

# Epidemiological and clinical features of 201 COVID-19 patients in Changsha, China

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Jian Zhou  
second xiangya hospital

Jing-jing Sun  
second xiangya hospital

Zi-qin Cao  
second xiangya hospital

Wan-chun Wang  
second xiangya hospital

Kang Huang  
First Hospital of changsha city

Fang Zheng  
first hospital of changsha city

Yuan-lin Xie  
first hospital of changsha city

Di-xuan Jiang  
first hospital of changsha city

Zhi-guo Zhou  
first hospital of changsha city

✉ [cszhouzhiguo@outlook.com](mailto:cszhouzhiguo@outlook.com) *Corresponding Author*

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## Abstract

### Background

In December 2019, a cluster of coronavirus Disease 2019 (COVID-19) occurred in Wuhan, Hubei Province, China. With the advent of the Chinese Spring Festival, this disease spread rapidly throughout the country. The information about the clinical characteristics of COVID-19 patients outside of Wuhan is limited.

### Methods

All of the patients with confirmed COVID-19 were admitted to the First Hospital of Changsha City, the designated hospital for COVID-19 assigned by the Changsha City Government. The clinical and epidemiological characteristics, data of laboratory, radiological picture, treatment, and outcomes records of 201 COVID-19 patients were collected using electronic medical records.

### Results

This study population consisted of 201 hospitalized patients with laboratory-confirmed COVID-19 in Changsha by February 15, 2020. The median age of the patients was 45 years (IQR 34–59). About half (50.7%) of the patients were male, and most of the infected patients were staff (96 [47.8%]). Concerning the epidemiologic history, the number of patients linked to Wuhan was 92 (45.8%). The most common symptoms were fever (125 [62.2%]), dry cough (118 [58.7%]), fatigue (65 [32.3%]), and pharyngalgia (31 [15.4%]). One hundred and forty-four (71.6%) enrolled patients showed bilateral pneumonia. Fifty-four (26.9%) patients showed unilateral involvement, and three (1.5%) patients showed no abnormal signs or symptoms. The laboratory findings differed significantly between the Intensive Care Unit (ICU) and non-ICU groups. Compared with non-ICU patients, ICU patients had depressed white blood cell (WBC), neutrocytes, lymphocytes, and prolonged prothrombin time (PT). Moreover, higher plasma levels of erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), procalcitonin (PCT), alanine aminotransferase (ALA), aspartate aminotransferase (AST), creatine kinase (CK), creatine kinase-MB (CK-MB), creatinine (CREA), and lactate dehydrogenase (LDH) were detected in the ICU group.

### Conclusions

In this single-center study of 201 COVID-19 patients in Changsha, China, 22.4% of patients were admitted to ICU. Based on our findings, we propose that the risk of cellular immune deficiency, hepatic injury, and kidney injury should be monitored. Previous reports focused on the clinical features of patients from Wuhan, China. With the global epidemic of COVID-19, we should pay more attention to the clinical and epidemiological characteristics of patients outside of Wuhan.

## Background

In December 2019, a series of COVID-19 occurred in Wuhan, Hubei Province, China[1-4], which was caused by SARS-CoV-2 infection. Most of the COVID-19 patients were concentrated in Wuhan, and their exposure history related them to the Huanan Seafood Wholesale Market at the beginning[5]. However, the infection rapidly spread from Wuhan to all over the country because of the population movement during the Spring Festival. As of March 2, 2020, a total of 80813 cases and 21304 cases had been detected in China and other countries around the world, respectively[6, 7].

Acute respiratory infection symptoms, including high temperature, dry cough, fatigue, and breathing difficulty, are the main early symptoms of the disease[8]. Along with disease progression, some patients rapidly develop acute respiratory distress syndrome (ARDS), acute respiratory failure, and other several complications, especially for older patients or those with immunodeficiency.

In the past month, several studies[9-13] reported the epidemiological, demographic, clinical, laboratory, and radiological characteristics of COVID-19 patients in Wuhan city. In the present study, we performed a comprehensive analysis to describe the clinical features, epidemiologic characteristics, treatment, and outcomes of 201 COVID-19 patients in Changsha, China, a city outside of Wuhan, and the differences of clinical features between ICU and non-ICU patients were analyzed. Our study findings provide information about COVID-19 patients outside of Wuhan.

## Methods

### Patients

Related data were collected from the First Hospital of Changsha city, the designated hospital for COVID-19 assigned by the Changsha city government. All of the patients enrolled in this report were admitted from January 1, 2020 to February 29, 2020. The First Hospital of Changsha city is located in Changsha, Hunan Province, a neighboring province of Hubei province. The ethics commissions

approved this study of the First Hospital of Changsha City, and written consents were obtained from the enrolled patients. All of the patients involved in the present study were diagnosed according to World Health Organization interim guidance[14]. The clinical outcomes, including discharge, hospitalization days, and death, were recorded up to February 15, 2020.

## Data Collection

The research team from the Second Xiangya Hospital of Central South University and The First Hospital of Changsha city conducted a comprehensive analysis of the medical information of COVID-19 patients. In this report, we obtained the clinical and epidemiological characteristics, data of laboratory, radiological picture, treatment, and outcomes records using electronic medical records. The medical information, including demographic data (age, gender, and occupation), exposure history, medical history, comorbidities, signs, symptoms, chest computed tomographic (CT) scans, laboratory results, and treatment, such as antibacterial therapy, glucocorticoid therapy, and antiviral therapy, was collected. The durations from exposure to Wuhan to the onset of disease and the course of disease were recorded.

## Real-Time Reverse Transcription Polymerase Chain Reaction (RT-PCR) Assay for SARS-CoV-2

The laboratory test assays of 2019-nCoV were conducted according to the WHO recommendation.[15] Laboratory identification of 2019-nCoV was performed in three different institutions: The First Hospital of Changsha City, Hunan Center for Disease Control, and Prevention (Hunan CDC) and Chinese CDC (CCDC). Upper and lower respiratory tract specimens were collected for extracting SARS-CoV-2 RNA. RNA was obtained and further tested by RT-PCR through the same method previously described[16]. Other respiratory viruses (influenza A virus, influenza B virus, respiratory syncytial virus) and parainfluenza virus were also tested in this study.

## Statistical Analysis

Continuous variables were described as median and IQR. Categorical variables were expressed using the number and percentages. Mann-Whitney U test was performed for continuous variables, and the  $\chi^2$  test or Fisher's exact test was conducted for categorical variables. A two-sided  $\alpha < 0.05$  was considered to be statistically significant. All of the statistical analyses were performed using

Statistical Package for the Social Sciences (SPSS) version 17.0 software.

## Role Of The Funding Source

The study funders/sponsors had no role in the design and conduction of the study, including the collection, management, analysis and interpretation of the data, preparation, review, or approval of the manuscript, and the decision to submit the manuscript for publication. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Results

This study population consisted of 201 hospitalized patients aged 1–84 with laboratory-confirmed COVID-19 in Changsha by February 15, 2020. Forty-five (22.4%) of the Severe Acute Respiratory Syndrome Coronavirus 2 CoV (SARS-COV-2) infected patients were admitted to the ICU due to a rapid deterioration of clinic condition, and 156 (77.6%) were in isolated wards. The median age of the ICU and non-ICU groups were 57.0 (IQR 46.0–66.0) and 40.0 (IQR 31.0–53.0), respectively. Nine (4.5%) adolescent patients under the age of 18 were all in the non-ICU group. About half of the patients (102 (50.7%)) were male, most of the infected patients work as staff (96 [47.8%]), and other occupations included farmer (5 [2.5%]), self-employed worker (13 [6.5%]), student (13 [6.5%]), retiree (48 [23.9%]), and unemployed (26 [12.9%]). Concerning the epidemiologic history, the number of patients with links to Wuhan was 92 (45.8%). The number of patients exposed to the Wuhan city in the ICU group (26 [57.8%]) was significantly higher than that of the non-ICU group (66 [42.3%]) ( $P = 0.048$ ). Most enrolled patients (138 [68.7%]) were admitted to the hospital between February 1 and February 15. Compared with the non-ICU group (42 [26.9%]), more patients were admitted to the ICU in January in the ICU group (21 [46.7%]) ( $P = 0.017$ ). The median time between onset and admission was five days (IQR 3–8) in both the ICU and non-ICU groups. Additionally, the incubation period of the disease was six days (IQR 4–9) in the ICU group, six days (IQR 3.0–7.3) in the non-ICU group, and six days (IQR 3.8–8.0) in total. As of February 15, 2020, 137 patients (68.2%) were still hospitalized. A total of 63 patients (31.3%) had been discharged, and one patient (0.5%) had died. Of the 45 patients admitted to the ICU, 32 (71.1%) were still in the ICU, 12 (26.7%) had been discharged, and 1 (2.2%) had died. The hospital stay was six days (IQR 5.0–9.0) (Table 1).

Table 1

Epidemiological characteristics of COVID-19 patients. Data are shown as median (IQR) or n (%). ICU = intensive care unit. P values comparing ICU group and non-ICU group were obtained from  $\chi^2$  test, Fisher's exact test, or Mann-Whitney U test. #Data available for 63 discharged patients. \*  $P < 0.05$ .

	No. (%)			
	ICU (n = 45)	Non-ICU (n = 156)	Total (n = 201)	P Value
Age, median (IQR), y	57.0 (46.0–66.0)	40.0 (31.0–53.0)	45.0(33.8–59.0)	< 0.0001*
Sex				
Male	27 (60.0%)	75 (48.1%)	102 (50.7%)	0.178
Female	18 (40.0%)	81 (51.9%)	99 (49.3%)	
Occupation				
Office worker	18 (40.0%)	78 (50.0%)	96 (47.8%)	0.006*
Unemployed	3 (6.7%)	23 (14.7%)	26 (12.9%)	
Retired	16 (35.6%)	32 (20.5%)	48 (23.9%)	
Self-employed laborer	5 (11.1%)	8 (5.1%)	13 (6.5%)	
Peasant	3 (6.7%)	2 (1.3%)	5 (2.5%)	
Student	0 (0.0%)	13 (8.3%)	13 (6.5%)	
Exposure with Wuhan				
Yes	26 (57.8%)	66 (42.3%)	92 (45.8%)	0.048*
No	19 (42.2%)	90 (57.7%)	109 (54.2%)	
Date of admission				
January	21 (46.7%)	42 (26.9%)	63 (31.3%)	0.017*
February	24 (53.3%)	114 (73.1%)	138 (68.7%)	
Duration of complaint	5.0 (3.0–8.0)	5.0 (3.0–8.0)	5.0 (3.0–8.0)	0.4904
Incubation	6.0 (4.0–9.0)	6.0 (3.0–7.3)	6.0 (3.8–8.0)	0.6978
Outcome				
Remained in hospital	32 (71.1%)	105 (67.3%)	137 (68.2%)	0.209
Discharge	12 (26.7%)	51 (3.3%)	63 (31.3%)	
Death	1 (2.2%)	0 (0.0%)	1 (0.5%)	
Hospitalization days <sup>#</sup>	11.0 (10.0–12.0)	6.0 (4.0–7.0)	6.0 (5.0–9.0)	< 0.00*

Seventeen (37.8%) patients of the ICU group and 24 patients (5.4%) of the non-ICU group had cardiovascular or respiratory system diseases. The most common symptoms were fever (135 [67.2%]), dry cough (118 [58.7%]), fatigue (65 [32.3%]), and pharyngalgia (31 [15.4%]). Less common symptoms were polypnea (22 [10.9%]), myalgia (21 [10.4%]), pharyngalgia (31 [15.4%]), headache (18 [9.0%]), diarrhea (17 [8.5%]), chest tightness (16 [8.0%]), rhinorrhoea (10 [5.0%]), and vomiting (8 [4.0%]). Compared with the non-ICU patients, patients admitted to ICU were more likely to report high-grade fever, dry cough, polypnea, and fatigue. Of the 201 patients, most patients had low (76 [37.8%]) to moderate (49 [22.4%]) grade fever or normal temperature (66 [32.8%]). One hundred and forty-four (71.6%) enrolled patients showed unilateral pneumonia by chest CT scan (Fig. 1). Fifty-four (26.9%) patients showed bilateral pneumonia, and three (1.5%) patients showed no abnormal signs or symptoms. Resting heart rate and mean arterial blood pressure did not differ between the two groups ( $P > 0.05$ ). Compared with patients who did not receive ICU care, patients

who received ICU care had a higher respiratory rate ( $P = 0.0457$ ). Forty-five (100%) patients, 44 (97.8%) patients, and 44 (97.8%) patients in the ICU group received treatments of antibiotic, glucocorticoid, and immunoglobulin, respectively; the frequency of patients who received no ICU care receiving these treatments was lower (Table 2).

Table 2

Clinical characteristics and treatment of COVID-19 patients. Data are shown as median (IQR) or n (%). ICU = intensive care unit. P values comparing ICU group and non-ICU group were obtained from  $\chi^2$  test, Fisher's exact test, or Mann-Whitney U test. \*  $P < 0.05$ .

	No. (%)			P Value
	ICU (n = 45)	Non-ICU (n = 156)	Total (n = 201)	
<b>Cardiovascular or respiratory system diseases</b>				
With	17 (37.8%)	24 (15.4%)	41 (20.4%)	0.003*
Without	28 (62.2%)	132 (84.6%)	160 (79.6%)	
<b>Signs and symptoms</b>				
<b>Maximum temperature (°C)</b>				
< 37.3	8 (17.8%)	58 (37.2%)	66 (32.8%)	0.005*
37.3–38.0	17 (37.8%)	59 (37.8%)	76 (37.8%)	
38.1–39.0	14 (31.1%)	35 (22.4%)	49 (24.4%)	
> 39.0	6 (13.3%)	4 (2.6%)	10 (5.0%)	
Cough	33 (73.3%)	85 (54.5%)	118 (58.7%)	0.026*
Polypnea	17 (37.8%)	5 (3.2%)	22 (10.9%)	0.000*
Myalgia	7 (15.6%)	14 (9.0%)	21 (10.4%)	0.266
Fatigue	23 (51.1%)	42 (26.9%)	65 (32.3%)	0.004*
Headache	6 (13.3%)	12 (7.7%)	18 (9.0%)	0.245
Pharyngalgia	6 (13.3%)	25 (16.0%)	31 (15.4%)	0.816
Chest pain /tightness	5 (11.1%)	11 (7.1%)	16 (8.0%)	0.361
Rhinorrhoea	3 (6.7%)	7 (4.5%)	10 (5.0%)	0.696
Diarrhea	5 (11.1%)	12 (7.7%)	17 (8.5%)	0.543
Vomiting	1 (2.2%)	7 (4.5%)	8 (4.0%)	0.687
Respiratory rate, median (IQR)	20.0 (20.0–22.0)	20.0 (20.0–20.0)	20.0 (20.0–21.0)	0.0457*
Heart rate, median (IQR), bpm	92.0 (79.0–102.0)	85.0 (78.0–96.5)	86.5 (78.0–98.8)	0.2004
Mean arterial pressure, median (IQR), mmHg	92.3 (84.3–101.3)	92.7 (86.7–100.3)	92.7 (86.7–100.6)	0.8912
<b>Chest CT findings</b>				
Unilateral pneumonia	29 (64.4%)	115 (73.7%)	144 (71.6%)	0.284
Bilateral pneumonia	16 (35.6%)	38 (24.4%)	54 (26.9%)	
No finding	0 (1.9%)	3 (1.9%)	3 (1.5%)	
<b>Treatment</b>				
Antibiotic treatment	45 (100.0%)	59 (37.8%)	104 (51.7%)	0.000*
Glucocorticoid treatment	44 (97.8%)	22 (14.1%)	66 (32.8%)	0.000*
Immunoglobulin treatment	44 (97.8%)	19 (12.2%)	63 (31.3%)	0.000*

The laboratory findings differed significantly between the ICU and non-ICU groups. Concerning the blood counts of patients on admission, the white blood cell count of 75 patients (37.3%) was less than  $4 \times 10^9/L$ , and the lymphocyte count of 46 patients (22.9%) was less than  $0.8 \times 10^9/L$ . Compared with the non-ICU group, high levels of ESR (median 52.0 [IQR 36.0–72.0]) CRP (median 42.4 [IQR 22.0–

73.9]), and PCT (median 0.05 [0.05-0.08]) were observed in the ICU group. Prolonged prothrombin time (median 12.0 [IQR 11.3-12.5]) and a higher level of D-dimer (median 0.25 [IQR 0.14-0.52]) on admission were found in the ICU patients. Levels of ALA, AST, CK, and LDH were significantly increased in the ICU group. These laboratory results were recorded on the first day after admission for all of the patients, and then on those who later received ICU care or not (Table 3).

Table 3

Laboratory results of COVID-19 patients. ICU = intensive care unit. P values comparing ICU group and non-ICU group were obtained from  $\chi^2$  test, Fisher's exact test, or Mann-Whitney U test. \* P < 0.05.

	Reference range	ICU (n = 45)	Non-ICU (n = 156)	Total (n = 201)	P Value
White-cell count ( $10^9/L$ )	4-10	4.53 (3.25-5.92)	4.63 (3.57-5.66)	4.58 (3.44-5.67)	0.5372
≤4		18 (40.0%)	57 (36.5%)	75 (37.3%)	0.727
>4		27 (60.0%)	99 (63.5%)	126 (62.7%)	
Platelet count ( $10^9/L$ )	100-300	160.0 (132.0-208.0)	171.5 (136.3-227.8)	170.0 (135.5-224.0)	0.2530
≤100		4 (8.9%)	11 (7.1%)	15 (7.5%)	0.748
>100		41 (91.1%)	145 (92.9%)	186 (92.5%)	
Hemoglobin (g/L)	110-160	131.0 (119.5-145.0)	130.5 (121.0-141.0)	131.0 (120.5-141.5)	0.7813
≤110		4 (8.9%)	11 (7.1%)	15 (7.5%)	0.748
>110		41 (91.1%)	145 (92.9%)	186 (92.5%)	
Absolute lymphocyte count ( $10^9/L$ )	0.8-4	0.78 (0.54-1.03)	1.22 (0.94-1.70)	1.1 (0.8-1.6)	< 0.0001*
≤0.8		23 (51.1%)	23 (14.7%)	46 (22.9%)	0.000*
>0.8		22 (48.9%)	133 (85.3%)	155 (77.1%)	
Absolute neutrophil count ( $10^9/L$ )	2-7	3.14 (2.11-4.40)	2.47 (1.92-3.13)	2.9 (2.0-3.8)	0.0256*
Erythrocyte sedimentation rate (mm/h)	0-15	52.0 (36.0-72.0)	35.0 (21.0-59.0)	39.0 (22.0-63.5)	0.0059*
C-reactive protein (mg/L)	0-8	42.4 (22.0-73.9)	12.2 (4.2-23.7)	15.7 (5.4-35.3)	< 0.0001*
≤8		2 (4.4%)	67 (42.9%)	69 (34.3%)	0.000*
>8		43 (95.6%)	89 (57.1%)	132 (65.7%)	
Procalcitonin (ng/ml)	0-0.05	0.05 (0.05-0.08)	0.05 (0.05-0.05)	0.05 (0.03-0.06)	0.0007*
≤0.05		26 (57.8%)	118 (75.6%)	144 (71.6%)	0.024*
>0.05		19 (42.2%)	38 (24.4%)	57 (28.4%)	
Activated partial thromboplastin time (s)	26.2-46	32.4 (30.2-34.5)	32.6 (30.4-35.2)	32.5 (30.4-35.1)	0.4956
Prothrombin time (s)	10-15	12.4 (11.8-13.0)	11.8 (11.3-12.4)	12.0 (11.3-12.5)	0.0001*
D-Dimer(ug/ml)	0-1	0.32 (0.13-0.61)	0.23 (0.14-0.50)	0.25 (0.14-0.52)	0.4248
≤1		42 (93.3%)	149 (95.5%)	191 (95.0%)	0.696
>1		3 (6.7%)	7 (4.5%)	10 (5.0%)	
Albumin (g/L)	35-55	35.4 (31.4-36.7)	38.7 (35.9-41.5)	38.0 (35.3-40.5)	< 0.0001*
≤35		20 (44.4%)	25 (16.0%)	45 (22.4%)	0.000*
>35		25 (55.6%)	131 (84.0%)	156 (77.6%)	
Alanine aminotransferase (U/L)	0-42	21.7 (17.2-31.2)	18.7 (14.5-26.4)	19.3 (14.8-27.7)	0.0096*
≤42		37 (82.2%)	144 (92.3%)	181 (90.0%)	0.085
>42		8 (17.8%)	12 (7.7%)	20 (10.0%)	
Aspartate aminotransferase	0-37	30.65 (25.59-43.85)	23.54 (18.94-28.45)	24.8 (20.0-31.3)	< 0.0001*

e (U/L)					
≤37		31 (68.9%)	139 (89.1%)	170 (84.6%)	0.002*
>37		14 (31.1%)	17 (10.9%)	31 (15.4%)	
Creatine kinase (U/L)	10-190	104.7 (66.7-160.3)	68.5 (44.5-110.9)	75.9 (46.6-120.8)	0.0011*
≤190		34 (75.6%)	143 (91.7%)	177 (88.1%)	0.007*
>190		11 (24.4%)	13 (8.3%)	24 (11.9%)	
Creatine kinase-MB (U/L)	0-24	11.2 (6.8-15.2)	9.7 (5.9-12.2)	10.0(6.1-12.8)	0.0981
≤24		38 (84.4%)	148 (92.5%)	186 (92.5%)	0.046*
>24		7 (15.6%)	8 (7.5%)	15 (7.5%)	
Creatinine (μmol/L)	21.5-104	50.1 (41.1-62.6)	49.7 (39.1-62.1)	50.0(39.9-62.0)	0.7878
≤104		43 (95.6%)	154 (98.7%)	197 (98.0%)	0.217
>104		2 (4.4%)	2 (1.3%)	4 (2.0%)	
Lactate dehydrogenase (U/L)	135-225	214.1 (184.9-314.4)	157.6 (134.1-198.3)	170.7 (140.3-213.0)	< 0.0001*
≤225		23 (51.1%)	131 (84.0%)	154 (76.6%)	0.000*
>225		22 (48.9%)	25 (16.0%)	47 (23.4%)	
Total bilirubin (μmol/L)	3.4-20.5	12.0 (9.0-16.7)	10.9 (8.3-15.3)	11.0 (8.5-15.5)	0.2260
≤20.5		41 (91.1%)	146 (93.6%)	187 (93.0%)	0.520
>20.5		4 (8.9%)	10 (6.4%)	14 (7.0%)	
Blood urea nitrogen (mmol/L)	2.86-8.2	4.5 (3.2-5.7)	4.1 (3.2-4.8)	4.2 (3.2-5.0)	0.0664
≤8.2		42 (93.3%)	154 (98.7%)	196 (97.5%)	0.075
>8.2		3 (6.7%)	2 (1.3%)	5 (2.5%)	
Venous lactate (mg/L)	120-160	742.7 (445.2-875.2)	777.2 (409.0-831.4)	769.4 (405.2-838.5)	0.9483

## Discussion

The number of COVID-19 patients is increasing, and so is the death toll[11, 17]. In this study, we reported a total of 201 patients with SARS-CoV-2 infection outside of Wuhan, China. Among them, 45 (22.4%) patients required ICU care, and 156 (77.6%) were admitted to the isolation ward of the First Hospital of Changsha City. Patients in the ICU group were older, while no significant difference in sex ratio was found between the two groups, which suggests that age may be a risk factor for a poor outcome. The occupational composition of the ICU group differed from the non-ICU group, and the number of patients exposed to Wuhan city in the ICU group was significantly higher than that of the non-ICU group, which indicates that the exposure history to Wuhan city may affect the outcome of COVID-19 patients. Compared with the non-ICU patients, more patients receiving ICU care were admitted in January, which suggests that the virulence of SARS-CoV-2 may be waning as it spreads. No significant differences in the duration, incubation, and prognosis were found between the ICU group and the non-ICU group. As of February 15, 2020, 63 (31.34%) of 201 patients had been discharged. Among those discharged alive (n = 63), the median hospital stay was six days (IQR, 5.0-9.0), which was shorter than in the COVID-19 patients in Wuhan, who had a median hospital stay of

10 days (IQR, 7.0-14.0). Moreover, one (0.5%) patient of the ICU group in this study died, and this overall mortality was lower than that reported for Wuhan (4.3%)[11]. However, there were remaining patients still hospitalized, and additional deaths might occur. These results suggested that the viral load might differ between patients in and outside of Wuhan.

In terms of clinical features, patients with cardiovascular or respiratory diseases were more likely to require ICU care. In addition, the maximum temperature of patients in the ICU group was significantly higher than that in the non-ICU group, and more patients in the ICU group presented fatigue and anhelation. Moreover, the respiratory rate of cases in the ICU group was higher than those of the non-ICU group, which may be attributed to inflammation of the lungs. Patients in the ICU group must breathe more frequently to provide the oxygen required compared to patients in the non-ICU group. The most common laboratory abnormalities observed in the present report included depressed WBC, neutrocytes, lymphocytes, prolonged prothrombin time, and elevated ESR, CRP, PCT, and LDH.

Compared with the non-ICU group, numerous laboratory abnormalities were detected in the ICU group. A previous study[10] indicated that SARS-CoV-2 might mainly act on lymphocytes, including T lymphocytes. SARS-CoV-2 could induce a cytokine storm in the body, thereby generating a series of immune responses and causing changes in peripheral white blood cells and lymphocytes.

Additionally, several reports confirmed that the decrease of lymphocytes indicates that coronavirus consumed many immune cells and inhibited cellular immune function, which might lead to exacerbations of COVID-19 patients[18]. In this report, lower levels of neutrocytes and lymphocytes were detected in the ICU group, which may be caused by the cellular immune deficiency of the ICU group. In addition, higher levels of ESR, CRP, and PCT were detected in the ICU group, which indicated higher levels of inflammation in the ICU group. A longer prothrombin time was found in the ICU group, which might represent coagulation activation in the ICU group. Compared with non-ICU patients, higher levels of ALA, AST, CK, CK-MB CREA, and LDH were detected in patients of the ICU group, which was similar to previous reports[11]. These abnormalities suggest that the SARS-CoV-2 infection may be associated with myocardial injury, hepatic injury, and kidney injury.

According to the suggestion of The Diagnosis and Treatment of Pneumonitis with 2019-nCoV Infection

(DTPI) published by the National Health Commission of the PRC, all of the patients in this study were given lopinavir, and ritonavir tablets (2 pills BID per os), which were used for HIV infection in the past, combined with interferon alfa-2b injection (5 million IU add into 2 ml of sterile water, inhalation BID), and 51.7% received antibacterial agents. During the Severe Acute Respiratory Syndrome (SARS) period in 2003, usage of high doses of glucocorticoids caused a series of sequelae in survivors such as osteonecrosis of the femoral head and glucose metabolism disorders. Because of this lesson, we gave a small dose (40–80 mg/day) of glucocorticoid therapy in a short period (5 days) and adjusted the dose and time of medication according to the dynamic changes of the patient's chest CT imaging to control the immune response in the lungs. The patients avoided the occurrence of cytokine storms, thereby reducing the risk of complications, such as acute ARDS, in patients. Glucocorticoid therapy was given to 32.8% of patients.

There are several limitations to this study. First, COVID-19 was diagnosed by RT-PCR using throat swab samples, while no serum was obtained to assess the viremia. Second, few patients were included in this study. A multi-center study with a more significant number of patients should be performed. Third, since most patients involved in the present study were still hospitalized at the time of submission, it is difficult to evaluate the risk factors for adverse outcomes.

## Conclusions

In this single-center study of 201 COVID-19 patients in Changsha, China, 22.4% of patients were admitted to ICU. Based on our findings, we propose that the risk of cellular immune deficiency, hepatic injury, and kidney injury should be monitored. Because SARS-nCoV-2 has pandemic potential, careful monitoring is essential, and more information about this disease is still needed for clinical management.

## Abbreviations

COVID-19

Coronavirus Disease 2019

ICU

Intensive Care Unit

WBC

white blood cell

PT  
prolonged prothrombin time

ESR  
erythrocyte sedimentation rate

CRP  
C-reactive protein

PT  
procalcitonin

ALA  
alanine aminotransferase

AST  
aspartate aminotransferase

CK  
creatine kinase

CK-MB  
creatine kinase-MB

CREA  
creatinine

LDH  
lactate dehydrogenase

CT  
computed tomographic

SPSS  
Statistical Package for the Social Sciences

SARS-CoV-2  
Severe Acute Respiratory Syndrome Coronavirus 2 CoV

RT-PCR  
Real-Time Reverse Transcription Polymerase Chain Reaction

CCDC  
Chinese Center for Disease Control and Prevention

RT-PCR  
Real-time reverse transcriptase-polymerase chain reaction

DTPI  
The Diagnosis and Treatment of Pneumonitis with COVID-19 Infection

ARDS

Acute respiratory distress syndrome

## Declarations

### **Ethics approval and consent to participate**

This study was approved by the the First Hospital of Changsha City Committee for Clinical Research and written consents were obtained from the enrolled patients. All of the methods were in accordance with the Declaration of Helsinki. All of the participants provided their written informed consent to participate in this study. All of the methods were performed in accordance with the relevant guidelines and regulations.

### **Consent for publication**

Written informed consent to publish has been received from each enrolled patient.

### **Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

### **Competing interests**

The authors declare that they do not have any competing interests.

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### **Author contributions**

Concept and design: JZ, ZC and ZZ. Acquisition, analysis, or interpretation of data: JZ, DJ and JS.

Drafting of the manuscript: JZ. Critical revision of the manuscript for important intellectual content:

YL. Statistical analysis: JS. Administrative, technical, or material support: WW, KH and ZZ. Supervision: KH, FZ, YX, DJ and ZZ. JZ and JS contributed equally.

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## **References**

1. Hui DS, I AE, Madani TA, Ntoumi F, Kock R, Dar O, Ippolito G, Mchugh TD, Memish ZA, Drosten C *et al*: **The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health - The latest 2019 novel coronavirus outbreak in Wuhan, China.** *INT J INFECT DIS* 2020, **91**:264-266.
2. Lu H, Stratton CW, Tang YW: **Outbreak of pneumonia of unknown etiology in Wuhan, China: The mystery and the miracle.** *J MED VIROL* 2020.
3. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, Ren R, Leung K, Lau E, Wong JY *et al*: **Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia.** *N Engl J Med* 2020.
4. **Wuhan Municipal Health Commission. Report of novel coronavirus-infected pneumonia in China. Published January 20, 2020. Accessed January 31, 2020.** <http://wjw.wuhan.gov.cn/front/web/showDetail/2020012009077>. In.
5. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X *et al*: **Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China.** *LANCET* 2020.
6. **World Health Organization. Novel Coronavirus (2019-nCoV) situation reports. Situation report - 21.** (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>). In.

7. **Johns Hopkins University CSSE. Wuhan coronavirus (2019-nCoV) global cases (<https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6>). In.**
8. Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, Xing F, Liu J, Yip CC, Poon RW *et al*: **A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster.** *LANCET* 2020.
9. Chen H, Guo J, Wang C, Luo F, Yu X: **Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records.** *LANCET* (S0140-6736(20)30360-3).
10. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y, Wei Y *et al*: **Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study.** *LANCET* 2020.
11. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y *et al*: **Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China.** *JAMA* 2020.
12. Xiong Y, Sun D, Liu Y, Fan Y, Zhao L, Li X, Zhu W: **Clinical and High-Resolution CT Features of the COVID-19 Infection: Comparison of the Initial and Follow-up Changes.** *INVEST RADIOL* 2020.
13. Xia W, Shao J, Guo Y, Peng X, Li Z, Hu D: **Clinical and CT features in pediatric patients with COVID-19 infection: Different points from adults.** *Pediatr Pulmonol* 2020.
14. **World Health Organization. Clinical management of severe acute respiratory infection when novel coronavirus (nCoV) infection is suspected: interim**

**guidance. Published January 28, 2020. Accessed January 31, 2020.**

**[https://www.who.int/publications-detail/clinical-managementof-severe-acute-respiratory-infection-when-novelcoronavirus-\(ncov\)-infection-is-suspected](https://www.who.int/publications-detail/clinical-managementof-severe-acute-respiratory-infection-when-novelcoronavirus-(ncov)-infection-is-suspected). In.**

15. **Laboratory diagnostics for novel coronavirus. WHO 2020 (<https://www.who.int/health-topics/coronavirus/laboratory-diagnostics-for-novel-coronavirus>). In.**
16. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R *et al*: **A Novel Coronavirus from Patients with Pneumonia in China, 2019.** *N Engl J Med* 2020.
17. Chang, Lin M, Wei L, Xie L, Zhu G, Dela CC, Sharma L: **Epidemiologic and Clinical Characteristics of Novel Coronavirus Infections Involving 13 Patients Outside Wuhan, China.** *JAMA* 2020.
18. Liu WJ, Zhao M, Liu K, Xu K, Wong G, Tan W, Gao GF: **T-cell immunity of SARS-CoV: Implications for vaccine development against MERS-CoV.** *Antiviral Res* 2017, **137**:82-92.

Figures

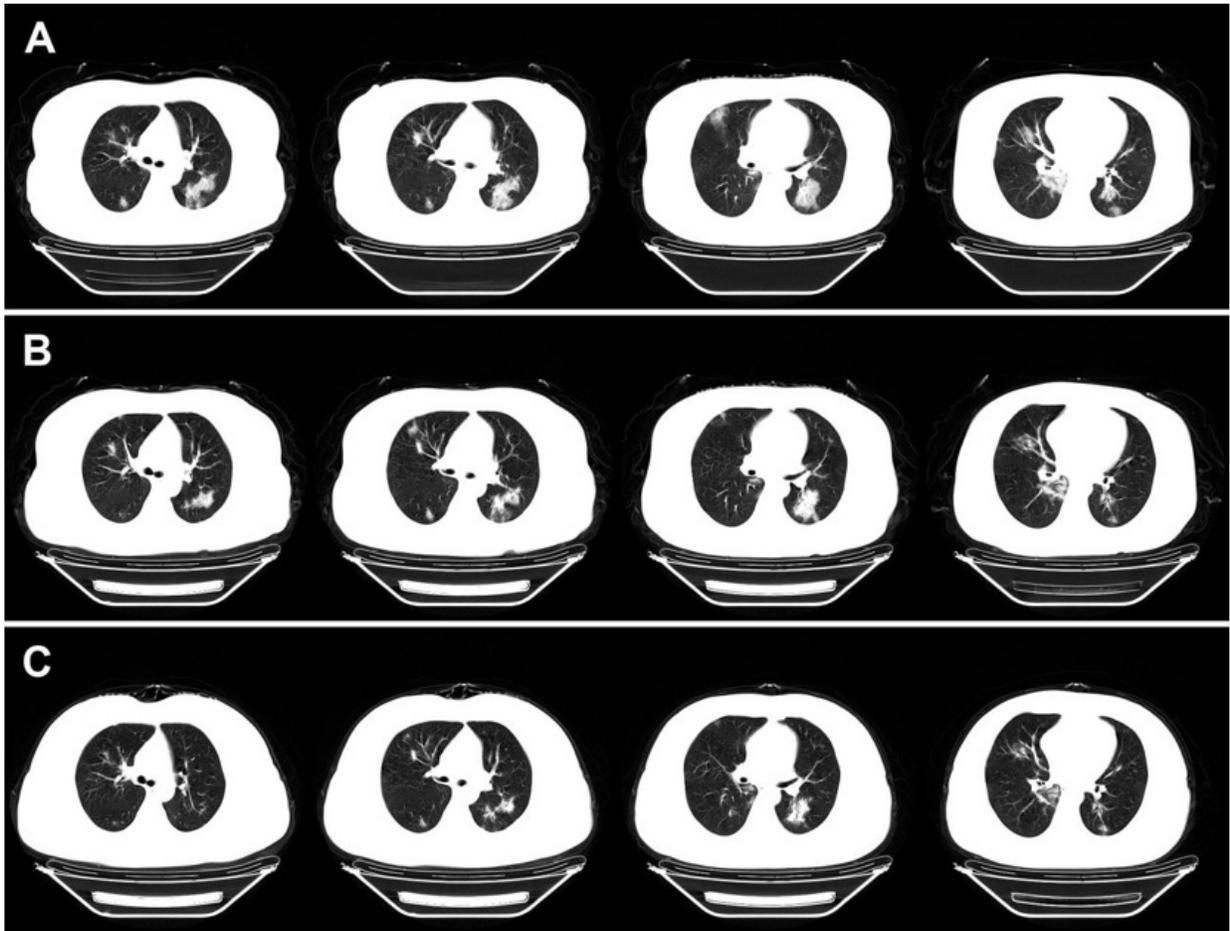


Figure 1

A. Chest CT was obtained on hospital day 2, multiple high-density exudation were observed in bilateral lung. B. Chest CT was obtained on hospital day 5. The exudation in both lungs were absorbed and the GGO than before. C. Chest CT was obtained on hospital day 8. The lesions of bilateral lung were further absorbed and a few cord shadows were formed.