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## Short Communication

## A three-generation family cluster with COVID-19 infection: should quarantine be prolonged?

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## ABSTRACT

**Objectives:** Families are a transmission route for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) because of the close contact. Monitoring of the viral load will be a valuable method to reduce the optimal number of quarantine days, especially in presymptomatic and symptomatic carriers of their households. The traditional three-generation families living together are seen frequently in East Asia, including in Taiwan.

**Study design:** We report on a family cluster with six individuals infected with coronavirus disease in Taiwan.

**Methods:** The current public policy in Taiwan is quarantine for at least 14 days, based on the incubation period, or until the patient has tested negative three days in a row using the SARS-CoV-2 reverse transcription polymerase chain reaction. Details on the onset date of clinical symptoms, throat swab conversion, and course of disease were collected from medical records retrospectively.

**Results:** In the household of this three-generation Taiwanese family, the infection rate was 60%. The ratio of males to females was 4:2, and the age range was 11–85 years. The prevalence of asymptomatic disease was 33.3% (2/6). The longest throat swab conversion time was 37 days, and the estimated course of disease from symptoms to first conversion of throat swab was 59 days.

**Conclusions:** Large families, including three-generation families in a single dwelling, should be monitored when the index case is found. Presymptomatic and symptomatic family members could be quarantined for an appropriate duration which, in our experience, is 2 months.

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Coronavirus disease (COVID-19) became a pandemic in 2020.<sup>1</sup> Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmits via social activity of family, friends, and coworkers.<sup>2,3</sup> Families are a transmission route for SARS-CoV-2 because of close contact.<sup>4</sup> The current public policy is quarantine for at least 14 days, based on the incubation period<sup>5</sup> or until the patient has tested negative three days in a row using the SARS-CoV-2 reverse transcription polymerase chain reaction (RT-PCR). Monitoring the viral load will be a valuable method to reduce the optimal quarantine

days, especially in asymptomatic carriers.<sup>6</sup> Identifying asymptomatic carriers within a family is important to guide quarantine policy.<sup>7</sup> In East Asia, grandparents, parents, and children living together is a common tradition, a pattern also seen in Taiwan.<sup>8</sup> Our study aimed to investigate a three-generation family cluster of COVID-19.

We report a family cluster with six individuals infected with COVID-19 in Taiwan. Details on the onset date of clinical symptoms, throat swab conversion, and course of disease were collected from medical records retrospectively.

The household cluster with COVID-19 infection status is summarized in [Table 1](#) and Supplemental Fig. 1. All dates mentioned henceforth are in 2020. Patient 1 is an 85-year-old, bed-ridden man with diabetes, hypertension, and continuous ambulatory peritoneal dialysis who was admitted to the hospital with pneumonia on

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**Table 1**  
Family infection status in family cluster.

Characteristic	Patient Number					
	1	2	3	4	5	6
Age (years)	85	74	53	49	11	31
Comorbidities	+	–	+	–	–	–
Probable cause of transmission	Taking care	Taking care	Taking care	Taking care	Hospital visit	Taking care
Symptoms onset	Feb. 9	Jan. 29	Jan. 31	Jan. 29	NA	NA
Symptoms status	SB	Sore throat	Cough, fever	Sore throat	NA	NA
Throat swab+	Feb. 21	Feb. 23	Feb. 23	Feb. 23	Feb. 25	Feb. 24
Throat swab-	NA	Mar. 28	Mar. 30	Feb. 26	Mar. 2	Mar. 28
Status	Mar. 20	Apr. 6	Apr. 6	Mar. 6	Mar. 13	Apr. 1
	Mortality	Discharge	Discharge	Discharge	Discharge	Discharge
Virus conversion (days)	>29	35	37	4	7	34
Course of disease (days)	>41	59	59	29	7	34

Course of disease: from symptoms to throat swab conversion or SARS-CoV-2 positive to negative in no symptomatic infection. SB: shortness of breath, NA: not applicable. The date of statistic was until April 1, 2020.

February 9. On February 16, his condition deteriorated, and he was intubated and transferred to the intensive care unit. Patient 1 tested positive by SARS-CoV-2 RT-PCR on February 21. Chest X-ray showed improved pneumonia, but he remained on a ventilator. Repeat testing was positive by SARS-CoV-2 RT-PCR. Patient 1 died due to bacteremia and profound septic shock on March 20. The course of disease was 41 days from the initiation of symptoms to death without sputum conversion.

Patient 2, aged 74 years, was patient 1's wife and was diagnosed with acute pharyngitis on February 6. She was confirmed as SARS-CoV-2 positive on February 23. Although confirmed with COVID-19 infection, she did not have fever or any other symptoms. Her throat swab was negative on March 28, and later, she had two sequential negative tests. The disease course was 59 days, and the duration of the throat swab conversion was 35 days.

Patient 3 is patient 1's 53-year-old elder son. On January 31, he had cough, fever, sore throat, and runny nose and was diagnosed as SARS-CoV-2 positive on February 23. Patient 3 took care of his father, including helping with peritoneal dialysis. His throat swab was negative on March 30 and, later, had two sequential negative tests. His disease course was 59 days with a throat swab conversion duration of 37 days.

On February 23, patient 4 (son of patient 1, patient 3's brother), aged 49 years, was confirmed to be SARS-CoV-2 positive, but without typical symptoms. Patient 4 had a sore throat on January 29 but did not seek medical treatment. He was a teacher and travelled around Wuhan and other cities of China in January. After returning to Taiwan, he joined patient 3 in caring for patient 1. His throat swab was negative on February 26 and later had two sequential negative tests. The disease course was estimated to be 38 days with the throat swab conversion duration of 4 days.

Patient 5 is patient 1's grandson. He visited patient 1 on February 11 and February 19 and was tested positive for SARS-CoV-2 on February 25. He did not develop any symptoms. His throat swab was negative on March 2, confirmed by two additional negative tests. The disease course was 7 days, and the throat swab conversion duration was 7 days.

Wives and daughters of patients 3 and 4 did not exhibit symptoms, although they lived together with the two patients. Their SARS-CoV-2 RT-PCR tests were all negative.

Patient 6 was patient 1's caregiver from February 11 to 16. She was quarantined in the hospital on February 24, as she was tested positive for SARS-CoV-2 but asymptomatic. Her throat swab was negative on March 28, showing a disease course and the throat swab conversion time of 34 days.

In the household of this three-generation Taiwanese family, the infection rate was 60%. The probable cause of transmission would be normal family interaction, such as taking care of older family

members and routine visits. The ratio of males to females was 4:2, and the age range was 11–85 years. The prevalence of asymptomatic disease was 33.3% (2/6).

Our report shows that the youngest asymptomatic case had shorter throat swab conversion time and disease course. By contrast, elderly family members may experience severe pneumonia, particularly with comorbid diseases, and death.<sup>9</sup> Elder patients had longer throat swab conversion and prolonged potential quarantine duration even after symptoms had improved. This highly contagious disease, when found in a traditional family structure, transmits to other household members of different ages and has the potential to infect all family members. If there is an insufficient quarantine period, the grandparents with pneumonia who are admitted to the hospital could be the source of nosocomial infection, and the parents will then transmit it to their colleagues. In Taiwan, a high attack rate was observed within 5 days of detection of a symptomatic index case than observed >5 days.<sup>10</sup> The attack rate was higher among household family contacts than that in health care settings.

Presymptomatic and symptomatic patients have a risk of transmission to their family, as per epidemiologic studies in Taiwan. In our report, the longest throat swab conversion was 5 weeks, and the disease course was 2 months.

This case only includes 6 individuals, which limits efficient external validity of the results. However, three-generation family clusters may be a strong transmission factor of COVID-19 in East Asia countries, as different from that of Western countries. The possibility of different living arrangements being a factor in the transmission of COVID-19 is a topic that should be studied in the future.

We propose three practical policies. First, if the index case was found, immediate examination of three generations of family members, especially if they live together, should be conducted. Second, presymptomatic and symptomatic family members could be quarantined at hotels with suitable social distance or be isolated at the hospital until their three sequential throat swabs show negative results. Finally, the effective quarantine duration remains a mystery. In our experience, the possible duration would be 2 months.

## Author statements

### Ethical approval

For this retrospective observational study, the informed consent waiver was received from IRB and the patient privacy rights including any individual person's data in any form (including individual details, images, or videos) are observed. This study was

approved by the Institutional Review Board of Taipei Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation (approval number 09-X-041) and conducted in accordance with the amended Declaration of Helsinki.

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#### Competing interest

The authors declare that they have no conflicting interests.

#### Authors' contributions

MCY, PPH, and WLS collected the data. WLS and YCC conceived the idea and drafted the paper. YKW, MYP, CCL, and PSW reviewed the article. All authors read and approved the final manuscript.

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