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Short report

Clinical characteristics of 80 hospitalized frontline medical workers infected with COVID-19 in Wuhan, China

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SUMMARY

More than 1000 medical workers have been infected with coronavirus disease 2019 (COVID-19) in China. From January 10th to February 24th, 2020, a total of 80 medical workers were admitted to Tongji Hospital, Wuhan, including 57 severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) confirmed and 23 clinically diagnosed. The median age was 39 years (interquartile range: 32–48.5), 49 (61.25%) were women, and one patient died. The most common symptoms at onset were fever (65; 81.25%), cough (47; 58.75%), fatigue (28; 35%), myalgia (19; 23.75%), expectoration (19; 23.75%), and diarrhoea (15; 18.75%). Frontline medical workers admitted as patients to this single-centre hospital showed some unique clinical and laboratory findings compared with other patients in Wuhan province and elsewhere.

Introduction

In December 2019, coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) occurred in Wuhan, China, and has spread rapidly [1,2]. Up to April 3rd, 2020, a total of 82,857 confirmed cases have been reported in China. Human-to-human transmission has been confirmed, though initial epidemiological evidence suggested animal-to-human transmission in patients who had visited the Huanan seafood market in Wuhan [3]. SARS-CoV-2

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shows close similarity to bat coronaviruses and belongs to the β-coronavirus genus, but is divergent from severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) [4]. The main clinical manifestations of COVID-19 include fever, cough, fatigue, myalgia, and bilateral distribution of ground glass opacity on chest radiograph. Acute respiratory distress syndrome (ARDS) and death occur in severely affected patients.

Several studies have reported the clinical characteristics of infected patients in both Wuhan and other cities in China [1,3,5–7]. Frontline medical workers were at high risk of infection; 1716 medical workers were infected up to February 11th, 2020, and 11 of them died up to February 24th, 2020 [8]. However, the clinical investigation of this special population group was insufficient [3].

We aimed to describe the clinical characteristics of 80 hospitalized frontline medical workers with COVID-19 at a single-centre hospital and to compare SARS-CoV-2 confirmed cases with clinically diagnosed cases.

Methods

Data collection

COVID-19 was diagnosed based on positive SARS-CoV-2 nucleic acid test from respiratory tract specimen or based on clinical diagnosis with fever and bilateral involvement on chest radiographs according to the fifth version of the COVID-19 diagnosis and control plan published by the Chinese government. Epidemiological, clinical, laboratory, radiological, treatment, and outcome data on the infected frontline medical workers at Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, were obtained from electronic medical records. Information recorded included occupation, exposure history, medical history, symptoms, duration from onset to hospital admission, laboratory test, chest computed tomography (CT), treatment measure, and outcome. Laboratory findings and chest CT were collected on admission to hospital. The Berlin definition of ARDS was adopted [9]. The study was approved by Tongji Hospital Ethics Committee (No. TJ-C2030).

SARS-CoV-2 nucleic acid detection

Throat swab samples were collected, stored in 5 mL virus preservation solution, and virus RNA was extracted within 24 h on the Tianlong PANA9600 automatic nucleic acid extraction system (Tianlong, Xi'an, China) with ready-to-use reagents. The open reading frame 1ab and nucleocapsid protein genes were simultaneously tested with commercial real-time reverse transcription–polymerase chain reaction (RT–PCR) kit from Da An Gene Co. Ltd (Guangzhou, Guangdong, China). RT–PCR assay was performed on the Tianlong Gentier 96E real-time PCR system with the following conditions: incubation at 50°C for 15 min, pre-denaturation at 95°C for 15 min, 45 cycles of denaturation at 94°C for 15 s, and extension at 55°C for 45 s (collecting fluorescence signal). A cycle threshold value (C_T) ≥40 for both genes was defined as negative, and C_T <40 for both genes was defined as positive. Samples with a single C_T <40 required confirmation by retesting.

Analysers used to measure laboratory results

The blood cell count was analysed using the Sysmex XE-2100 haematology analyser (Sysmex, Kobe, Japan). Coagulation tests were conducted by STA-R MAX coagulation analyser (Diagnostica Stago, Saint-Denis, France). Biochemical items were analysed with Cobas C8000 (Roche, Mannheim, Germany). Antibodies against SARS-CoV-2 including IgM and IgG were tested using iFlash3000 (Shenzhen YHLO Biotech Co. Ltd, Shenzhen, China).

Statistical analysis

Patients were classified as SARS-CoV-2 nucleic acid confirmed (NAC) or as clinically diagnosed (CD). The inclusion criteria for CD are listed in Supplementary Table S1. Continuous variables are presented as medians with interquartile (IQR) ranges or as means and standard deviations. Student's *t*-test was used for normally distributed data; otherwise, Wilcoxon's rank-sum test was used. Categorical variables were analysed using the χ^2-test or Fisher's exact test. All analyses were done with SPSS 16 (SPSS, Chicago, IL, USA). $P < 0.05$ was considered statistically significant.

Results and discussion

The patients were admitted from January 10th to February 24th, 2020. The median age was 39 years (IQR: 32–48.5); 49 (61.25%) were women (Table I). Nurses accounted for 51.25% of all cases. Hypertension (10; 12.50%) and renal disease (3; 3.75%) were the most common coexisting diseases. The most common symptoms at onset were fever (65; 81.25%), cough (47; 58.75%), fatigue (28; 35%), myalgia (19; 23.75%), expectoration (19; 23.75%), diarrhoea (15; 18.75%), and headache (8; 10%). The median duration from onset to hospital admission was seven days.

In the NAC group, 17 (29.82%) patients presented myalgia, whereas only two (8.70%) patients had myalgia in the CD group ($P = 0.044$). Twenty-eight (49.12%) NAC patients had cough, and 19 (82.61%) CD patients had cough ($P = 0.006$). Expectoration was significantly different between the two groups (17.54% vs 39.13% for NAC and CD groups, respectively; $P = 0.040$).

The clinical characteristics were stratified by sex (Supplementary Table S2). Composition was quite different between males and females. Doctors accounted for 61.29% of males affected, whereas they accounted for 8.16% of females affected. Moreover, 22.58% of males had hypertension, and only 6.12% of females suffered with hypertension. Other aspects of clinical characteristics were similar between males and females.

Laboratory tests were performed on hospital admission. Nineteen of the 80 (23.75%) patients showed leucopenia and 38 (47.5%) showed lymphopenia. The platelet and D-dimer levels were within normal range. Twelve (15%) patients showed prolonged prothrombin time (PT), and 13 (26.53%) showed shortened activated partial thromboplastin time (APTT). Nineteen (23.75%) patients showed increased serum creatinine level, and 30 (37.5%) had decreased creatine kinase (CK). Levels of lactate dehydrogenase (LDH), alanine aminotransferase (ALT), and aspartate aminotransferase (AST) were increased in 37

Table I
Clinical characteristics, treatment and outcome of 80 frontline medical staff infected with COVID-19 at a single-centre hospital in Wuhan

Characteristics	All	SARS-CoV-2 confirmed	Clinically diagnosed	*P*-value
No.	80	57	23	–
Age (years)[a]	39 (32–48.5)	40 (33–49)	39 (32–48)	0.953
Sex (%)				
Male	31 (38.75)	25 (43.86)	6 (26.09)	0.139
Female	49 (61.25)	32 (56.14)	17 (73.91)	
Composition (%)				
Doctor	23 (28.75)	19 (33.33)	4 (17.39)	0.248
Nurse	41 (51.25)	26 (45.61)	15 (65.22)	
Other	16 (20.00)	12 (21.05)	4 (17.39)	
Comorbidities (%)				
Hypertension	10 (12.50)	9 (15.79)	1 (4.35)	0.161
Diabetes	1 (1.25)	1 (1.75)	0	0.523
Cardiovascular disease	2 (2.50)	1 (1.75)	1 (4.35)	0.501
Cerebrovascular disease	1 (1.25)	1 (1.75)	0	0.523
Chronic obstructive pulmonary disease	1 (1.25)	1 (1.75)	0	0.523
Renal disease	3 (3.75)	2 (3.51)	1 (4.35)	0.858
Liver disease	2 (2.50)	2 (3.51)	0	0.363
Symptoms (%)				
Fever	65 (81.25)	48 (84.21)	17 (73.91)	0.286
Fatigue	28 (35.00)	23 (40.35)	5 (21.74)	0.114
Myalgia	19 (23.75)	17 (29.82)	2 (8.70)	0.044
Cough	47 (58.75)	28 (49.12)	19 (82.61)	0.006
Expectoration	19 (23.75)	10 (17.54)	9 (39.13)	0.040
Diarrhoea	15 (18.75)	9 (15.79)	6 (26.09)	0.286
Headache	8 (10.00)	7 (12.28)	1 (4.35)	0.284
Time from onset to hospital admission (days)[a]	7 (4–8)	7 (3–10)	6 (4–8)	0.936
Admission to intensive care unit	4 (5.00)	3 (5.26)	1 (4.35)	0.804
Acute respiratory distress syndrome	4 (5.00)	2 (3.51)	2 (8.70)	0.335
Treatment				
Antiviral treatment	78 (97.50)	56 (98.25)	22 (95.65)	0.501
Antibiotics	75 (93.75)	52 (91.23)	23 (100.00)	0.142
Corticosteroid	46 (57.50)	34 (59.65)	12 (52.17)	0.540
Non-invasive ventilation	68 (85.00)	48 (84.21)	20 (86.96)	0.756
Invasive mechanical ventilation	2 (2.50)	2 (3.51)	0	0.363
Extracorporeal membrane	2 (2.50)	2 (3.51)	0	0.363
Outcome				
Discharge	78 (97.50)	55 (96.49)	23 (100.00)	0.359
Death	1 (1.25)	1 (1.75)	0	0.523
Hospitalization day[a]	20.5 (15–28)	21 (17–28)	18 (15–30)	0.297

[a] Median (interquartile range).

(46.25%), 14 (17.5%), and 21 (26.25%) patients, respectively. Bilateral involvement on chest radiographs was observed in all patients except for one (Table II).

NAC and CD groups showed similar laboratory findings except for lymphocyte count, which was lower in the NAC group. Thirty (52.63%) NAC patients showed lymphopenia, compared with only eight (34.78%) CD patients.

Laboratory findings showed significant differences between males and females (Supplementary Table S3). Females had higher platelet count than did males. Of males, 19.35% had decreased platelet count, compared with only 4.08% for females. APTT was slightly different between males and females. Males had higher levels of creatinine than did females. Of males, 54.84% had increased creatinine, compared with only 4.08% of females. Moreover, males had higher levels of CK, ALT, and AST than did females.

Four of the 80 patients were transferred to intensive care unit (ICU) for acute respiratory distress syndrome (ARDS). Seventy-eight (97.5%) patients received antiviral treatment including umifenovir (Arbidol; Pharmstandard, Dolgoprudny, Russia), lopinavir/ritonavir (Kaletra; Abbott, Abbott Park, IL, USA), and interferon-α; 75 (93.75%) received antibiotic treatment; and 46 (57.5%) received corticosteroid treatment. Sixty-eight (85%) patients received non-invasive ventilation; two (2.5%) received invasive ventilation and further received extracorporeal membrane oxygenation (ECMO). At this point, 78 (97.5%) patients had been discharged, one patient had died, and one was still in ICU (Table I). The median time of hospitalization was 20.5 days. No significant difference was found between NAC and CD groups in treatment and outcome. No significant difference was found between males and females in treatment and outcome.

Table II
Laboratory findings on 80 frontline medical staff infected with COVID-19 on hospital admission

Variables	All	SARS-CoV-2 confirmed ($N = 57$)	Clinically diagnosed ($N = 23$)	Reference	*P*-value	
					Wilcoxon rank-sum test	χ^2-test
White blood cell count ($\times 10^9$/L)[a]	4.38 (3.58–5.53)	4.31 (3.49–5.27)	4.90 (3.64–5.73)	3.50–9.50	0.253	0.231
Increased	5 (6.25%)	2 (3.51%)	3 (13.04%)			
Decreased	19 (23.75%)	15 (26.32%)	4 (17.39%)			
Neutrophil count ($\times 10^9$/L)[a]	2.55 (2.01–3.66)	2.43 (1.97–3.55)	2.86 (2.18–3.83)	1.80–6.30	0.401	0.714
Increased	8 (10.00%)	5 (8.77%)	3 (13.04%)			
Decreased	14 (17.50%)	11 (19.30%)	3 (13.04%)			
Lymphocyte count ($\times 10^9$/L)[a]	1.12 (0.83–1.59)	1.09 (0.76–1.49)	1.33 (1.04–1.88)	1.10–3.20	0.019	0.148
Increased	–	–	–			
Decreased	38 (47.50%)	30 (52.63%)	8 (34.78%)			
Monocyte count ($\times 10^9$/L)[a]	0.41 (0.32–0.53)	0.41 (0.32–0.52)	0.41 (0.33–0.53)	0.10–0.60	0.861	0.704
Increased	12 (15.00%)	8 (14.04%)	4 (17.39%)			
Decreased	–	–	–			
Platelet count ($\times 10^9$/L)[a]	181.5 (148.00–227.50)	180.00 (148.00–218.00)	212.00 (148.00–260.00)	125.0–350.0	0.339	0.827
Increased	3 (3.75%)	2 (3.51%)	1 (4.35%)			
Decreased	8 (10.00%)	5 (8.77%)	3 (13.04%)			
D-dimer (mg/L)[a]	0.40 (0.29–0.58)	0.40 (0.29–0.57)	0.40 (0.27–0.59)	<0.22	0.864	–
Increased	–	–	–			
Decreased	–	–	–			
Prothrombin time (s)[a]	14.00 (12.90–14.00)	13.30 (12.90–14.00)	13.70 (13.00–14.00)	11.5–14.5	0.469	0.909
Increased	12 (15.00%)	8 (14.04%)	4 (17.39%)			
Decreased	3 (3.75%)	2 (3.51%)	1 (4.35%)			
Activated partial thromboplastin time (s)[a]	41.80 (37.20–44.10)	42.60 (37.70–44.10)	40.35 (35.50–43.90)	29.0–42.0	0.174	0.880
Increased	–	–	–			
Decreased	13 (26.53%)	8 (25.81%)	5 (27.78%)			
Creatinine (μmol/L)[a]	63.00 (51.00–84.00)	73.00 (56.00–84.00)	54.00 (47.00–86.00)	45–84	0.051	0.907
Increased	19 (23.75%)	13 (22.81%)	6 (26.09%)			
Decreased	6 (7.50%)	4 (7.02%)	2 (8.70%)			
Creatine kinase (U/L)[a]	78.50 (49.00–151.00)	77.00 (49.00–155.00)	81.50 (42.00–122.00)	18–198	0.721	0.962
Increased	8 (10.00%)	6 (10.53%)	2 (8.70%)			
Decreased	30 (37.5%)	21 (36.84%)	9 (39.13%)			
Lactate dehydrogenase (U/L)[a]	208.00 (185.00–266.00)	205.00 (183.00–253.00)	216.00 (190.00–296.00)	135–214	0.376	0.587
Increased	37 (46.25%)	25 (43.86%)	12 (52.17%)			
Decreased	2 (2.50%)	1 (1.75%)	1 (4.35%)			
Alanine aminotransferase (U/L)[a]	18.00 (12.00–26.00)	18.50 (12.00–26.00)	16.00 (12.00–27.00)	≤33	0.821	0.505
Increased	14 (17.50%)	11 (19.30%)	3 (13.04%)			
Decreased	–	–	–			
Aspartate aminotransferase (U/L)[a]	22.00 (18.00–32.00)	23.50 (19.50–33.00)	21.00 (17.00–29.00)	≤32	0.214	0.560
Increased	21 (26.25%)	16 (28.07%)	5 (21.74%)			
Decreased	–	–	–			
Bilateral involvement on chest radiographs	79 (98.75%)	56 (98.25%)	23 (100.00%)			0.522

[a] Mean (SD).

This is the first report on hospitalized frontline medical workers with COVID-19 including 57 SARS-CoV-2 confirmed and 23 clinically diagnosed cases. None of these workers had visited Huanan seafood market in Wuhan. The median age was 39 years (IQR: 32–48.5), similar to that in a report from Zhejiang province, China (41 years; IQR: 32–52), but different from a local study from Wuhan including 138 patients (56 years; IQR: 42–68) [7]. Female patients accounted for the majority (61.25%) of all cases in our study, quite different from other studies [1,3,7]. This suggests that the infected frontline

medical workers were younger than other patients, and female workers were infected more than male workers, consistent with the large number of nurses serving in the hospital. Hypertension was the most common comorbidity, consistent with other studies from Wuhan, whereas liver disease was the most common comorbidity in Zhejiang province [3,7]. Wuhan is an inland city and Zhejiang includes several coastal cities; whether the difference in comorbidity is caused by the geographic difference is unknown. The most common symptoms were similar to those in other studies; however, a higher ratio of diarrhoea was observed in the frontline medical workers (18.75%) than in other patients in Wuhan (10.1%) and Zhejiang province (8%) [3,7]. The median time from onset to hospital admission was two days in Zhejiang province, shorter than that in our study (seven days), which may be due to the urgent alarm of the government from January 23rd, 2020. The NAC group had a higher ratio of myalgia but lower ratio of cough and expectoration than the CD group. The clinical features varied between male and female patients. These data indicate that the frontline medical workers showed some unique characteristics.

Laboratory findings were consistent with previous studies, including leucopenia, lymphopenia, increased LDH, ALT, and AST. Yet, some results were different from other studies. D-dimer levels were all in normal range, whereas several other studies showed increased D-dimer [6]. In a recent study, Tang *et al*. found that COVID-19 non-survivors showed significantly higher level of D-dimer than did surviving patients [10]. Some medical workers had already taken actions before hospital admission, and most patients experienced mild-to-moderate symptoms in our study. Twelve (15%) patients showed prolonged PT and three (3.75%) showed decreased PT; these proportions were 5% and 30%, respectively, in a previous study including 99 patients in Wuhan [6]. Slightly prolonged PT was also observed in another study in our centre [10]. Coagulation test may be influenced by several factors of patients. The laboratory findings also varied between male and female patients. Moreover, NAC group had lower level of lymphocyte than CD group.

The treatments in this hospital were different than in other regions. Antibiotics were administered for 93.75% of all cases, compared with 45% in Zhejiang province [7]. Moreover, corticosteroid treatment was carried out in 57.5% of all patients, compared with only 26% in Zhejiang and 44.9% in another hospital in Wuhan [6,7]. The mortality rate was 1.25% in our study, compared with 4.3% in other patients in Wuhan [6]. Both NAC and CD groups received similar treatments and showed similar outcomes.

Sixteen of the 23 CD patients received an antibody test against SARS-CoV-2 including IgM and IgG. All 16 patients showed positive IgG, and five out of 16 patients had positive IgG and IgM. Therefore, the negative nuclear acid result of SARS-CoV-2 in CD patients might be due to the low sensitivity of the method.

In conclusion, patients of frontline medical workers at a single-centre hospital showed some unique clinical and laboratory findings compared with other patients in Wuhan and in other regions.

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Conflict of interest statement
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Appendix A. Supplementary data

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