



## Short Communication

## Transmission of COVID-19 in the terminal stages of the incubation period: A familial cluster



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## ABSTRACT

We report a familial cluster of 2019 novel coronavirus disease (COVID-19) to assess its potential transmission during the incubation period. The first patient in this familial cluster was identified during the presymptomatic period, as a close contact of a confirmed patient. Five family members had close contact with this first patient during his incubation period, with four of them confirmed positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in the subsequent sampling tests.

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An emerging infectious disease, 2019 novel coronavirus disease (COVID-19), was identified as being associated with a novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which was initially reported in December 2019 in Wuhan City, China (Li et al., 2020). Family and hospital clusters of COVID-19 cases were reported and person-to-person transmission was confirmed (Chan et al., 2020). Until now, the infectious period of the disease has not been fully explained (Tong et al., 2020; Yu et al., 2020). We report a familial cluster of COVID-19 to assess potential transmission of the disease during the incubation period.

On February 8, 2020, Zhoushan Center for Disease Control and Prevention (CDC) received a request from Wuxi CDC, Jiangsu Province, China, for assistance in the management of the close contacts of a SARS-CoV-2-infected person (person A) confirmed in Wuxi City. Zhoushan CDC responded immediately and placed person A's family members (persons B, C, D, E, F, in Zhoushan City) together at an isolation site, collecting their throat-swab samples for SARS-CoV-2 testing. On February 9, 2020, Zhoushan CDC identified four laboratory-confirmed SARS-CoV-2 infections

among person A's family members, one of whom remained asymptomatic throughout the isolation period. The subsequent detailed epidemiological investigations are reported below. The timeline of exposure to the asymptomatic carrier of the SARS-CoV-2 that caused COVID-19 in this familial cluster is shown in Figure 1.

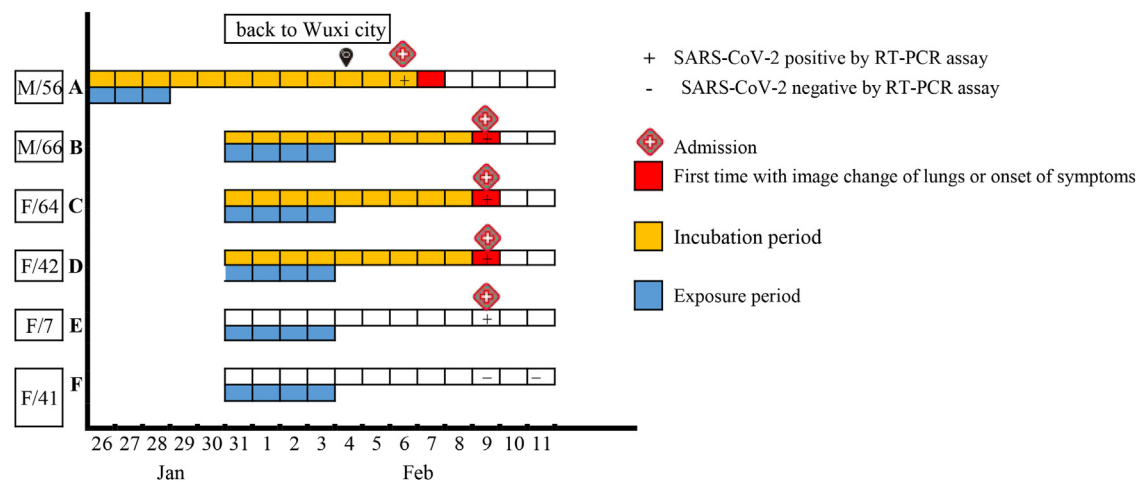
Person A, a 51-year-old man, was the first reported SARS-CoV-2 infection in this familial cluster. On January 26 he drove back to Wuxi City alone from his hometown in Hunan Province, where he stayed with relatives from January 26 to January 28 in Wuxi city. He was then placed under quarantine at home for 14 days, on January 29, by the community organization. However, residential segregation in the community was not mandatory at the time, and on January 31 he drove to Zhoushan City alone and stayed with his family for 4 days. On February 3, he drove back to Wuxi City alone, where he remained without venturing out. On February 4, the relatives with whom he had first stayed (January 26 to January 28) were shown to be infected with SARS-CoV-2. On February 5, as the close contact, he was transferred to an isolation site and his throat swab samples were collected for SARS-CoV-2 detection. On February 6, he was confirmed to have SARS-CoV-2 infection by RT-PCR (Ct values were not available), but he did not display any symptoms at the time (Wang et al., 2020). He was then transported to a local infectious diseases hospital for isolation. On February 7, he developed fever, and a chest CT showed slight ground glass changes.

From January 31 to February 3, person A had lived together with his father-in-law (person B), mother-in-law (person C), wife (person F), wife's sister (person D), and daughter (person E). On 9 February 2020, as the close contacts of person A, the family

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**Figure 1.** Epidemiological linkage and timeline of severe acute respiratory syndrome coronavirus 2 infection within a familial cluster.

**Table 1**

Ct values for the RT-PCR results of four laboratory-confirmed COVID-19 patients.

Cases	Gender	Age	Sample types	ORF1ab	Nucleoprotein gene	Sampling date
Person B	Male	66	Sputum	22.33	23.19	9 February 2020
Person C	Female	64	Throat swab and sputum	19.66	22.40	9 February 2020
Person D	Female	42	Throat swab and sputum	24.96	26.09	9 February 2020
Person E	Female	7	Throat swab and sputum	25.13	26.16	9 February 2020

underwent throat swab sampling by staff from Zhoushan CDC, for SARS-CoV-2 detection, and four of them were positive (persons B, C, D, E) (Ct values are shown in Table 1). They had reported no contact with people with fever or respiratory symptoms in Wuhan or other areas with persistent local COVID-19 transmission in the 14 days prior to the onset of the disease, and no history of contact with wild animals or poultry. Person B had no clinical symptoms, but a chest CT showed mild ground glass changes in both lungs at the time of confirmation. Persons C and D had slight symptoms, with cough, and the chest CT showed mild ground glass changes in the lungs at the time of confirmation. Person E was a 7-year-old girl who was asymptomatic during the whole medical observation period, with the chest CT showing as normal.

This familial cluster of four patients with COVID-19 in Zhoushan, China, therefore had close contact before their symptom onset with an asymptomatic family member who developed symptoms later and was diagnosed in Wuxi City. All persons' respiratory specimens were collected for SARS-CoV-2 detection by RT-PCR assay (Wang et al., 2020). Person A's laboratory test and epidemiological investigation was conducted by Wuxi CDC. Unfortunately, SARS-CoV-2 detection as well as chest CT examination for person A had not been conducted before February 6, so we do not know when he began to shed virus or show imaging changes in both lungs.

This study suggests that the SARS-CoV-2 in this case may have been transmitted in the terminal stages of the incubation period. Infectivity during the incubation period for SARS-CoV-2 is a big challenge for controlling the disease, especially regarding considerations for potential infectious sources, and the recognition and isolation of close contacts.

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#### Ethical approval

Approval was not required.

#### Conflicts of interest

No conflicts of interest to declare.

#### References

- Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, 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;395(10223):514–23. doi:[http://dx.doi.org/10.1016/S0140-6736\(20\)30154-9](http://dx.doi.org/10.1016/S0140-6736(20)30154-9).
- Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med* 2020;382(13):1199–207. doi:<http://dx.doi.org/10.1056/NEJMoa2001316>.
- Tong ZD, Tang A, Li KF, Li P, Wang HL, Yi JP, et al. Potential presymptomatic transmission of SARS-CoV-2, Zhejiang Province, China, 2020. *Emerg Infect Dis* 2020;26(May (5)). doi:<http://dx.doi.org/10.3201/eid2605.200198>.
- Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA* 2020;323(11):1061–9. doi:<http://dx.doi.org/10.1001/jama.2020.1585>.
- Yu P, Zhu J, Zhang Z, Han Y, Huang L. A familial cluster of infection associated with the 2019 novel coronavirus indicating potential person-to-person transmission during the incubation period. *J Infect Dis* 2020;(February). doi:<http://dx.doi.org/10.1093/infdis/jiaa077> pii: jiaa077.