Original Article

Epidemiological and clinical characteristics of severe acute respiratory coronavirus virus 2 (SARS-CoV-2) infection among healthcare workers in Hubei Province, China

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Abstract

Objective: To evaluate the epidemiological and clinical characteristics of severe acute respiratory coronavirus virus 2 (SARS-CoV-2) infection among healthcare workers (HCWs) in Hubei Province, China.

Design: Retrospective cohort study.

Setting: Hubei Provincial Center for Disease Control and Prevention.

Participants: The participants in this study are cases identified by epidemiological investigation in Hubei Province, as of February 27, 2020, and were followed until March 7, 2020. In total, 1,989 HCWs and 41,137 other occupational cases were included for analysis.

Methods: We used descriptive statistics to summarize patient characteristics.

Results: Of 1,989 laboratory-confirmed HCWs, 297 (14.93%) had severe or critical cases, 73 (3.67%) had asymptomatic infections, and 18 died of coronavirus disease 2019 (COVID-19). The case fatality rate was 0.9%. The proportion of severe or critical cases decreased from the beginning to the end of the outbreak (from 21.29% to 3.52%), and the proportion of asymptomatic cases increased from 0.0% to 47.18%. Nearly half of HCWs with confirmed COVID-19 reported no known contact with COVID-19 patients (969, 48.72%). Fever and cough were the most common symptoms at disease onset in both HCWs and other occupational cases; however, HCWs had higher rates of fatigue (30.90% vs 25.02%; \( P < .001 \)) and myalgia (19.15% vs 13.43%; \( P < .001 \)). Additionally, compared with other occupational groups, HCWs were associated with a lower risk of death after adjustment for potential confounders (odd ratio [OR], 0.50; 95% confidence interval [CI], 0.30–0.79).

Conclusions: Compared with COVID-19 cases in other occupational groups, HCWs with COVID-19 have half the risk of death, although they have been shown to have higher rates of fatigue and myalgia.

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determine the epidemiological and clinical characteristics of these infections. However, studies on this issue are scarce thus far. Additionally, under the current context of heavy workload and continuing psychological stress placed on frontline HCWs, the critical question that needs to be addressed is whether there are differences in signs, symptoms, and case fatality rates between HCWs and other occupational groups. We conducted this study to address these questions.

**Methods**

**Study design, data source, and study population**

The participants in this study were all cases identified through epidemiological investigation in Hubei Province as of February 27, 2020, who were followed until March 7, 2020. Individuals were classified as HCWs or “other” occupational cases based on their occupation. Specifically, HCW refers to medical and health professionals who are directly involved in patient care. These occupations include reception, screening, inspection, testing, transfer, treatment, nursing, epidemiological investigation and medical observation, as well as medical and health professionals who directly perform case specimen collection, pathogen detection, pathological examination, and pathological anatomy. The others are defined as other occupational cases. After excluding suspected or clinically diagnosed cases and those who had a missing value recorded for their occupation, 43,126 cases remained in the data set. First, we included HCWs only, and we analyzed the epidemiological and clinical characteristics of the subgroup of HCWs with COVID-19 (Fig. 1). Second, to compare the differences in signs and symptoms between HCWs and other occupational cases, we further excluded those with a missing value for the onset of symptoms variable. From the initial 43,126 cases, this left 1,013 HCWs and 17,972 other occupational cases. We then matched 2,026 other occupational cases based on sex, age, address and the date of symptom onset (Fig. 1). Third, for these 43,126 cases, and we analyzed the association between occupation and the risk of COVID-19 mortality (Fig. 1).

**Variables**

Demographic characteristics and clinical features were collected using a case questionnaire at the time of diagnosis and were then input into the infectious disease information system by local epidemiologists or public health professionals. The case questionnaire contains basic demographic or epidemiological information (eg, sex, birthdate, present address, occupation, Wuhan-related exposure and confirmed cases exposure) and clinical information (eg, symptom onset, the date of symptom onset, blood cell count). We computed the age of each case using the date of symptom onset and birthdate. According to the present address, all of the records were further classed as residents in Wuhan or elsewhere. The severity of symptoms variable was categorized as asymptomatic, mild, common, severe, or critical. Our diagnostic criteria on clinical severity followed the Chinese clinical guidance for COVID-19 pneumonia diagnosis and treatment. All of the confirmed HCWs were diagnosed based on positive viral nucleic acid test results from throat swab samples. The date of symptom onset in asymptomatic cases was based on the date of the positive nucleic acid test results.
Statistical analyses

Categorical variables were expressed as counts (alongside percentages), and continuous variables were expressed as medians (alongside interquartile ranges). All statistical analyses were performed using R version 3.5.3 software (R Foundation for Statistical Computing, Vienna, Austria). A 2-tailed $P$ value < .05 was considered statistically significant.

To describe the epidemiological characteristics and clinical features of SARS-CoV-2 infection among HCWs, we classified the date of symptom onset into 4 categories: before January 23, 2020, January 24–February 3, 2020, February 4–13, 2020, and February 14–27, 2020.

### Table 1. Characteristics of 1,989 Healthcare Workers (HCWs)

| Characteristic | Before 2020/01/23 (n=587) | 01/24–02/03 (n=974) | 02/04–02/13 (n=286) | 02/14–02/27 (n=142) |
|----------------|----------------------------|---------------------|---------------------|---------------------|
| Age, median (IQR) | 38.08 (31.34–47.66) | 38.76 (30.61–49.31) | 37.18 (29.52–46.89) | 33.82 (27.34–44.41) |
| 20–29 y, no. (%) | 111 (18.91) | 217 (22.28) | 79 (27.62) | 57 (40.14) |
| 30–39 y, no. (%) | 218 (37.14) | 302 (31.01) | 84 (29.37) | 38 (26.76) |
| 40–49 y, no. (%) | 136 (23.17) | 223 (22.9) | 76 (26.57) | 23 (16.2) |
| 50–59 y, no. (%) | 90 (15.33) | 154 (15.81) | 26 (9.09) | 19 (13.38) |
| ≥60 y, no. (%) | 32 (5.45) | 78 (8.01) | 21 (7.34) | 5 (3.52) |
| Sex, male, no. (%) | 230 (39.18) | 324 (33.26) | 74 (25.87) | 39 (27.46) |
| Contact with confirmed patients, no. (%) | 277 (47.19) | 515 (52.87) | 146 (51.05) | 82 (57.75) |
| Clinical severity, no. (%) | | | | |
| Asymptomatic | 0 (0.00) | 0 (0.00) | 6 (2.10) | 67 (47.18) |
| Mild | 198 (33.73) | 487 (50.00) | 149 (52.10) | 37 (26.06) |
| Common | 264 (44.97) | 342 (35.11) | 109 (38.11) | 33 (23.24) |
| Severe or critical | 125 (21.29) | 145 (14.89) | 22 (7.69) | 5 (3.52) |
| Wuhan city, no. (%) | 445 (75.81) | 635 (65.20) | 190 (66.43) | 68 (47.89) |
| Signs and symptoms, no. (%) | | | | |
| Fever, °C | 278 (76.16) | 341 (71.04) | 62 (65.26) | 8 (10.96) |
| <37.5 | 20 (7.22) | 34 (10.03) | 6 (9.68) | 2 (25) |
| 37.5–37.9 | 84 (30.32) | 143 (42.18) | 38 (61.29) | 5 (62.5) |
| 38.0–38.4 | 69 (24.91) | 78 (23.01) | 6 (9.68) | 0 (0) |
| 38.5–38.9 | 71 (25.63) | 61 (17.99) | 9 (14.52) | 0 (0) |
| ≥39.0 | 33 (11.91) | 23 (6.78) | 3 (4.84) | 1 (12.5) |
| Missing | 310 | 635 | 224 | 134 |
| Cough | 194 (53.15) | 258 (53.75) | 47 (49.47) | 13 (17.81) |
| Fatigue | 156 (42.74) | 137 (28.54) | 16 (16.84) | 4 (5.48) |
| Myalgia | 88 (24.11) | 98 (20.42) | 6 (6.32) | 2 (2.74) |
| Headache | 61 (16.71) | 77 (16.04) | 7 (7.37) | 1 (1.37) |
| Chest tightness | 36 (9.86) | 63 (13.12) | 5 (5.26) | 5 (6.85) |
| Sore throat | 37 (10.14) | 38 (7.92) | 7 (7.37) | 2 (2.74) |
| Chills | 49 (13.42) | 52 (10.83) | 6 (6.32) | 1 (1.37) |
| Diarrhea | 34 (9.32) | 30 (6.25) | 7 (7.37) | 1 (1.37) |
| Polypnea | 35 (9.59) | 27 (5.62) | 1 (1.05) | 1 (1.37) |
| Dyspnea | 20 (5.48) | 30 (6.25) | 1 (1.05) | 0 (0) |
| Arthralgia | 28 (7.67) | 27 (5.62) | 0 (0) | 0 (0) |
| Nasal obstruction | 18 (4.93) | 20 (4.17) | 2 (2.11) | 1 (1.37) |
| Nasal discharge | 20 (5.48) | 27 (5.62) | 1 (1.05) | 2 (2.74) |
| Vomit | 13 (3.56) | 15 (3.12) | 2 (2.11) | 1 (1.37) |
| White blood cell count <9.5, no. (%) | 208 (94.98) | 245 (98) | 57 (96.61) | 24 (100) |
| Lymphocytes, <1.0, no. (%) | 93 (42.47) | 102 (40.8) | 19 (32.2) | 1 (4.17) |
| Computed tomography, no. (%) | 303 (85.35) | 413 (85.51) | 72 (75.79) | 30 (41.1) |
| Death, no. (%) | 6 (1.02) | 12 (2.3) | 0 (0) | 0 (0) |
2020 (the lockdown date in Wuhan city), January 24–February 3, February 4–13, and February 14–27. Moreover, an epidemic curve for the distribution of case severity was constructed to show the progression of illness among HCWs involved in the outbreak over time.

To include controls in our study, we matched 1,013 HCWs and 2,026 other occupational cases based on sex, age, address, and the date of symptom onset, and we compared the differences in clinical signs or symptoms. The Wilcoxon signed-rank test was used to compare continuous variables with skewed distribution, and the χ² test or the Fisher exact test was used to compare categorical variables.

A logistic regression model was performed to analyze the association between occupation and the risk of COVID-19 mortality. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for the output. The potential confounders were ascertained based on prior publications 12,13 and these included age range (20–29, 30–39, 40–49, 50–59, and 60+ years), sex (male or female), disease severity (severe or nonsevere), address (Wuhan city or elsewhere), and the date of symptom onset (before January 24–February 3, February 4–13, or February 14–27).

Results

Epidemiological and clinical characteristics of HCWs stratified by the date of symptom onset

From December 27, 2019, through February 27, 2020, a total of 1,989 HCWs were laboratory-confirmed to have SARS-CoV-2 infection in Hubei Province, China. The epidemiological and clinical characteristics of HCWs, stratified by the date of symptom onset, are shown in Table 1. Fever and cough were the most common onset symptoms in HCWs during any period. In total, 297 HCWs (14.93%) were diagnosed with severe or critical cases, and 18 HCWs had died by the end date of the follow-up period. Nearly half of HCWs had no reported contact with known COVID-19 patients (969, 48.72%). Before the date of lockdown in Wuhan city (January 23, 2020), a total of 587 HCWs were laboratory-confirmed to have SARS-CoV-2 infection, and most of these cases occurred in Wuhan city (445, 75.81%). From February 14 to February 27, a total of 142 HCWs were laboratory-confirmed to have SARS-CoV-2 infection, and asymptomatic cases accounted for 47.18% of the cases (68, 47.18%).

We created an epidemiological curve to illustrate the progression of illness among HCWs involved in the outbreak over time (Fig. 2). Asymptomatic, mild, common, and severe or critical cases were stacked to show total daily cases by date of symptom onset. In general, the peak number of cases occurred around January 23–25, 2020. Thereafter, illness incidence declined.

The comparison of clinical characteristics between HCWs and other occupational cases

Based on sex, age, address, and the date of symptom onset we matched 1,013 HCWs and 2,026 other occupational cases. The results of the comparison of clinical characteristics between the 2 groups are presented in Table 2. Fever and cough were the most prevalent symptoms at disease onset in both HCWs (689 [68.02%] and 512 [50.54%]) and other occupational cases (1,583 [78.13%] and 1,095 [54.05%]). Compared with other occupational cases, HCWs had higher rates of fatigue (30.90% vs 25.02%; P < .001), myalgia (19.15% vs 13.43%; P < .001), and chills (10.66% vs 8.09%);
but they had a lower rate of dyspnea (5.03% vs 7.35%; \( P = .019 \)). HCWs also had a (borderline) significantly lower case fatality rate (0.99% vs 2.02%; \( P = .052 \)).

**The association between occupation (HCWs or other) and death with COVID-19**

Of the overall laboratory-confirmed cases, those who were older, male, severely or critically ill, Wuhan residents, and cases with disease onset at early outbreak had significantly higher risk of death (Table S1). After adjustment for these confounders, HCWs had a lower risk of death than other occupational cases (OR, 0.50; 95% CI, 0.30–0.79) (Table 3).

**Discussion**

In the study cohort, 1,989 HCWs were infected by SARS-CoV-2, including 297 (14.93%) severe or critical cases and 73 (3.67%) asymptomatic cases. Fever and cough were the most prevalent symptoms at disease onset in both HCWs and other occupational cases. Compared with other occupational cases, HCWs had higher rates of fatigue (30.90% vs 25.02%; \( P < .001 \)) and myalgia (19.15% vs 13.43%; \( P < .001 \)).

**Table 2. The Comparison of Clinical Characteristics Between Healthcare Workers (HCWs) and the Matched Cases in Other Occupations**

| Characteristic                  | Other Occupational Cases (n=2,026) | HCWs (n=1,013) | \( P \) Value |
|--------------------------------|-----------------------------------|----------------|--------------|
| Age, median y [IQR]            | 39.27 (30.48–49.23)               | 39.06 (30.84–48.89) | .764         |
| 20–29 y, no. (%)               | 465 (22.95)                       | 221 (21.82)     |              |
| 30–39 y, no. (%)               | 594 (29.32)                       | 318 (31.39)     |              |
| 40–49 y, no. (%)               | 511 (25.22)                       | 246 (24.28)     |              |
| 50–59 y, no. (%)               | 318 (15.7)                        | 159 (15.7)      |              |
| \( \geq 60 \) y, no. (%)       | 138 (6.81)                        | 69 (6.81)       |              |
| Sex, male, no. (%)             | 793 (39.14)                       | 369 (36.43)     | .158         |
| Contact with confirmed patients, no. (%) | 472 (23.3) | 472 (46.59) | <.001 |
| Severe or critical, no. (%)    | 287 (14.17)                       | 151 (14.91)     | .622         |
| Wuhan city, no. (%)            | 734 (36.23)                       | 367 (36.23)     | 1.000        |
| Signs and symptoms, no. (%)    |                                   |                |              |
| Fever, °C                      | 1,583 (78.13)                     | 689 (68.02)     | <.001        |
| \(<37.5\)                      | 121 (7.71)                        | 62 (9.04)       | .727         |
| \(37.5–37.9\)                  | 607 (38.66)                       | 270 (39.36)     |              |
| \(38.0–38.4\)                  | 364 (23.18)                       | 153 (22.3)      |              |
| \(38.5–38.9\)                  | 321 (20.45)                       | 141 (20.55)     |              |
| \(\geq 39\)                    | 157 (10)                          | 60 (8.75)       |              |
| Missing                        | 456                               | 327            |              |
| Cough                          | 1,095 (54.05)                     | 512 (50.54)     | .074         |
| Fatigue                        | 507 (25.02)                       | 313 (30.9)      | <.001        |
| Myalgia                        | 272 (13.43)                       | 194 (19.15)     | <.001        |
| Headache                       | 261 (12.88)                       | 146 (14.41)     | .267         |
| Chest tightness                | 237 (11.7)                        | 109 (10.76)     | .480         |
| Sore throat                    | 145 (7.16)                        | 84 (8.29)       | .296         |
| Chills                         | 164 (8.09)                        | 108 (10.66)     | .023         |
| Diarrhea                       | 135 (6.66)                        | 72 (7.11)       | .703         |
| Polypnea                       | 161 (7.95)                        | 64 (6.32)       | .123         |
| Dyspnea                        | 149 (7.35)                        | 51 (5.03)       | .019         |
| Arthralgia                     | 78 (3.85)                         | 55 (5.43)       | .056         |
| Nasal obstruction              | 95 (4.69)                         | 41 (4.05)       | .476         |
| Nasal discharge                | 100 (4.94)                        | 50 (4.94)       | 1.000        |
| Vomit                          | 65 (3.21)                         | 31(3.06)        | .912         |
| White blood cell count <9.5, no. (%) | 1,250 (95.2) | 534 (96.74) | .173 |
| Lymphocytes <1.0, no. (%)      | 454 (34.58)                       | 215 (38.95)     | .081         |
| Computed tomography, no. (%)   | 1,661 (83.09)                     | 812 (81.2)      | .332         |
| Death, no. (%)                 | 41 (2.02)                         | 10 (0.99)       | .052         |

\( P = .023 \), but they had a lower rate of dyspnea (5.03% vs 7.35%; \( P = .019 \)). HCWs also had a (borderline) significantly lower case fatality rate (0.99% vs 2.02%; \( P = .052 \)).

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vs 13.43%; \( P < .001 \). As of March 7, 2020, 18 HCWs and 2,056 other occupational cases died due to COVID-19, for case fatality rates of 0.9% and 5.0%, respectively. HCWs also had a significantly lower risk of death than other occupational cases (OR, 0.50; 95% CI, 0.30–0.79) after adjusting for potential confounders. To the best of our knowledge, this is the largest sample among the reports on the epidemiological and clinical characteristics of SARS-CoV-2 infections among HCWs in China.

Fever and cough were the dominant symptoms among HCWs at any period of time since the SARS-CoV-2 outbreak (Table 1), which is in line with recent findings based on the general population.\(^{14,15}\) Notably, HCWs had significantly higher rates of myalgia and fatigue than other occupational cases. One of the possible reasons for this may be that HCWs had heavier workloads, longer working hours, and higher work pressure than other occupations during this special period. Another plausible reason might be that HCWs have a more comprehensive understanding of the disease and may report more symptoms than other occupations.

| Characteristic | No. Deaths/No. Survivors | OR (95% CI)\(^a\) | \( P \) Value |
|---------------|--------------------------|-------------------|--------------|
| **Age**       |                          |                   |              |
| 20–29 y       | 11/3,963 Ref             | -                 | . . .         |
| 30–39 y       | 31/6,497 Ref             | 1.32 (0.68–2.76)  | .428         |
| 40–49 y       | 71/7,595 Ref             | 2.36 (1.30–4.72)  | .008         |
| 50–59 y       | 258/9,486 Ref            | 6.13 (3.51–11.97) | <.001        |
| \( \geq 60 \) y | 1,703/13,511              | 22.3 (12.91–43.20) | <.001        |
| **Sex**       |                          |                   |              |
| Male          | 1,323/20,385 Ref         | -                 | . . .         |
| Female        | 751/20,667 Ref           | 0.54 (0.40–0.60)  | <.001        |
| **Severe or critical** |                |                   |              |
| No            | 621/34,062 Ref           | -                 | . . .         |
| Yes           | 1,453/6,390 Ref          | 7.05 (6.37–7.80)  | <.001        |
| **Wuhan city** |                       |                   |              |
| No            | 578/15,784 Ref           | -                 | . . .         |
| Yes           | 1,496/25,268             | 1.10 (0.99–1.22)  | .084         |
| **The date of symptom onset** | |                   |              |
| Before 2020/01/23 | 664/7,999 Ref      | -                 | . . .         |
| 01/24–02/03 | 1,074/20,724             | 0.76 (0.68–0.84)  | <.001        |
| 02/04–02/13 | 278/8,319                | 0.52 (0.45–0.61)  | <.001        |
| 02/14–02/27 | 58/4,010                 | 0.30 (0.23–0.40)  | <.001        |
| **HCWs**      |                          |                   |              |
| No            | 2,056/39,081 Ref         | -                 | . . .         |
| Yes           | 18/1,971                 | 0.50 (0.30–0.79)  | .005         |

Note: OR, odds ratio; CI, confidence interval; HCWs, healthcare workers.

\( ^a \)Covariates in model included age, sex, Wuhan city, disease severity, occupations, and the date of symptom onset.

\( \text{Table 3. The Risk Factors of SARS-CoV-2 Deaths Among Laboratory-Confirmed Cases (n=43,126)} \)

In summary, compared with cases in other occupation groups, our results suggest that HCWs have a lower risk of death in the Hubei Province but have higher rates of fatigue and myalgia. Nearly half of HCWs with confirmed COVID-19 reported no known contact with COVID-19 patients, which highlights the need for appropriate public health measures and a more comprehensive understanding of diseases and are, on average, younger than those in other occupations, and potentially important protective factors may be related to these factors. Another potential explanation might be the easy access to medical resources that comes with being a HCW.
to maintain strict vigilance and precautionary measures at all times. Additionally, to protect the health and safety of this essential national workforce, it is crucial to strengthen the detection strategies and to reinforce infection control among HCWs.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2020.1321

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