

Predictors of COVID-19 Disease Course and Pulmonary Insult

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Received: June 2022 Accepted: July 2022; Published: August 1, 2022.

Citation: Diana S. Al-jammal et al.. Predictors of COVID-19 Disease Course and Pulmonary Insult. World Family Medicine. 2022; 20(8): 98-101 DOI: 10.5742/MEWFM.2022.9525126

Abstract

Background: The novel coronavirus disease COVID-19 first appeared in Wuhan, Hubei. It is crucial to identify patients who are susceptible to severe forms of the disease. Imaging has an important role in the confirmation and treatment of COVID-19 pneumonia.

Aim: To assess the predictors of the COVID-19 disease course and pulmonary insult.

Methods: Our retrospective investigation included 115 patients with COVID-19, with a median age of 49.1-66.3 years old, at King Hussein Medical Center, Amman, Jordan. Patients were assigned into one of two groups based on the disease course: group I (n=63) included patients with moderate disease and group II (n=52) included patients with severe disease. Computed tomography (CT) scores of pulmonary insult were determined. Baseline CT findings showed ground-glass opacity, consolidation, crazy-paving pattern and reticular shadow. Each lung region was scored using the five-grade scale to calculate the CT score. Independent factors of moderate COVID-19 were evaluated using binary logistic regression. Multivariate logistic regression was used to predict the CT score in COVID-19.

Results: The independent factors for the COVID-19 disease course were baseline CT score ($P < 0.05$) and C-reactive protein (CRP) ($P < 0.05$). The factors for pulmonary insult were age, neutrophil, lymphocyte and CRP levels and CT score ($P < 0.05$). The cut-off value for CRP was 19.0 and the cut-off value for CT score was 9.0.

Conclusion: Age, baseline CT score, CRP, neutrophil and lymphocyte percentages may predict the CT score of pulmonary insult. A CRP value of more than 19 and baseline CT score of more than 9 were independent factors of severe COVID-19 disease.

Keywords: COVID-19, moderate, severe, pulmonary insult, computed tomography score, neutrophil, lymphocyte, CRP, age.

Introduction

The novel coronavirus COVID-19 is an infectious disease that can lead to pneumonia. It is of unknown cause and appeared primarily in Wuhan, Hubei, China in 2019, endangering public health systems with its fast spread (1). It is crucial to identify patients who are susceptible to severe forms of the disease. A specific epidemiologic history with fever and dry cough are highly indicative of infection with SARS-CoV-2 (the virus that causes COVID-19). Influenza A and B viruses lead to similar symptoms to COVID-19, and it is difficult to distinguish between them (2). For most of cases of suspected COVID-19, laboratory confirmation is time-consuming with false negative results.

Imaging has an important role in the confirmation and treatment of COVID-19 pneumonia. Computed tomography (CT) is the first-step imaging method used in highly suspected cases and for following up modifications during therapy. CT is a powerful tool for clinical confirmation of suspected COVID-19. It confirms negative reverse transcription–polymerase chains in suspected COVID-19. COVID-19 pneumonia is the most frequent clinical feature of the disease (3). The features of CT may give data about the intensity of the disease.

Our investigation aimed to predict pulmonary insult and the clinical course of COVID-19 based on the baseline information of patients, to determine a future therapy protocol.

Methods

Our retrospective investigation included 115 patients with COVID-19, with a median age of 49.1-66.3 years old, at King Hussein Medical Center, Amman, Jordan, during the period April 2020-April 2021. Patients were assigned into one of two groups based on the disease course: group I (n=63) included patients with moderate disease and group II (n=52) included patients with severe disease. Ethical approval was granted by the ethics and research board review committee of the Jordanian Royal Medical Services. CT scores of pulmonary insult were determined. Independent factors affecting the course of moderate disease were evaluated using binary logistic regression. Multivariate logistic regression was used to assess the independent factors and to predict the CT score of pulmonary insult in COVID-19.

COVID-19 was graded into four grades (1): mild (no signs of pneumonia); moderate (fever and respiratory signs with pneumonia); severe (respiratory distress, such as high respiratory rate, reduced oxygen saturation or arterial partial pressure of oxygen/fraction of inspired oxygen < 300 mmHg); critical (respiratory failure and shock).

The CT findings showed the presence of ground-glass opacity, consolidation, crazy-paving pattern and reticular shadow. The scores of chest CT were recorded as in (3); each region was scored on a five-point scale as follows: 0: normal lung; 1: lesion less than 25%; 2: lesion 25%

- 50%; 3: lesion 50% - 75%; 4: lesion more than 75%. CT scores were the baseline score and the score of maximal pulmonary insult. Neutrophil, lymphocyte and C-Reactive Protein (CRP) levels were recorded.

Statistics

Data were analysed using chi-square tests for comparisons between groups. The CT score of maximal pulmonary insult was the dependent variable and the baseline data was the independent variable. Multivariate regression was used; a P-value less than 0.05 was considered statistically significant.

Results

The patients in the moderate group had a median age of 49.1 years. In total, 52 subjects (45.2%), 33 men and 19 women with a median age of 66.3 years, were in group II. Sixty-three patients (54.8%) had no worsening (28 men and 35 women). Around a quarter of the patients' condition (31; 26.96%) developed into the severe form of the disease and 21 (18.3%) into the critical condition.

Age, sex, lymphocyte, neutrophil and CRP levels, consolidation, crazy-paving aspect, reticular shadow and baseline CT score were statistically significant ($P < 0.05$; Table 1). Multivariate logistic regression was performed with moderate and severe groups as the dependent factors. Independent factors influencing clinical picture were CRP ($P < 0.05$) and baseline CT ($P < 0.05$) (Table 2).

The disease duration lasted from 12 to 35 days, and subjects were assigned to three CT investigations. Age, CRP, CT score, neutrophil and lymphocyte levels were statistically significantly related to the CT score of maximal pulmonary insult ($P < 0.05$), with B coefficients of 0.060, 0.108 and 0.387, respectively, of the first three factors. Lymphocyte and neutrophil levels were negatively associated with B coefficients of -0.104 and -0.103, respectively (Table III). The cut-off value for CRP was 19.0 and the cut-off for baseline CT score was 9.0 (Table 3).

Table 1: Characteristics of all COVID-19 patients

	Moderate group (I)	Severe group (II)	P-value
n=	63	52	>0.05
Median age (yrs.)	49.1	66.3	<0.05
Gender (no.)			<0.05
M	27	34	
F	36	18	
Lymphocyte percentage % (median)	29.3	20.6	<0.05
Neutrophil percentage % (median)	61.4	72.2	<0.05
CRP(mg/L) median	13.4	25.5	<0.05
Baseline CT score	4(2,7)	10(5,16)	<0.05
Ground-glass opacity (no.)	52	45	>0.05
Consolidation (no.)	28	34	<0.05
Reticular shadow (no.)	20	27	<0.05
Crazy-paving aspect (no.)	16	23	<0.05

Table 2: Moderate COVID-19 patients

	B coefficient	
	Moderate COVID-19 patients	Maximal pulmonary insult
Baseline CT score	0.101	0.387
CRP mg/L	0.054	0.108
Age	0.021	0.060
Lymphocyte percentage	-0.046	-0.104
Neutrophil percentage, %	-0.065	-0.103

Table 3: Severe COVID-19 patients

	Sensitivity (%)	Specificity (%)
Baseline CT score	40.1	87.2
CRP mg/L	65.2	55.6

Discussion

The disease course of COVID-19 goes through the early, progressive, peak and absorption stages, based on the chest CT (3). Localized ground-glass opacities are seen in the early stage and new ground-glass lesions are seen progressively. Dispersed consolidations with white lung are seen in the peak stage and fibrosis is seen in the absorption stage. For the severe and critical forms of the disease, the tissue insult in pulmonary CT can be seen more at primary confirmation with interstitial lesions more common than in the disease's moderate form (4). Most patients have pathognomonic imaging features necessary for therapy (5). In the severe and critical forms, reduced lymphocytes are seen (6); in mild and moderate cases, CBC and chemistry are normal.

Predictors of maximal pulmonary insult were investigated. Age, baseline CT score, CRP, neutrophil and lymphocyte levels were all important. Age was positively associated

with maximal pulmonary insult; older age is correlated with mortality. CRP was positively associated with maximal pulmonary insult and CT score was positively associated with CRP (7). The baseline CRP level might predict the CT score of maximal pulmonary insult. The baseline CT score was positively associated with the CT score of maximal pulmonary insult. An increased baseline CT score is correlated with a rapid progression of pneumonia and pulmonary insult lung injury. Baseline neutrophil and lymphocyte levels were negatively associated with the maximal pulmonary insult (8). Lymphocyte and neutrophil levels were associated with Murray score values. A CRP level of 19.0 and a baseline CT score of 9 predicted patients developing the severe form of the disease. The CT scores of COVID-19 pneumonia in the severe group were higher than the scores in the moderate group (9). The volume percentage of pneumonia showed increased sensitivity and specificity among those in the severe or critical groups (10). High CRP was a predictor of COVID-19 severity (11).

Conclusion

The maximal pulmonary insult in patients with COVID-19 was associated with baseline CT score, CRP, age and neutrophil levels. A CRP value of 19 and a baseline CT score of 9 were factors for the severe and critical forms of the disease. Maximal pulmonary insult and scoring might be predicted by CT and laboratory analysis.

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