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Research Brief

# An exploration of the characteristics of COVID-19 patients referred to a central cardiology hospital with acute coronary syndrome

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ABSTRACT

This study aimed to evaluate the clinical features of COVID-19 patients diagnosed with acute coronary syndrome (ACS). After obtaining patients' demographic and clinical data, ECG and transthoracic echocardiography were performed for all 228 patients. On average, patients aged 63.23 years. The most common underlying disease was hypertension (59.2%). The most common ECG abnormalities in COVID-19 patients with ACS were ST-T changes and pathological Q wave, and 12.3% experienced atrial fibrillation. According to the Multiple logistic regression analysis, a significant relationship between on admission tachycardia and left ventricular ejection fraction with in-hospital mortality was found (OR = 24.06, 95% CI: 4.63–125.11, OR = 0.92, 95% CI: 0.087–0.98).


## 1. Introduction

Although respiratory involvement is the primary clinical manifestation of COVID-19, it can affect various organs leading to a variety of complications, prominently cardiac damage and coagulation disorders.[1] Earlier investigation on COVID-19 patients indicated that the history of underlying cardiovascular disease (CVD) is a negative prognostic factor.[2] Accordingly, the case fatality rate in COVID-19 patients with no underlying disease is 0.9%, while comorbidities such as CVD, hypertension (HTN), and diabetes mellitus (DM) substantially increase the mortality rate.[2] At least 20% of critically ill COVID-19 patients experience cardiac injuries. Of note, this infection can cause cardiac problems even in patients without a history of CVD.[3] Certain ethnicities and racial groups are disproportionately influenced by COVID-19 disease.[4] Because of differences in demographic and genetic characteristics of the various populations, the generalizability of previously reported pathophysiological parameters to COVID-19 patients may be limited. Therefore, this study aimed to evaluate the clinical, electrocardiographic, and echocardiographic features of COVID-19 patients diagnosed with acute coronary syndrome (ACS) in a central cardiology hospital in the north of Iran.

## 2. Methods

In this observational study, 228 consecutive ACS patients with COVID-19 disease confirmed by a positive reverse transcription-polymerase chain reaction test who were admitted from 02/2020–08/2020 were included. The diagnosis of the ACS was performed based on classical triage of ACS (Typical signs and symptoms of cardiac ischemia, electrocardiographic changes including ST-segment elevation or depression (including J-point elevation in multiple leads), T-wave tenting or inversion, and pathologic Q waves, in addition to assessing cardiac biomarkers) by the physician in charge. Patients' demographic and clinical information was collected by a physician of the team. Patients were admitted to ICU if vital signs and oxygen saturation were difficult to maintain or if lung infection progressed quickly. Vital signs were charted every 4 h. A 12 lead electrocardiography (ECG) was performed for every subject at admission and was repeated when clinically indicated

*Abbreviations:* HF, heart failure; VHD, valvular heart disease; IHD, ischemic heart disease; COPD, chronic obstructive pulmonary disease; CKD, chronic kidney disease; CVA, cerebrovascular accident; HLP, hyperlipidemia; HTN, hypertension; DM, diabetes mellitus; CAG, coronary angiography; CABG, coronary artery bypass graft; SBP, systolic blood pressure; DBP, diastolic blood pressure.

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during hospitalization. Transthoracic echocardiography was performed on the entire population by an expert cardiologist using the 2Dimensional echo of Siemens device. The study protocol was in accordance with the 2013 Helsinki Declaration and was approved by the ethics committee of our University (Code number: 1399.582). Informed consent for participation was obtained from all subjects.

Multiple logistic regression analysis was also applied to examine the relationships of clinical and demographic characteristics with ICU admission and in-hospital mortality. Data analysis was carried out using SPSS version 16.0. The level of significance was set at 0.05.

## 3. Results

The description of baseline characteristics is shown in Table 1. Of the 228 patients, the mean (SD) age was 63.23 (13.59), and 54.8% were male. The most common clinical symptoms of COVID-19 disease were dyspnea (58.3%), nausea/vomiting (20.2%), and cough (12.3%). The mean (SD) length of hospital stay was 9.28 (7.38) days (range:1–45 days). Of the total, 16 (0.7%) were admitted to the ICU due to the disease aggravation, and 16 (0.7%) died in hospital.

Echocardiographic and ECG characteristics are shown in Table 2. The mean ± SD of left ventricular ejection fraction (LVEF) of patients in the ICU and deceased group was significantly lower than survived and non-ICU groups (P < 0.001). Seventy-one percent of patients showed ST-segment changes (42.1% ST-elevation). Pathological Q wave was significantly higher in ICU patients than in the non-ICU group (P = 0.005). Multiple logistic regression analysis showed that the chance of ICU admission in patients with tachycardia (OR = 11.11, 95% CI: 1.93–63.78), and patients who had pathological Q-wave was higher (OR = 6.52, 95% CI; 1.49–28.43). The chance of ICU admission and death decreased with increasing EF (OR = 0.93, 95% CI:0.95–0.99, P = 0.024, OR = 0.93, 95% CI:0.87–0.98, P = 0.012). A significant relationship between tachycardia and LVEF with mortality was also found (OR = 24.06, 95% CI: 4.63–125.11) (Supplementary Table 1).

## 4. Discussion

The most common clinical symptoms in the studied population were dyspnea, nausea/vomiting, and cough. Nearly half of the patients had two or more comorbidities, of which HTN was the most common one. An initial cohort study on COVID-19 characteristics in China revealed that the most common symptoms in COVID-19 patients at presentations were cough, fatigue, and fever.[5] Another large case series of COVID-19 patients in the USA reported that 30% of patients presented with fever, 20% with hypoxia, and 12.2% needed mechanical ventilation.[6] Concordantly, according to previous research, common underlying comorbidities in COVID-19 patients included HTN, DM, and coronary artery diseases, respectively.[7,8] In the present study, severe COVID-19 patients had significantly lower blood pressure (BP) at the admission compared

**Table 1**
Demographic and clinical characteristics of patients with COVID-19 by in-hospital mortality and ICU admission.

| | Total (n = 228) (%) | ICU admission | | | In-hospital mortality | | |
|---|---|---|---|---|---|---|---|
| | | Non-ICU (n = 212) (%) | ICU(n = 16) (%) | P | Survived (n = 212) (%) | Deceased (n = 16) (%) | P |
| Demographics | | | | | | | |
| Age (years) | 63.23 ± 13.59 | 62.85 ± 13.42 | 68.31 ± 15.33 | 0.121 | 63.21 ± 13.15 | 63.56 ± 19.06 | 0.943 |
| Male Sex | 125 (54.8) | 114 (53.8) | 11 (68.8) | 0.246 | 115 (54.2) | 10 (62.5) | 0.522 |
| Active smoking | 67 (29.4) | 60 (28.3) | 7 (43.8) | 0.253 | 61 (28.8) | 6 (37.5) | 0.460 |
| Opium consumption | 38 (16.7) | 33 (15.6) | 5 (31.2) | 0.000 | 33 (15.6) | 5 (31.2) | 0.154 |
| Comorbidities | | | | | | | |
| HF | 16 (7.0) | 14 (6.6) | 2 (12.5) | 0.311 | 13 (6.1) | 3 (18.8) | 0.090 |
| VHD | 3 (1.3) | 3 (1.4) | 0 (0) | 1.000 | 3 (1.4) | 0 (0) | 1.000 |
| IHD | 25 (11.0) | 20 (9.4) | 5 (31.2) | 0.020 | 22 (10.4) | 3 (18.8) | 0.395 |
| COPD | 2 (0.9) | 2 (0.9) | 0 (0) | 1.000 | 2 (0.9) | 0 (0) | 1.000 |
| CKD | 8 (3.5) | 7 (3.3) | 1 (6.2) | 0.447 | 7 (3.3) | 1 (6.2) | 0.447 |
| CVA | 8 (3.5) | 7 (3.3) | 1 (6.2) | 0.447 | 7 (3.3) | 1 (6.2) | 0.447 |
| DM | 87 (38.2) | 79 (37.3) | 8 (50.0) | 0.424 | 79 (37.3) | 8 (50.0) | 0.312 |
| HLP | 74 (32.5) | 69 (32.5) | 5 (31.2) | 0.915 | 71 (33.5) | 3 (18.8) | 0.225 |
| HTN | 135 (59.2) | 125 (59.0) | 10 (62.5) | 0.781 | 125 (59.0) | 10 (62.5) | 0.781 |
| No. of comorbidities | | | | 0.059 | | | 0.149 |
| 0 | 50 (21.9) | 50 (23.6) | 0 (0) | | 49 (23.1) | 1 (6.2) | |
| 1 | 72 (31.6) | 64 (30.2) | 8 (50.0) | | 64 (30.2) | 8 (50.0) | |
| ≥ 2 | 106 (46.5) | 98 (46.2) | 8 (50.0) | | 99 (46.7) | 7 (43.8) | |
| Cardiac intervention | | | | | | | |
| CAG | 65 (28.5) | 61 (28.8) | 4 (25.0) | 1.000 | 62 (29.2) | 3 (18.8) | 0.567 |
| CABG | 23 (10.1) | 22 (10.4) | 1 (6.2) | 1.000 | 22 (10.4) | 1 (6.2) | 1.000 |
| No. of symptoms | | | | 0.237 | | | 0.207 |
| 0 | 53 (23.2) | 50 (23.6) | 3 (18.8) | | 51 (24.1) | 2 (12.5) | |
| 1 | 116 (50.9) | 110 (51.9) | 6 (37.5) | | 109 (51.4) | 7 (43.8) | |
| ≥ 2 | 59 (25.9) | 52 (24.5) | 7 (43.8) | | 52 (24.5) | 7 (43.8) | |
| Physiological parameters | | | | | | | |
| SBP | 128.32 ± 24.81 | 129.49 ± 24.60 | 112.81 ± 22.87 | 0.009 | 130.20 ± 24.34 | 103.44 ± 16.50 | <0.001 |
| DBP | 78.38 ± 12.63 | 79.03 ± 12.39 | 69.69 ± 12.97 | 0.004 | 79.20 ± 12.44 | 67.50 ± 10.00 | <0.001 |
| Temperature | 36.96 ± 0.43 | 36.96 ± 0.44 | 36.90 ± 0.31 | 0.570 | 36.96 ± 0.44 | 36.97 ± 0.28 | 0.927 |
| Respiratory Rate | 19.07 ± 3.54 | 19.13 ± 3.32 | 18.31 ± 5.77 | 0.373 | 19.02 ± 3.13 | 19.81 ± 7.12 | 0.664 |
| Heart Rate | 85.60 ± 18.86 | 85.07 ± 18.53 | 92.62 ± 22.35 | 0.122 | 84.82 ± 18.60 | 95.94 ± 19.87 | 0.023 |
| O2 sat | 93.99 ± 6.53 | 94.33 ± 6.15 | 89.56 ± 9.54 | 0.067 | 94.43 ± 6.16 | 88.19 ± 8.49 | 0.011 |

Values are given as numbers (percentage) for categorical variables and mean ± standard deviation for continuous variables. Continuous variables are presented as mean (standard deviation (SD)) and compared using the independent t-test. Categorical variables are presented as numbers (percentages) and compared using the chi-square test. HF; heart failure, VHD; valvular heart disease, IHD; ischemic heart disease, COPD; chronic obstructive pulmonary disease, CKD; chronic kidney disease, CVA; cerebrovascular accident, HLP; hyperlipidemia, HTN; hypertension, DM; diabetes, CAG; coronary angiography, CABG; coronary artery bypass graft, SBP; systolic blood pressure, DBP; diastolic blood pressure.

**Table 2**
Echocardiographic and electrocardiographic (ECG) characteristics of patients with COVID-19 by in-hospital mortality and ICU admission.

| | Total (n = 228) (%) | ICU admission | | | In-hospital mortality | | |
|---|---|---|---|---|---|---|---|
| | | Non-ICU (n = 212) (%) | ICU (n = 16) (%) | P | Survived (n = 212) (%) | Deceased (n = 16) (%) | P |
| Echocardiographic Findings | | | | | | | |
| Pericardial effusion | 29 (12.7) | 26 (12.3) | 3 (18.8) | 0.437 | 27 (12.7) | 2 (12.5) | 1.000 |
| Pleural effusion | 4 (1.8) | 4 (1.9) | 0 (0) | 1.000 | 3 (1.4) | 1 (6.2) | 0.254 |
| LV dilation | 31 (13.6) | 29 (13.7) | 2 (12.5) | 1.000 | 30 (14.2) | 1 (6.2) | 0.704 |
| RV dilation | 8 (3.5) | 7 (3.3) | 1 (6.2) | 0.447 | 7 (3.3) | 1 (6.2) | 0.447 |
| LV systolic dysfunction | 108 (47.4) | 98 (46.2) | 10 (62.5) | 0.299 | 98 (46.2) | 10 (62.5) | 0.209 |
| LV diastolic dysfunction | 11 (4.8) | 10 (4.7) | 1 (6.2) | 0.559 | 10 (4.7) | 1 (6.2) | 0.559 |
| LVH | 32 (14.0) | 32 (15.1) | 0 (0) | 0.137 | 30 (14.2) | 2 (12.5) | 1.000 |
| Mitral regurgitation | 173 (75.9) | 161 (75.9) | 12 (75.0) | 1.000 | 159 (75.0) | 14 (87.5) | 0.369 |
| Mitral stenosis | 10 (4.4) | 10 (4.7) | 0 (0) | 1.000 | 10 (4.7) | 0 (0) | 1.000 |
| Tricuspid regurgitation | 139 (61.0) | 130 (61.3) | 9 (56.2) | 0.688 | 127 (59.9) | 12 (75.0) | 0.294 |
| Aortic regurgitation | 80 (35.1) | 74 (34.9) | 6 (37.5) | 0.834 | 73 (34.4) | 7 (43.8) | 0.451 |
| Pulmonary regurgitation | 11 (4.8) | 10 (4.7) | 1 (6.2) | 0.559 | 9 (4.2) | 2 (12.5) | 0.175 |
| EF | 36.14 ± 12.99 | 36.96 ± 12.72 | 25.31 ± 11.89 | <0.001 | 36.98 ± 12.70 | 25.00 ± 12.38 | <0.001 |
| ECG Findings | | | | | | | |
| Heart Rate | | | | 0.005 | | | <0.001 |
| Normal | 164 (71.9) | 158 (74.5) | 6 (37.5) | | 160 (75.5) | 4 (25.0) | |
| Tachycardia | 55 (24.1) | 46 (21.7) | 9 (56.2) | | 44 (20.8) | 11 (68.8) | |
| Bradycardia | 9 (3.9) | 8 (3.8) | 1 (6.2) | | 8 (3.8) | 1 (6.2) | |
| Heart Rhythm | | | | 0.425 | | | 0.425 |
| Sinus | 200 (87.7) | 187 (88.2) | 13 (81.2) | | 187 (88.2) | 13 (81.2) | |
| AF | 28 (12.3) | 25 (11.8) | 3 (18.8) | | 25 (11.8) | 3 (18.8) | |
| Axis | | | | 0.215 | | | 0.215 |
| Normal | 175 (76.8) | 165 (77.8) | 10 (62.5) | | 165 (77.8) | 10 (62.5) | |
| Right or left deviation | 53 (23.2) | 47 (22.2) | 6 (37.5) | | 47 (22.2) | 6 (37.8) | |
| P wave (199 = n) | | | | 1.000 | | | 0.337 |
| Normal | 193 (97.0) | 180 (96.8) | 13 (100) | | 181 (97.3) | 12 (92.3) | |
| Abnormal | 6 (3.0) | 6 (3.2) | 0 (0) | | 5 (2.7) | 1 (7.7) | |
| PR interval (198 = n) | 156.26 ± 30.23 | 155.57 ± 30.36 | 166.15 ± 27.55 | 0.223 | 156.00 ± 30.13 | 160.00 ± 32.66 | 0.646 |
| Pathologic Q wave | 83 (36.4) | 72 (34.0) | 11 (68.8) | 0.005 | 74 (34.9) | 9 (56.2) | 0.087 |
| ST segment | | | | 0.636 | | | 0.935 |
| Normal | 66 (28.9) | 61 (28.8) | 5 (31.2) | | 62 (29.2) | 4 (25.0) | |
| Elevation | 96 (42.1) | 88 (41.5) | 8 (50.0) | | 89 (42.8) | 7 (43.8) | |
| Depression | 66 (28.9) | 63 (29.7) | 3 (18.8) | | 61 (28.8) | 5 (31.2) | |
| T wave | | | | 0.166 | | | 0.393 |
| Normal | 91 (39.9) | 82 (38.7) | 9 (56.2) | | 83 (39.2) | 8 (50.0) | |
| Abnormal (sharp, inverted, flat) | 137 (60.1) | 130 (61.3) | 7 (43.8) | | 129 (60.8) | 8 (50.0) | |
| Corrected QT interval (QTc) | 412.46 ± 42.95 | 413.13 ± 42.83 | 403.56 ± 44.79 | 0.391 | 412.07 ± 41.74 | 417.69 ± 58.13 | 0.615 |
| Block | | | | 0.555s | | | 0.072 |
| No | 171 (75.0) | 160 (75.5) | 11 (68.8) | | 162 (76.4) | 9 (56.2) | |
| YES | 57 (25.0) | 52 (24.5) | 5 (31.2) | | 50 (23.6) | 7 (43.8) | |

Values are given as numbers (percentage) for categorical variables and mean ± standard deviation for continuous variables. Continuous variables are presented as mean (standard deviation (SD)) and compared using the independent t-test. Categorical variables are presented as numbers (percentages) and compared using the chi-square test. LV; left ventricle, RV; right ventricle, LVH; left ventricular hypertrophy, EF; ejection fraction, AF; atrial fibrillation.

to the non-severe group. Similarly, one previous study on critical COVID-19 patients showed that those admitted with hypotension and those who developed persistent hypotension developed critical status consequently. The primary reason for low BP can be a septic shock due to severe infection. Also, other reversible causes of low BP include fever, sweating, and inadequate intake leading to hypovolemia and electrolyte imbalance.[9]

ECG changes for COVID-19 patients demonstrate several cardiovascular alterations ranging from ST-T changes to rhythm disorders, acute pulmonary thromboembolism, and acute myocarditis.[10] In the present study, the most common ECG abnormality in COVID-19 patients with ACS were ST-T changes and pathological Q waves. Moreover, atrial fibrillation (AF) was the most common observed arrhythmia. Previous studies provided a prevalence of acute myocardial infarction (MI) of 12% in their cohort as defined by either high sensitivity-troponin or CK-MB > 99th percentile or new ECG and echocardiographic abnormalities.[11] It is unclear whether the increase in cardiac biomarkers is linked to viral myocarditis, plaque rupture secondary to virus-induced inflammatory response, or a type 1 MI.[12] Also, based on the results of similar studies, it was suggested that MI might be a marker of more severe infection and not causally related.[8] In line with our findings, earlier research demonstrated that AF appeared to be the most reported arrhythmia with COVID-19 patients, with a prevalence of up to 50% in patients requiring intensive care.[13] This finding spotlight the consideration for long-term anticoagulant treatment. Further, patients of the present study seemed to have severely reduced EF, and nearly half of the population had left ventricular (LV) systolic dysfunction. The mean EF of patients in the ICU and deceased group was significantly lower than others. Likewise, Karan Sud et al showed that 54% of their patients had LV dysfunction described as regional and/or global systolic dysfunction. This can be suggestive of ischemia due to large or small vessel obstruction, and a prothrombic state might be a prevalent mechanism of damage. Also, it raises the concern for potential direct cardiotoxicity by virus resulting in a decrease in myocardial function.[14,15] Identifying the pattern of organ involvement and illness progression course is one of the main purposes of ongoing clinical research about COVID-19. Based on the findings of the present study, it seems that ECG changes in patients with Covid-19, whether due to underlying heart disease or complications of the infection, can affect patient outcomes. Also, the findings of the present study showed that evaluation of changes in ECG,

echocardiogram, and serum troponin could provide valuable information about the prognosis of patients with Covid-19.

## Declarations

*Conflict of interests*

All authors declare that they have no conflict of interest.

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This research did not receive any specific grant from funding agencies in public, commercial or not-for-profit sectors.

*Ethics approval and consent to participate*

The study protocol was in accordance with the guidelines of the 2013 version of the Helsinki Declaration and was approved by the ethics committee of Guilan University of Medical Sciences with the code number IR. GUMS.REC.1399.582. Informed consent for participation was obtained from all subjects.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ihj.2021.12.013.

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