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## Coronavirus Disease 2019 Infection Among Medical Staff in Wuhan

### A Retrospective Study From a Single Center



To the Editor:

#### Patients and Methods

COVID-19 infection rates, models of infection, and clinical characteristics and outcomes among HCWs were examined in Renmin Hospital of Wuhan University, a general hospital with 5,200 beds, 118 clinical departments, 33 administrative divisions, and 6,507 staff members. This study enrolled 166 medical staff members diagnosed with COVID-19 from January 10, 2020, to February 11, 2020. The data cutoff date was February 19, 2020. Nucleic acid testing for COVID-19 is mandatory for all symptomatic staff members, suspected case subjects, and close contacts of COVID-19 patients, and optional for any other staff members. Diagnostic criteria for COVID-19 were based on the Diagnosis and Treatment Scheme of Novel Coronavirus-Infected Pneumonia, Version 6, by the China CDC.<sup>2</sup> This retrospective study was approved by the institutional ethics board of Renmin Hospital of Wuhan University (No. 2020020).

#### Results

The incidence curve of COVID-19 patients and infected HCWs is shown in [Figure 1](#). Among 6,507 HCWs (median age, 33.0 years [interquartile range, 28.0-42.0 years]; 1,920 male subjects, 4,587 female subjects), the infection rate was 2.55% ( $n = 166$ ; median age, 34.0 years [interquartile range, 21.0-57.0 years]; 50 male subjects, 116 female subjects). Staff members with both clinical (140 cases [46 in the red area, 94 outside the red area]; 84.3%) and nonclinical (26 cases; 15.7%) cases were involved. No epidemic chain of transmission of COVID-19 originated from one super spreader.

[Table 1](#) includes the clinical characteristics for patients. Most cases were classified into the mild (9.64%) or moderate (80.12%) group. As of the study cutoff date, 69 patients (including eight mild, 54 moderate, and seven severe cases) were discharged (median length of stay, 16.7 days). The 97 remaining hospitalized cases recovered significantly. As of March 25, 2020, all moderate or mild cases and two severe cases had been

The coronavirus disease 2019 (COVID-19) outbreak in Wuhan, China, has caused considerable infection in health-care workers (HCWs). More than 3,000 cases in 422 involved medical facilities have been reported by the Chinese Center for Disease Control and Prevention (China CDC) as of February 22, 2020; 64% occurred in Wuhan.<sup>1</sup> However, the incidence and patterns of infection in medical staff have not yet been described.

Clinical characteristics and distribution of the study subjects were recorded. Red area was defined as where those diagnosed or suspected cases were isolated or treated. The study subjects were divided into three groups: a mild group, with asymptomatic or mild symptoms but no radiographic evidence of pneumonia; a moderate group, with moderate symptoms such as a fever or respiratory symptoms, or with radiographic evidence of pneumonia; and a severe group, with respiratory distress (respiratory rate  $\geq 30$  times per minute), hypoxemia (blood oxygen saturation  $\leq 93\%$  at rest), or  $\text{PaO}_2/\text{FiO}_2 \leq 300$  mm Hg. All patients were managed with standard treatment protocols of antivirals and antiinflammatory drugs,<sup>3-5</sup> symptomatic and respiratory support, and assessment of demographic, clinical, radiologic, and laboratory characteristics. The total CT score was the sum of lung involvement (5 lobes, score 1-5 for each lobe, range, 0 none, 25 maximum). The CT score was recorded according to previously reported methods.<sup>6,7</sup>

discharged. The other eight with severe disease were discharged on April 17, 2020, and no one died (data not shown).

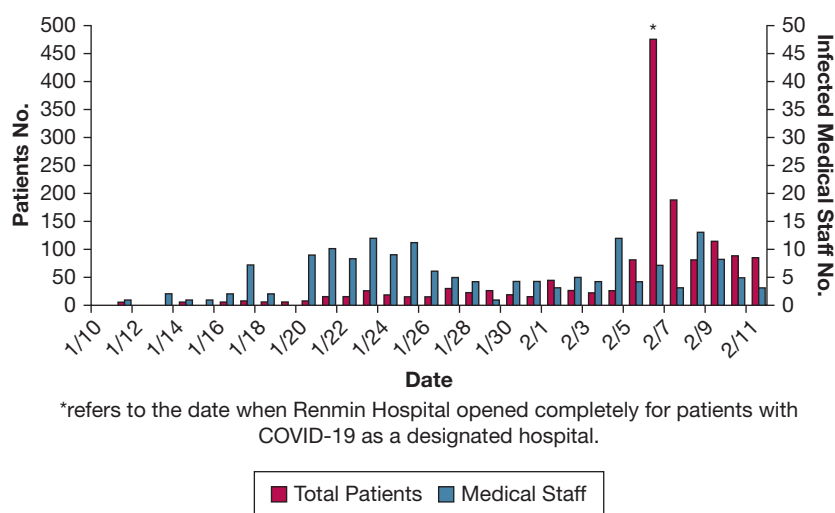
Representative characteristics in this population included a higher proportion of young, prime-aged subjects, a majority of mild or moderate cases, feasibility of treatment within the “golden first week” of disease, and lower mortality compared with the general population.

#### Discussion

We describe here the COVID-19 infection pattern in medical staff in Wuhan for the first time, which featured various types of medical personnel involved even outside the red area. Here, red area was defined as where those diagnosed or suspected cases were isolated or treated.

On the incidence curve, two peaks were observed ([Fig 1](#)), which coincided with the COVID-19 epidemic peaks in

Figure 1 – The number of patients with COVID-19 and number of infected hospital staff members in Renmin Hospital. \*Date when Renmin Hospital opened completely for patients with COVID-19 as a designated hospital. COVID-19 = coronavirus disease 2019.



China.<sup>8</sup> We attribute the first peak (January 20-26, 2020), at least partly, to the lack of knowledge regarding the disease, enforcement of procedures, and specialized COVID-19 wards, as well as inadequate personal protective equipment (PPE), especially for those outside the red area at the early stages of the COVID-19 outbreak. On January 20, 2020, the China CDC announced that COVID-19 is categorized as B type infectious disease but with A type infectious disease management.<sup>9</sup> Prior to the announcement, workers in the red area were equipped with level 1 protection (disposable work cap, medical surgical mask, work clothes, disposable impermeable isolation clothing, and disposable latex gloves), whereas those outside the red area had no protection when dealing with patients on the front-line without effective COVID-19 screening. During this period, some nonclinical staff members were infected due to cross-infection in the hospital.

We attribute the second peak (February 4-8, 2020) to close and frequent contact with COVID-19 patients with insufficient supply of PPE. When level 3 protection (disposable working cap, full-mask respirator or other respirator with positive air pressure, medical N95 mask, protective clothing, disposable latex gloves, and disposable shoe covers) was enforced in the red area, the infection was significantly reduced. To reduce the impact of medical runs (all medical resources concentrated on COVID-19 patients, which leads to lack of medical resources for non-COVID-19 patients) on non-COVID-19 patients, all clinical staff members outside the red area worked on the front-line. Due to the insufficient PPE supply, most of them were

equipped with level 1 protection under the premise of COVID-19 screening. However, COVID-19 screening was not yet thorough enough, which resulted in noticeable infection among HCWs outside the red area. Similarly, with incomplete level 1 protection, nonclinical staff members provided logistics and administrative support for the main campus designated for non-COVID-19 patients, the east campus appointed for severe COVID-19 cases, the Wuchang mobile cabin hospital, and several medical assistance teams from other provinces, and a few were infected.

After mid-February, PPE supply was compensated by government allocation and social donations, and protection of clinical workers outside the red area increased to level 2 (disposable working cap, goggles or protective screen, N95 mask, protective clothing and disposable latex gloves, and disposable shoe covers). Meanwhile, strict safety protocols, disinfection routines, and training programs were implemented and enforced. Few sporadic infections occurred thereafter.

We draw some experiences and lessons from prevention of COVID-19 infection in the hospital. In each work area, regardless of whether it was in the red area, we set up three zones (infected, buffering, and cleaning zones) and two channels for staff and patients, respectively. Common outpatient clinics receive patients all by online time-segment appointment. We screened patients by using a “twice screening, twice buffering” strategy. First, in the outpatient department, patients with fever were shifted into fever clinics. Second, in the emergency

**TABLE 1 ]** Baseline Characteristics of Hospital Staff Infected With COVID-19

Variable	Total (N = 166)	Mild Cases (n = 16)	Moderate Cases (n = 133)	Severe Cases (n = 17)	P
<b>Characteristic</b>					
Age, median (range), y	34 (21-57)	29 (24-42)	35 (21-58)	42 (27-57)	.009
<b>Sex</b>					.001
Male	50 (30.12)	1 (6.25)	38 (28.57)	11 (64.71)	
Female	116 (69.88)	15 (93.75)	95 (71.43)	6 (35.29)	
<b>Comorbidities</b>	19 (11.45)	1 (2.17)	7 (6.80)	11 (64.71)	< .001
<b>Signs and symptoms</b>					
Fever	103 (62.05)	0	86 (64.66)	17 (100)	< .001
Cough	81 (48.80)	3 (18.75)	63 (47.37)	15 (88.24)	< .001
Fatigue	51 (30.72)	2 (12.50)	41 (30.83)	8 (47.06)	.099
Dyspnea	33 (19.88)	0	19 (14.29)	14 (82.35)	< .001
Sore throat	31 (18.67)	5 (31.25)	25 (18.80)	1 (5.88)	.190
Myalgia	29 (17.47)	1 (6.25)	16 (12.03)	12 (70.50)	< .001
Headache	18 (10.84)	1 (6.25)	14 (10.53)	3 (17.65)	.555
Nausea	11 (6.63)	0	9 (6.77)	2 (11.76)	.351
Diarrhea	9 (5.42)	0	7 (5.26)	2 (11.76)	.406
<b>Laboratory</b>					
Leukocyte < 3.5 × 10 <sup>9</sup> /L	27 (16.27)	1 (6.25)	22 (16.54)	4 (23.53)	.691
Neutrophils < 1.8 × 10 <sup>9</sup> /L	30 (18.07)	3 (18.75)	26 (19.55)	1 (5.88)	.563
Lymphocyte < 1.1 × 10 <sup>9</sup> /L	48 (28.92)	0	37 (27.82)	11 (64.71)	< .001
Monocyte < 0.1 × 10 <sup>9</sup> /L	2 (1.20)	0	2 (1.50)	0	.914
Eosinophils < 0.02 × 10 <sup>9</sup> /L	63 (37.95)	1 (6.25)	49 (36.84)	13 (76.47)	< .001
CRP > 10 mg/L	34 (20.48)	0	20 (15.04)	14 (82.35)	< .001
SAA ≥ 10 mg/L	89 (53.61)	4 (25.00)	68 (51.13)	17 (100)	< .001
<b>Abnormalities on CT imaging</b>					
Ground-glass opacity	133 (88.67)	0	118 (88.72)	15 (88.24)	.998
Patchy shadowing	119 (79.33)	0	102 (76.69)	17 (100)	.024
Interstitial abnormalities	67 (44.67)	0	52 (39.10)	15 (88.24)	< .001
Crazy-paving pattern	48 (32.00)	0	32 (24.06)	16 (94.12)	< .001
Consolidation	51 (34.00)	0	37 (27.82)	14 (82.35)	< .001
Linear densities	71 (47.33)	0	56 (42.11)	15 (88.24)	< .001
CT score, mean ± SD (range)	3.0 ± 2.4 (1-14)	0	2.3 ± 1.2 (1-7)	8.3 ± 2.9 (5-14)	< .001
<b>Outcomes</b>					
Hospitalization	97 (58.43)	8 (50.00)	79 (59.40)	10 (58.82)	.771
Discharge	69 (41.57)	8 (50.00)	54 (40.60)	7 (41.18)	...
Length of stay, mean ± SD, d	16.7 ± 5.7	12.2 ± 4.6	18.0 ± 4.7	23.8 ± 5.0	< 0.001

Data are presented as No. (%) unless otherwise indicated. CRP = C-reactive protein; SAA = serum amyloid A.

ward, COVID-19 patients and carriers were screened by using CT imaging and blood testing and allocated to fever clinics. Prior to hospitalization, patients were housed temporarily in a specialized buffering ward for

3 days receiving symptomatic and supportive treatment. Patients were then transferred to the buffering zone of an ordinary ward for another 3 days and received professional treatment.

This study has several limitations. In calculating infection rate, we used the total number of HCWs as the denominator, although not everyone underwent testing. Here we assumed that the staff members not tested were not infected under the principle of mandatory testing for symptomatic or suspected staff (or close contacts) and freewill testing for other staff.

However, for potential missed cases with asymptomatic or atypical initial symptoms, or false-negative results of nucleic acid testing, we probably underestimated the infection rate. Instead, we may have overestimated the infection rate as not all HCWs have the same exposure risk in different health-care settings.

In addition, the data from the medical staff infected with COVID-19 may vary dramatically in different hospitals with diverse missions in Wuhan. Even so, our study will be helpful in preventing COVID-19 in HCWs from other hospitals currently dealing with this pandemic.

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