.66	11.66±1.88	0.014*
Lymphocyte count ($\times10^9$/L)	1st day	17.85±6.46	18.97±20.54	0.126
	7th day	16.05±9.27	13.52±8.45	0.382
Platelet count ($\times10^9$)	1st day	194.65±67.97	190.51±91.16	0.554
	7th day	290.87±149.13	173.38±75.33	0.001*
Serum creatinine concentration (µmol/L)	1st day	1.13±0.27	1.73±2.05	0.173
	7th day	1.04±0.46	2.46±2.97	0.003*
Blood urea nitrogen (BUN)	1st day	16.45±7.94	29.97±24.87	0.003*
	7th day	19±8.73	50.25±12.2	0.000*
Total bilirubin	1st day	0.50±0.17	0.92±0.33	0.99
	7th day	0.60±0.43	1.62±2.02	0.655
Alkaline phosphatase (ALKP)	1st day	169.3±56.45	209.25±115	0.226
	7th day	183.94±79.95	233.65±90.91	0.042*
Alanine transaminase (ALT)	1st day	38.16±28.2	91.72±2.41	0.639
	7th day	118.05±227.63	53.33±82.09	0.130
Aspartate transaminase (AST)	1st day	65.52±80.31	132.06±409.15	0.532
	7th day	149.3±462.68	46.66±35.86	0.744
Mg	1st day	2.21±0.40	2.29±0.39	0.495
	7th day	2.27±0.25	2.37±0.41	0.511
Na	1st day	135.53±4.79	144.34±37.70	0.339
	7th day	136.05±3.70	137.88±4.71	0.137
K	1st day	4.10±0.61	4.14±0.69	0.765
	7th day	4.09±0.43	4.20±0.72	0.610
White Blood Cell (WBC)	1st day	7.88±3.77	9.40±5.43	0.300
	7th day	10.14±3.74	11.30±5.85	0.538

* Significant relationship.

Table 3. Logistic regression analysis of the relationship between some variables and mortality risk of patients with severe COVID-19 disease

Variables	β	SE	OR	95% CI	P
Platelet	-0.009	0.003	0.991	0.985-0.997	0.002*
Hemoglobin concentration	-0.370	0.183	0.691	0.502-0.951	0.023*
Blood urea nitrogen	0.078	0.028	1.081	1.024-1.141	0.005*
Serum creatinine	1.400	0.613	4.055	1.220-13.476	0.022
Time admission until transfer to ICU	-0.141	0.078	0.869	0.746-1.012	0.071
Time admission in ICU until intubation	-0.205	0.227	0.366	0.522-1271	0.366

* Significant relationship.

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hypertension (n=28, 37.8%), diabetes (n=21, 28.4%), and coronary heart disease (n=19, 25.7%). The most frequent findings in the lung CT scan were ground-glass opacities (70.3%) (Table 1). The most common clinical symptoms in all patients were shortness of breath (n=55, 74.3%), cough (n=44, 59.5%), fever, and shivering (n=36, 48.6%) at the time of admission to the ICU. Most patients (n=71, 95.9%) received antibiotics. Of the 74 patients admitted to the ICU, 45 died during hospitalization in the ICU, and 29 were discharged. The Mean±SD time from admission to ICU discharge was 12.39±6.48 days, and the Mean±SD time from admission to death was 7.88±6.13 days. The two groups (survivors and non-survivors) did not differ significantly regarding demographic characteristics, lung CT scans, clinical signs at admission, or treatment method. Comparison of vital signs and laboratory tests in the two groups of survivors and non-survivors indicated that $satO_2$ (P=0.014), hemoglobin level (P=0.014), platelet count (P=0.001), serum creatinine concentration (P=0.003), BUN (P=0.001), and alkaline phosphatase (ALP) (P=0.042) were significantly different in the two groups. Other laboratory values were not significantly different in the two groups. $satO_2$ and basal hemoglobin levels in the non-survivors group were significantly lower; in addition, BUN levels were significantly higher in the non-survivors group (Table 2). The logistic regression test indicated that the amount of BUN was associated with increased mortality risk (OR=1.081, 95% CI=1.024-1.141, P=0.005) (Table 3). Moreover, the same test showed that platelet count (OR=0.991, 95% CI: 0.985-0.997; P=0.002) and hemoglobin concentration (OR=0.691, 95% CI: 0.502-0.951; P=0.023) were associated with a decreased mortality risk in ICU patients. Thus, the patients with higher hemoglobin concentration and platelet counts had a lower mortality risk in the ICU.

4. Discussion

In the current study, the clinical course and mortality of critically-ill cases with COVID-19 in the ICU are reported. In terms of gender, different results have been reported in different studies. In the current study, there was no gender difference between the two study groups. Aggarwal et al. have pointed to a similar conclusion in their study [8]. Moreover, there was no difference between the two groups in terms of gender in the study by Zhou et al. [4]. The results of the present study were in line with the study of Guan et al., who also acknowledged that males are more likely to be infected with COVID-19 than females [9]. Although efforts are still ongoing to determine who is the most at risk for ARDS, preliminary data indicate that older patients and those with chronic illnesses such as hypertension, diabetes, and cardiovascular diseases are more at risk [10]. In the current study, the deceased cases were old, which was very similar to the findings of other studies [11]. It is believed that this outcome is associated with poor immune function in the elderly [12]. Moreover, elderly patients may have other risk factors, such as underlying diseases, that not only enhance the risk of pneumonia but also affect their prognosis [13]. On the other hand, evaluating underlying diseases is a key factor in determining the prognosis of several diseases, especially pneumonia [14]. In the present study, all study patients had underlying diseases.

In the present study, the most common finding in patients' lung CT scans was ground-glass opacities, which was not statistically significant between the two groups of survivors and non-survivors. Radiographic findings in patients with pneumonia vary greatly depending on the time since the onset of symptoms. Nev-

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ertheless, most findings are bilateral infiltration with a pattern of ground-glass opacities [15].

Following data analysis, the three most prevalent symptoms in the patients were shortness of breath, cough, fever, and shaking, in that order in the present study. This finding was similar to previous studies [4, 16].

Clinical and laboratory manifestations in patients vary and can range from asymptomatic disease to severe illness with mortality. One of the findings of our study was that the mean values of baseline BUN and BUN at the time of death in the non-survivors group were higher than those in the survivors group, and this increase was statistically significant (P<0.001). In addition, an increase in BUN after regression analysis was presented as a predictor of mortality in patients with COVID-19 (OR=1.010, 95% CI=1.010-1.134, P=0.02). The results were consistent with those in other studies in this regard [17, 18]. Although COVID-19 disease mostly affects the respiratory system, other organs may also be involved, and kidney involvement following virus entry into the bloodstream and accumulation in the kidney can permanently damage kidney cells [19]. In this regard, Liu et al. [20] indicated that patients of COVID-19 with an elevated baseline of BUN level are at a higher risk of death and poor outcomes than those with a normal range of BUN level, and suggested that the BUN levels should be closely monitored.

In the current study, the mean platelet count was lower in the non-survivors group than in the survivors group. In some studies, platelet depletion was associated with increased mortality in patients with COVID-19 [21, 18]. In 40% to 50% of patients with SARS-CoV infection, thrombocytopenia, bone marrow involvement, and hematopoietic disorders have been reported [22]. Because 79% of the genomic sequence of coronavirus is similar to SARS-CoV, the same cell entry receptor of angiotensin-converting enzyme 2 [23] may cause thrombocytopenia in COVID-19, similar to that in SARS-COV. Besides, thrombosis and diffuse vascular coagulation may be the causes of platelet consumption in critically ill patients with COVID-19 disease [24]. In addition, the mean alkaline phosphatase value among the non-survivors group was higher than that in the survivors group, which was consistent with the results of the study by Sun et al. [25].

One of the limitations of the current study was that the generalizability of the results is limited because of the centrality and retrospective nature of the study.

5. Conclusion

The current study found that an increase in BUN is a predictor of mortality in patients with COVID-19. Therefore, it is recommended that BUN be measured during an initial referral to conduct timely and appropriate corrective actions. The results also indicated that platelet count and hemoglobin concentration are associated with a decreased risk of mortality in patients in the ICU. Thus, it is recommended to take appropriate measures and consider these two factors in treating patients with COVID-19.

Ethical Considerations

Compliance with ethical guidelines

The Research Ethics Committee of Qazvin University of Medical Sciences approved this study (Code: IR.QUMS.REC.1399.184).

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Authors' contributions

Mohammadali Zohal and Azam Ghorbani designed the study and wrote the manuscript. Maryam Qeraati, Khdijeh Esmaelzadeh, Monirosadat Mirzadeh, and Nafiseh Rastgoo contributed to data analysis, interpretation, and editing of the manuscript. All authors read the manuscript and participated in the preparation of the final version of the manuscript. All authors read and approved the final manuscript.

Conflict of interest

The authors declared no conflict of interest.

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