Predictors of hospital mortality among patients with COVID-19 in Tehran, Iran

Fatemeh Esfahanian[1], SeyedAhmad SeyedAlinaghi[2],
Nazanin Janfaza[3] (iD) and Marcarious M. Tantuoyir[4] (iD)

Abstract

Objective: The coronavirus disease 2019 (COVID-19) has become a global pandemic. Timely and effective predictors of survival and death rates are crucial for improving the management of COVID-19 patients. In this study, we evaluated the predictors of mortality based on the demographics, comorbidities, clinical characteristics, laboratory findings, and vital signs of 500 patients with COVID-19 admitted at Imam Khomeini Hospital Complex, the biggest hospital in Tehran, Iran.

Methods: Five hundred hospitalized laboratory-confirmed COVID-19 patients were included in this study. Subsequently, electronic medical records, including patient demographics, clinical manifestation, comorbidities, and laboratory test results were collected and analyzed. They were divided into two groups: expired and discharged. Demographics, clinical, and laboratory data were compared among the two groups. The related factors with death in the patients were determined using univariate and multivariate logistic regression approaches.

Results: Among the 500 hospitalized patients, most patients were male (66.4% versus 33.6%). The expired group had more patients ≥70 years of age compared with the discharged group (32.9% versus 16.3%, respectively). Almost 66% of the expired patients were hospitalized for ≥5 days which was higher than the discharge group (26.9%). Patients with a history of opium use in the expired group were significantly higher compared to the discharged group (14.8% versus 8.6%, p = 0.04) as well as a history of cancer (15.5% versus 4.7%, p < 0.001). Out of the 500 patients with COVID-19, four patients (2.6%) were HIV positive, all of whom expired. Dyspnea (76.4%), fever (56.6%), myalgia (59.9%), and dry cough (67%) were the most common chief complaints of hospitalized patients. Age ≥70 years (adjusted odds ratio = 2.49; 95% confidence interval, 1.02–6.04), being female (adjusted odds ratio = 2.06; 95% confidence interval, 1.25–3.41), days of hospitalization (adjusted odds ratio = 5.73; 95% confidence interval, 3.49–9.41), and having cancer (adjusted odds ratio = 3.23; 95% confidence interval, 1.42–7.39) were identified as independent predictors of mortality among COVID-19 patients.

Conclusion: Discharged and expired COVID-19 patients had distinct clinical and laboratory characteristics, which were separated by principal component analysis. The mortality risk factors for severe patients identified in this study using a multivariate logistic regression model included elderly age (≥70 years), being female, days of hospitalization, and having cancer.

Introduction

In late December 2019, an outbreak of an emerging disease with remarkably high virulence in Wuhan, China, soon became a global concern. The COVID-19 pathogen was discovered to be a novel beta-coronavirus termed the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[1,2] A spectrum of presentations has been reported, ranging from asymptomatic infection to severe lower respiratory tract illness presenting with fever, cough, and dyspnea that may progress to acute respiratory distress syndrome (ARDS) and

[1]Department of Endocrinology, Imam Khomeini Hospital Complex, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
[2]Iranian Research Center for HIV/AIDS, Iranian Institute for Reduction of High-Risk Behaviors, Tehran University of Medical Sciences, Tehran, Iran
[3]Internal Medicine Department, Imam Khomeini Hospital Complex, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
[4]School of Medicine, Tehran University of Medical Sciences, Tehran, Iran

Corresponding author:
Nazanin Janfaza, Internal Medicine Department, Imam Khomeini Hospital Complex, School of Medicine, Tehran University of Medical Sciences, Tehran, 1419733141, Iran.
Email: n.janfaza@gmail.com

death. Severe viral pneumonia with respiratory failure and the deterioration of underlying diseases are the main cause of death in severe patients.[3,4]

Antibodies can be detected quickly and easily in COVID-19 patients. In our quest to understand the path of disease progression in COVID-19 patients, using the serological technique for detecting SARS-CoV-2 in addition to RNA testing is critical. It is suggested that this procedure be used in conjunction with Real-time polymerase chain reaction (RT-PCR) or an RNA test to increase the sensitivity and accuracy of the results. COVID-19 patients can receive prompt diagnosis and management as a result of this technique.[5] Infection, viral entrance, immunological response to the virus, COVID-19 intensity, and death may all be affected by different genetic patterns. Some genes connected with the immune system's response have been linked to the severity and predisposition of COVID-19.[6]

Early reports from Asia and Europe have identified older age, male gender, and chronic medical conditions, such as diabetes mellitus (DM), hypertension, obesity, coronary artery disease (CAD), and heart failure, as associated factors with worse outcomes.[7] A major problem of the SARS-CoV-2 pandemic is the considerable burden imposed on the National Health System (NHS) worldwide due to the hyper-acute outbreak and the proportional increase of patients requiring intensive care unit (ICU) support in an extremely limited period. As a result, outcomes may differ depending on the disease load in each country.[8]

Early identification of related factors for critical conditions is crucial, not only to more precisely define the distinguishing clinical and epidemiological characteristics but also to provide adequate supportive care and, if necessary, timely admission to the ICU.[9] Therefore, this study was aimed to investigate the predictors of hospital mortality based on the demographics, comorbidities, clinical characteristics, laboratory findings, and vital signs of 500 patients with COVID-19 admitted to Imam Khomeini Hospital Complex, the biggest hospital in Tehran, Iran.

Materials and methods

Study design and patient population

The retrospective cross-sectional study was performed on 500 patients with COVID-19 who were admitted to Imam Khomeini Hospital Complex, a referral center in Tehran, Iran, from 20 February to 19 April 2020. All the patients enrolled in the study were admitted after being matched with World Health Organization (WHO) confirmation guidelines of COVID-19 (WHO 2020a). The diagnosis was confirmed by RNA detection of the SARS-CoV-2 in an onsite clinical laboratory. In cases in which polymerase chain reaction (PCR) was not available, lung involvement (all the patients) in favor of COVID-19 was considered as the basis of diagnosis. Out of the total study subjects, 273 (54.6%) of patients had positive COVID-19 PCR.

Data extraction

All information of this study was obtained using a structured questionnaire from electronic patient health records. The questionnaire was adopted from previous similar studies by Alamdari et al.[10] and SeyedAlinaghi et al.[11] and it was modified and used only by the authors purposely for carrying out this study (Supplemental Material). Table 1 shows the collected data through the questionnaire.

Ethical considerations

The research protocol was fully assessed and approved by the Ethics Committee, Deputy of Research, Tehran University of Medical Sciences, Tehran, Iran (ethics approval code: 99-1-101-47345).

Sample size calculation

For the sample size calculation and data synthesis, z tests–logistic regression was used with our type I error rate (α err

Table 1. List of the variables included in the data analysis.

Demographics	Signs, symptoms, and related morbidities
Gender	Dyspnea
Age	Fever
Marital status	Headache
Duration of admission	Sore throat
Comorbidities	Chills
Coronary artery disease (CAD)	Fatigue
Hypertension	Myalgia
Diabetes mellitus (DM)	Coryza
Chronic pulmonary disease	Cough
Chronic liver disease	Vomiting
HIV	Nausea
Chronic renal failure (CRF)	Hemoptysis
Cancer	Appetite loss
Hypothyroid	Chest pain
Hyperthyroid	Dizziness
Smoking history	Anosmia
Opium history	

Laboratory findings and vital signs	
O_2 saturation	Body mass index
Temperature	Fasting blood sugar (FBS)
Pulse rate	D-dimer
Respiratory rate	Lactate dehydrogenase
Creatine phosphokinase	Calcium
Potassium	AST
Sodium	ALT
Phosphorous	Erythrocyte sedimentation rate (ESR)
C-reactive protein (CRP)	Platelet
White blood cell (WBC)	Lymphocyte count

AST: aspartate transaminase; ALT: alanine transaminase.

prob) as 0.05. For the Power (1-β err prob), we choose 0.95 as the required level and the X-distribution was normal.

Outcomes and statistical analysis

Data extraction and analysis were performed with IBM SPSS Statistics software (version 25). In our calculations, a z test for logistic regression for a continuous predictor helped us to test whether a continuous predictor is a significant predictor of a binary outcome, with or without other covariates. However, for better interpretations, continuous variables were converted to categorical characteristics based on the evidence and experience of the researchers. An univariate analysis looks at each element in a dataset individually and analyzes the response pattern to that variable, whereas the investigation of two variables to identify the empirical relationship between them is known as bivariate analysis (Table 2). On the other hand, multivariate analysis is a statistical process for analyzing data including multiple types of measurements or observations as well as used in circumstances in which more than one dependent variable is investigated at the same time as other variables. Considering the type of dataset obtained for this study, the former two (univariate and bivariate logistic analysis) were not appropriate; hence, multivariate analysis was used in investigating the predictors of mortality within the hospital. As such, a value of $p \leq 0.10$ was considered statistically significant for our multivariate logistic analysis.[11] We further adjusted all the variables utilized in our analysis because we had numerous independent variables and also to control other predictor variables and account for the dynamics between the predictors in our multivariate regression analysis. Table 3 gives the variables used in our final analysis with their respective adjusted odds ratios (AORs). In the final model, factors associated with hospital mortality were considered based on reports and evidence from previous studies at the $p < 0.05$ level (Alamdari et al.[10] and SeyedAlinaghi et al.[11] presented the $p < 0.10$ level for potential predictors and the $p < 0.05$ level for final predictors of characteristics associated with COVID-19 mortality).

Results

Descriptive characteristics

The demographic and clinical characteristics of the patients are described in Table 2. Briefly, among 500 hospitalized patients, most patients were male (66.4% versus 33.6%). The expired group had more patients ≥70 years of age compared with the discharged group (32.9% versus 16.3%, respectively). We compared men and women in different age groups. There was no significant difference between them ($p = 0.83$). A total of 66.2% of expired patients were hospitalized for ≥5 days which was higher than the discharge group (26.9%). Respectively, 19.4% and 16.0% of discharged and expired groups had a history of smoking which showed no

statistically significant difference ($p = 0.36$); however, patients with a history of opium use in the expired group was significantly higher compared to the discharged group (14.8% versus 8.6%, $p = 0.04$) as well as a history of cancer (15.5% versus 4.7%, $p < 0.001$). Finally, out of 500 patients with COVID-19, four patients (2.6%) were HIV positive, all of whom expired. One hundred fifty-two (30.4%) of patients did not have the COVID-19 PCR test available. But, all the patients had lung involvement in favor of COVID-19.

Associated factors

Table 2 indicates that dyspnea (76.4%), fever (56.6%), myalgia (59.9%), and dry cough (67%) were the most common chief complaints of hospitalized patients, whereas hemoptysis (0.8%), coryza (0.6%), and dizziness (0.8%) were the least common ones. In addition, dyspnea has been reported considerably more in the expired group rather than the discharged one ($p = 0.09$).

Almost 84% of patients had less than 93% oxygen saturation when they entered the hospital. The following laboratory findings were significantly more common in patients with the final status of death: (1) increased alanine transaminase (ALT) ($p = 0.07$) and aspartate transaminase (AST) ($p = 0.03$), (2) decreased lymphocyte count ($p < 0.001$), and (3) increased levels of lactate dehydrogenase (LDH) ($p = 0.004$).

Thereupon, all the variables associated with hospital mortality of COVID-19 at the $p \leq 0.10$ level were entered into a multivariate regression model, and the results are summarized in Table 3. Age ≥70 years (AOR = 2.49; 95% confidence interval (CI), 1.02–6.04), being female (AOR = 2.06; 95% CI, 1.25–3.41), the number of days of hospitalization (AOR = 5.73; 95% CI, 3.49–9.41), and having cancer (AOR = 3.23; 95% CI, 1.42–7.39) were identified as independent predictors of mortality among COVID-19 patients.

Discussion

Patients' characteristics

The percentage of older age (≥70 years) in patients who died was much higher than those who survived. This study supports the association of elderly age with an increased mortality rate in COVID-19 patients which is consistent with a previous study.[9] Older age has already been previously identified as a significant, independent mortality predictor in the Middle East respiratory syndrome (MERS) and SARS. Age-related impairments in T-cell and B-cell activity, as well as an excess of type 2 cytokines, may result in a lack of viral replication control and longer pro-inflammatory responses, potentially resulting in poor prognosis.[12–15]

Interestingly, our findings are somewhat different from the global picture in regard to male versus female mortality. It is widely known that gender is also a risk factor for higher

Table 2. Demographic, clinical, and laboratory findings of patients with COVID-19 based on two groups, Imam Khomeini Hospital Complex, Tehran, 2020.

Variables	Groups		OR (95% CI) referent	P-value referent
	Expire N (%)[a]	Discharge N (%)[a]		
Total	155 (31.4%)	338 (68.6%)		
Gender				
Male	89 (57.4%)	243 (71.9%)	0.52 (0.35–0.78)	0.002
Female	66 (42.6%)	95 (28.1%)		
Age (years)				
<39	17 (11.0%)	50 (14.8%)		
39–49	16 (10.3%)	61 (18.0%)	0.52 (0.29–0.94)	0.51
50–59	27 (17.4%)	92 (27.2%)	0.56 (0.35–0.91)	0.67
60–69	44 (28.4%)	80 (23.7%)	1.28 (0.83–1.97)	0.15
≥70	51 (32.9%)	55 (16.3%)	2.52 (1.62–3.93)	0.003
Duration of admission (days)				
<5	52 (33.8%)	247 (73.1%)		
≥5	102 (66.2%)	91 (26.9%)	5.32 (3.52–8.03)	<0.001
Marital status				
Single	9 (5.9%)	29 (8.7%)		
Married	144 (64.1%)	304 (91.3%)	1.52 (0.70–3.30)	0.28
Coronary artery disease (CAD)				
Yes	49 (31.6%)	84 (24.9%)	1.39 (0.91–2.11)	0.12
Hypertension				
Yes	65 (41.9%)	116 (34.3%)	1.38 (0.93–2.04)	0.10
Diabetes mellitus (DM)				
Yes	43 (27.9%)	91 (26.9%)	1.05 (0.68–1.61)	0.82
Chronic pulmonary disease				
Yes	13 (8.4%)	27 (8.0%)	1.05 (0.52–2.10)	0.88
HIV				
Yes	4 (2.6%)	0 (0.0%)	20.69 (1.11–386.85)	0.99
Chronic liver disease				
Yes	4 (2.6%)	8 (2.4%)	1.09 (0.32–3.68)	0.89
Chronic renal failure (CRF)				
Yes	11 (7.1%)	14 (4.1%)	1.76 (0.78–3.98)	0.17
Cancer				
Yes	24 (15.5%)	16 (4.7%)	3.68 (1.89–7.16)	<0.001
Hypothyroid				
Yes	21 (13.5%)	44 (13.0%)	1.04 (0.59–1.83)	0.87
Hyperthyroid				
Yes	2 (1.3%)	0 (0.0%)	11.19 (0.53–234.55)	0.99
Smoking history				
Yes	30 (19.4%)	54 (16.0%)	1.26 (0.77–2.06)	0.36
Opium history				
Yes	23 (14.8%)	29 (8.6%)	1.85 (1.03–3.31)	0.04
Exposure history				
Yes	29 (18.8%)	71 (21.1%)	0.86 (0.53–1.40)	0.57
Dyspnea				
Yes	126 (81.3%)	251 (74.3%)	1.50 (0.94–2.41)	0.09
Fever				
Yes	94 (60.6%)	187 (55.3%)	1.24 (0.84–1.83)	0.27
Headache				
Yes	17 (11.0%)	50 (14.8%)	0.71 (0.39–1.27)	0.25
Sore throat				
Yes	3 (1.9%)	26 (7.7%)	0.23 (0.07–0.79)	0.02

(Continued)

Table 2. (Continued)

Variables	Groups		OR (95% CI) referent	P-value referent
	Expire N (%)ᵃ	Discharge N (%)ᵃ		
Chills				
Yes	56 (36.1%)	138 (40.8%)	0.58 (0.35–0.95)	0.75
Fatigue				
Yes	15 (9.7%)	22 (6.5%)	1.53 (0.77–3.05)	0.22
Myalgia				
Yes	82 (52.9%)	211 (62.4%)	0.67 (0.46–0.99)	0.05
Coryza				
Yes	0 (0.0%)	3 (0.9%)	0.32 (0.01–6.32)	0.99
Cough				
Yes	109 (70.3%)	221 (65.4%)	1.25 (0.83–1.89)	0.28
Vomiting				
Yes	23 (14.8%)	58 (17.2%)	0.84 (0.49–1.42)	0.52
Nausea				
Yes	21 (13.5%)	68 (20.1%)	0.62 (0.36–1.05)	0.08
Diarrhea				
Yes	13 (8.4%)	30 (8.9%)	0.94 (0.47–1.85)	0.86
Hemoptysis				
Yes	1 (6.0%)	3 (0.9%)	0.72 (0.07–6.98)	0.65
Appetite loss				
Yes	35 (22.6%)	96 (28.4%)	0.73 (0.47–1.14)	0.18
Chest pain				
Yes	15 (9.7%)	52 (15.4%)	0.58 (0.32–1.08)	0.09
Dizziness				
Yes	0 (0.0%)	4 (1.2%)	0.24 (0.01–4.54)	0.99
Anosmia				
Yes	13 (8.4%)	24 (7.1%)	1.19 (0.59–2.42)	0.62
Fasting blood sugar (FBS)				
<126	13 (8.4%)	9 (2.7%)		
≥126	23 (14.8%)	10 (3.0%)	0.61 (2.85–13.3)	0.42
D-dimer (mg/liter)				
<290	1 (0.6%)	1 (0.3%)		
≥290	7 (4.5%)	16 (4.7%)	0.95 (0.38–2.37)	0.86
Lactate dehydrogenase				
<480	16 (10.3%)	41 (12.1%)		
≥480	75 (48.4%)	111 (32.8%)	1.96 (1.30–2.95)	0.004
Creatine phosphokinase				
<195	23 (14.8%)	43 (12.7%)		
≥195	15 (9.7%)	18 (5.3%)	1.97 (0.96–4.04)	0.15
Potassium				
<3.5	12 (7.7%)	17 (5.0%)		
3.5–5.0	100 (64.5%)	211 (62.4%)	1.49 (0.91–2.42)	0.13
≥5.1	15 (9.7%)	22 (6.5%)	2.14 (0.98–4.68)	0.05
Sodium				
<135	19 (12.3%)	37 (10.9%)		
135–145	101 (65.2%)	206 (60.9%)	1.59 (0.98–2.59)	0.03
≥146	7 (4.5%)	4 (1.2%)	5.68 (1.55–20.85)	0.009
Phosphorus				
<2.5	9 (5.8%)	9 (2.7%)		
2.5–5.0	37 (23.9%)	67 (19.8%)	1.37 (0.86–2.18)	0.17
≥5.1	6 (3.9%)	5 (1.5%)	2.99 (0.89–10.02)	0.07

(Continued)

Table 2. (Continued)

Variables	Groups		OR (95% CI) referent	P-value referent
	Expire N (%)[a]	Discharge N (%)[a]		
Calcium				
<8.6	45 (29.0%)	42 (12.4%)		
8.6–10.2	10 (6.5%)	44 (13.0%)	0.56 (0.27–1.17)	0.12
≥10.3	1 (6.0%)	4 (1.2%)	0.62 (0.06–5.67)	0.67
AST				
<41	49 (31.6%)	129 (38.2%)		
≥41	47 (30.3%)	67 (19.8%)	1.68 (1.04–2.73)	0.03
ALT				
<41	58 (37.4%)	143 (42.3%)		
≥41	38 (24.5%)	53 (15.7%)	1.72 (1.03–2.88)	0.07
Erythrocyte sedimentation rate (ESR)				
<16	5 (3.2%)	23 (6.8%)		
≥16	117 (75.5%)	244 (72.2%)	1.03 (0.64–1.64)	0.89
C-reactive protein (CRP) mg/liter				
<6	1 (0.6%)	8 (2.4%)		
≥6	135 (87.1%)	279 (82.5%)	1.29 (0.73–2.28)	0.36
Platelet				
<150,000	153 (98.7%)	329 (97.3%)	1.87 (0.21–16.84)	0.29
≥150,000	0 (0.0%)	3 (0.9%)		
White blood cell (WBC)				
<4000	24 (15.5%)	39 (11.5%)	0.39 (0.05–2.82)	0.35
4000–9999	83 (53.5%)	212 (62.7%)	0.54 (0.07–3.96)	0.54
≥10,000	46 (29.7%)	85 (25.1%)		
Lymphocyte count				
≤1000	103 (69.1%)	172 (52.8%)	0.49 (0.33–0.75)	0.001
>1000	46 (30.9%)	154 (47.2%)		
O_2 saturation				
<93	134 (86.5%)	284 (84.0%)		
≥93	16 (10.3%)	40 (11.8%)	1.12 (0.34 –3.62)	0.85
Temperature (°C)				
<37.3	41 (26.5%)	151 (44.7%)		
37.3–38	66 (42.6%)	107 (31.7%)	1.07 (0.56–2.03)	0.83
38.1–39	25 (16.1%)	31 (9.2%)	1.40 (0.64–3.03)	0.39
≥39.1	4 (2.6%)	16 (4.7%)	0.43 (0.12–1.48)	0.18
Pulse rate				
<60	5 (3.2%)	10 (3.0%)	0.68 (0.36–1.25)	0.21
60–99	69 (44.5%)	208 (61.5%)	1.57 (0.82–2.98)	0.16
≥100	62 (40.0%)	81 (24.0%)		
Respiratory rate				
<25	57 (36.8%)	121 (35.8%)	2.41 (1.46–4.0)	0.001
≥25	43 (27.7%)	53 (15.7%)		
Body mass index				
<30	1 (0.6%)	13 (3.8%)	1.08 (0.06–19.31)	0.96
≥30	1 (0.6%)	12 (3.6%)		
Drug history				
Yes	76 (49.0%)	150 (44.5%)	1.19 (0.81–1.75)	0.35
No	79 (51.0%)	187 (55.5%)		

OR: odds ratio; CI: confidence interval; AST: aspartate transaminase; ALT: alanine transaminase.
[a]Subgroups do not always add up to total due to missing data.

Table 3. Independent associations with the hospital mortality of COVID-19 in multiple conditional logistic regression analysis; Imam Khomeini Hospital, Tehran, 2020.

Factors	AOR	95% CI	P-value
Gender			
Female	2.06	1.25–3.41	0.005
Male	Referent	Referent	Referent
Age (years)			
<39	Referent	Referent	Referent
39–49	0.92	0.36–2.35	0.87
50–59	0.45	0.18–1.13	0.09
60–69	1.38	0.58–3.23	0.46
≥70	2.49	1.02–6.04	0.04
Duration of admission (days)			
0–5	Referent	Referent	Referent
>5	5.73	3.49–9.41	<0.001
Hypertension	1.05	0.62–1.78	0.10
Opium history	0.68	0.32–1.45	0.04
Dyspnea	0.67	0.36–1.22	0.09
Cancer	3.23	1.42–7.39	0.005
Chest pain	2.26	1.09–4.72	0.02
Lactate dehydrogenase			
<480	Referent	Referent	Referent
≥480	1.49	0.88–2.53	0.004
Calcium			
<8.6	Referent	Referent	Referent
8.6–10.2	0.49	0.21–1.14	0.12
≥10.3	0.39	0.39–3.98	0.67
ALT			
<41	Referent	Referent	Referent
≥41	0.90	0.39–1.85	0.007
Pulse rate			
<60	Referent	Referent	Referent
60–99	0.57	0.26–1.21	0.21
≥100	1.54	0.60–3.37	0.16
Respiratory rate			
<25	Referent	Referent	Referent
≥25	0.49	0.28–0.87	0.001

AOR: adjusted odds ratio; CI: confidence interval; ALT: alanine transaminase.

severity and COVID-19 mortality, independent of age and susceptibility.[16] However, this study found that although men were more likely to be infected than women, women were at a higher risk of death suggesting a typical regional pattern rather than a global pattern.

We found that most patients who were discharged had less than 5 days of hospitalization and the length of hospitalization was significantly associated with mortality. This also suggests that the duration of hospital greater than 5 days may put a COVID-19 patient at a higher risk of death. Concerning this, a study was conducted in Iran on 500 COVID-19 patients. It reported an average hospital stay of 10 days. Another interesting point of our study showed that patients with a history of opium use were significantly higher in the expired group compared to the discharged group. However, this may need further investigations to ascertain the exact correlation between mortality rate and opium use in COVID-19 patients.

In terms of COVID-19 patients with a smoking history, a meta-analysis of 1399 COVID-19 cases in a Chinese population found that current smoking status is not related to an elevated risk of poor prognoses in COVID-19 patients which is consistent with our findings.[17] This may point toward a negative relation between the history of smoking and mortality in COVID-19 patients.

Comorbidities

Comorbidities such as DM, hypertension, and cancer predispose COVID-19 patients to poor clinical outcomes, similar to other severe acute respiratory outbreaks, according to our findings. In our analysis, cancer was also attributed to a considerable chance of death. Based on our personal experience, vital medical care for cancer patients was not readily available throughout this outbreak. According to a study on the likelihood for deadly COVID-19 in cancer patients, a small number of patients who were readmitted had other identifiable risk factors for severe disease, rather than the malignancy-specific etiology.[14] In other words, due to complex conditions generated by the malignancy and the co-existing states of chemotherapy and/or radiotherapy, individuals with malignancy cannot be examined and properly assessed.

Clinical manifestations

The most common signs and symptoms were dyspnea, fever, cough, and myalgia. Although a recent study has demonstrated that losing the sense of smell and taste in patients with influenza-like illness manifestations is significantly present in SARS-COV-2 infection, we identified anosmia in 7.4% of all patients.[18] The prevalence of anosmia/hyposmia and ageusia/dysgeusia was found to be 10.5% and 7.5%, respectively, among COVID-19 patients in a similar Iranian study, which overall was more common than what we found in our study.[10]

Laboratory findings

In our investigation, an increased level of LDH and declined levels of lymphocytes were revealed to be significant prognostic predictors of the disease. Similarly, high blood pressure, hypoxia, leukocytosis, lymphopenia, and high serum LDH levels have all been found to be independent predictors of in-hospital mortality in various investigations.[15,19,20]

Study limitations

This investigation was limited to a small number of cases, which may have hampered statistical power, as well as the

inclusion of only hospitalized patients (non-hospitalized patients were not included in the analysis). Because of these restrictions, differences in demographic and clinical variables, as well as laboratory data, may exist between the groups. In addition, missing data on some variables, such as information of computerized tomography (CT) scans, may cause a lack of the identification of other associated factors for mortality in the patients. Also, the study questionnaire has not been validated since it was designed and used by only the authors, per our experience, in gathering the data.

Conclusion

The mortality risk factors for hospitalized patients found in this study using a multivariate logistic regression model include an elderly age (≥ 70 years), being a female, the number of days of hospitalization, and having cancer. Even though opium history, lymphocyte counts, and LDH levels were considerably different in expired and discharged patients, these variables were not determined to be independently related factors for COVID-19 patients' death. However, assessment of these parameters may help to identify severe COVID-19 patients at a higher risk of death. Ultimately, earlier medical intervention and support on these patients with high risk may reduce the fatality of this disease.

ORCID iDs

Nazanin Janfaza [iD] https://orcid.org/0000-0002-0990-620X

Marcarious M. Tantuoyir [iD] https://orcid.org/0000-0002-7645-9999

Supplemental material

Supplemental material for this article is available online.

References

1. Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med* 2020; 382: 727–733.
2. Ghiasvand F, Ghadimi M, Ghadimi F, et al. Symmetrical polyneuropathy in coronavirus disease 2019 (COVID-19). *Idcases* 2020; 21: e00815.
3. Drosten C, Günther S, Preiser W, et al. Identification of a novel coronavirus in patients with severe acute respiratory syndrome. *N Engl J Med* 2003; 348(20): 1967–1976.
4. Sekhavati E, Jafari F, SeyedAlinaghi S, et al. Safety and effectiveness of azithromycin in patients with COVID-19: an open-label randomised trial. *Int J Antimicrob Agents* 2020; 56(4): 106143.
5. Tantuoyir MA-O and Rezaei NA-O. Serological tests for COVID-19: potential opportunities. *Cell Biol Int* 2021; 45(4): 740–748.
6. SeyedAlinaghi S, Mehrtak M, MohsseniPour M, et al. Genetic susceptibility of COVID-19: a systematic review of current evidence. *Eur J Med Res* 2021; 26(1): 46.
7. Mehraeen E, Karimi A, Barzegary A, et al. Predictors of mortality in patients with COVID-19: a systematic review. *Eur J Int Med* 2020; 40: 101226.
8. Halvatsiotis P, Kotanidou A, Tzannis K, et al. Demographic and clinical features of critically ill patients with COVID-19 in Greece: the burden of diabetes and obesity. *Diabetes Res Clin Pract* 2020; 166: 108331.
9. Yuki K, Fujiogi M and Koutsogiannaki S. COVID-19 pathophysiology: a review. *Clin Immunol* 2020; 215: 108427.
10. Alamdari NM, Afaghi S, Rahimi FS, et al. Mortality risk factors among hospitalized COVID-19 patients in a major referral center in Iran. *Tohoku J Exp Med* 2020; 252(1): 73–84.
11. SeyedAlinaghi S, Abbasian L, Solduzian M, et al. Predictors of the prolonged recovery period in COVID-19 patients: a cross-sectional study. *Eur J Med Res* 2021; 26(1): 41.
12. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* 2020; 395(10223): 507–513.
13. Zhang Dong X, Cao YY, Yuan YD, et al. Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. *Allergy* 2020; 75(7): 1730–1741.
14. Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus–infected pneumonia in Wuhan, China. *JAMA* 2020; 323: 1061–1069.

15. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 2020; 394: 1054–1062.

16. Jin J-M, Bai P, He W, et al. Gender differences in patients with COVID-19: focus on severity and mortality. *Front Public Health* 2020; 8: 152.

17. Lippi G and Henry BM. Active smoking is not associated with severity of coronavirus disease 2019 (COVID-19). *Eur J Int Med* 2020; 75: 107–108.

18. Mehraeen E, Behnezhad F, Salehi MA, et al. Olfactory and gustatory dysfunctions due to the coronavirus disease (COVID-19): a review of current evidence. *Eur Archiv Oto-Rhino-Laryngol* 2020; 2020: 1–6.

19. Tian W, Jiang W, Yao J, et al. Predictors of mortality in hospitalized COVID-19 patients: a systematic review and meta-analysis. *J Med Virol* 2020; 92(10): 1875–1883.

20. Li X, Xu S, Yu M, et al. Risk factors for severity and mortality in adult COVID-19 inpatients in Wuhan. *J Allergy Clin Immunol* 2020; 146(1): 110–118.