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Original Article

# Epidemiological investigation of the first locally acquired case of COVID-19 identified by influenza surveillance—Taiwan, February 2020

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surveillance;  
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investigation;  
Contact tracing

**Abstract** *Background:* COVID-19 and influenza have similar clinical presentations that can range from mild to severe disease. The World Health Organization recommends that countries use existing influenza surveillance to monitor COVID-19 transmission in communities. We aim to describe the surveillance and investigation of COVID-19 at the early stage of the pandemic in Taiwan.

*Methods:* In February 2020, the Taiwan Centers for Disease Control enhanced COVID-19 surveillance through its existing influenza surveillance. We retrospectively tested patients for SARS-CoV-2 who had symptoms of severe complicated influenza but were negative in influenza testing. We conducted an epidemiological investigation and contact tracing for the index patient and secondary cases to prevent virus transmission.

*Results:* We identified the first COVID-19 patient on February 15 through enhanced COVID-19 surveillance. He had no history of traveling abroad and an unclear history of contact with COVID-19 cases. He presented with influenza-like illness on January 27 and was hospitalized from February 3 to 15. We identified 39 close contacts of the index patient, including 11 family members and 28 healthcare workers. In total, four close family contacts of the index patient tested positive for SARS-CoV-2. An additional 84 close contacts of the four secondary cases were identified and traced; none was diagnosed with COVID-19.

*Conclusions:* We recommend enhancing COVID-19 surveillance by testing patients with influenza-like illness. To prevent the spread of COVID-19, we recommend using appropriate

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personal protective equipment when in close contact with patients who present with influenza-like illness or when caring for patients with pneumonia of unknown etiology. Copyright © 2023, Taiwan Society of Microbiology. Published by Elsevier Taiwan LLC. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

In response to the global spread of coronavirus disease 2019 (COVID-19), the Taiwan Centers for Disease Control (TCDC) listed COVID-19 as a notifiable disease on January 15, 2020. From January 21 to February 14, 2020, there were a total of 18 COVID-19 cases in Taiwan, all of which were imported or import-related cases. At the same time, seasonal influenza virus was circulating in the community.

Because COVID-19 and influenza-like illness (ILI) have similar clinical presentations—from asymptomatic or mild symptoms to severe symptoms, complications, and death—it is suggested that using existing influenza surveillance systems is an effective way to detect COVID-19 in the community.<sup>1–3</sup> Severe, complicated influenza is a notifiable disease in Taiwan; it is defined as ILI causing death or the need for intensive care due to severe complications within two weeks of illness onset. Severe complicated influenza must be reported to the National Notifiable Disease Surveillance System (NNDSS), and the patients must be tested for influenza by reverse transcription polymerase chain reaction (RT-PCR).<sup>4,5</sup> To identify local COVID-19 cases early, TCDC conducted an enhanced COVID-19 surveillance program through an existing influenza surveillance system.

Here, we report a locally acquired case of COVID-19 identified by an existing influenza surveillance system and the epidemiological investigation of COVID-19 cases to prevent further transmission.

## Methods

### Enhanced COVID-19 surveillance program

TCDC conducted enhanced COVID-19 surveillance through an existing influenza surveillance system, beginning February 12, 2020. Since January 31, 2020, throat swabs from patients whose symptoms were compatible with severe complicated influenza (a national notifiable disease in Taiwan) but who tested negative for influenza by RT-PCR were retrospectively tested for SARS-CoV-2 by RT-PCR.

### Definitions

Patients were considered to have COVID-19 if they tested positive for SARS-CoV-2 by RT-PCR. The index patient was defined as the first to have COVID-19 identified by the existing influenza surveillance system in this familial cluster. Secondary cases were defined by testing positive for SARS-CoV-2 by RT-PCR after contact with the index patient.

Persons were considered to have had close contact with a COVID-19 patient if they were within two meters for  $\geq 15$  min or if they were healthcare workers (HCWs) who provided medical care or performed aerosol generating procedures (AGPs) to a COVID-19 patient without appropriate personal protective equipment (PPE).

## Epidemiological investigations

We started the investigation immediately after the index case tested positive for COVID-19 on February 15, 2020. We interviewed family members, healthcare workers, and colleagues of the index patient and secondary cases for their history of traveling abroad, exposure, and activities; a standard questionnaire was used to identify close contacts and to confirm whether secondary cases had other possible sources of infection. We also reviewed medical records and infection control practices in the hospital to identify the clinical course of the index patient and AGPs during the hospitalization.

To identify close contacts and evaluate their risk of infection in different settings, we visited healthcare, occupational, and other settings and checked surveillance videos to confirm the manner of contact with the COVID-19 patient and use or nonuse of PPE. Close contacts of COVID-19 patients were identified and interviewed within 24 hours by officials at the Taiwan Field Epidemiology Training Program (Taiwan FETP), the regional center of TCDC and local health bureau. All close contacts were tested for SARS-CoV-2 when they were identified and then were quarantined for 14 days after last exposure to a COVID-19 patient; during quarantine, their health status was tracked. If the close contacts developed fever (temperature  $\geq 38^\circ\text{C}$ ) or any respiratory symptoms during quarantine, local health bureau officials arranged for their admission, isolation, and retesting for SARS-CoV-2, as well as reports to the NNDSS. Before returning to work in the hospital, all HCWs had to be negative when retested for SARS-CoV-2.

## Laboratory testing

Throat swab specimens were obtained from all close contacts in family and health care settings and tested for SARS-CoV-2 by RT-PCR in the national laboratory of the TCDC; other close contacts were tested on the basis of risk of infection. RT-PCR was performed according to the "Detection of Viral RNA of SARS-CoV-2 Protocol" issued by the TCDC.<sup>6</sup> Because this investigation was for an emergency public health issue, an ethics review was not carried out.

## Results

### The index patient identified by enhanced COVID-19 surveillance program

From January 31 to February 15, 2020, a total of 113 specimens from patients with symptoms compatible with severe complicated influenza but who tested negative for influenza were tested for SARS-CoV-2. Among them, only one tested positive for COVID-19 as of February 15; this was the first patient with locally acquired COVID-19 identified by influenza surveillance and was therefore the index patient in our investigation. During the same period, 114 patients were reported to have severe complicated influenza and tested positive for influenza.

The index patient was a 62-year-old male who had no history of traveling abroad within 14 days prior to symptom onset. According to his family members, he was a taxi driver in central and southern Taiwan and had underlying conditions of hypertension, diabetes, and hepatitis B. He presented a cough on January 27 and a fever on January 28. He initially was positive for influenza by rapid influenza antigen test when he visited the clinic on February 1, but he tested negative for influenza by RT-PCR when he was hospitalized on February 3 for pneumonia of unknown etiology. He died on February 15.

To limit further transmission of SARS-CoV-2, the Taiwan FETP conducted an epidemiological investigation and contact tracing of the index patient (hereafter referred to as Case 1).

### Epidemiological investigation

In total, 10 family members attended a luncheon with Case 1 on January 27 in an air-conditioned indoor restaurant without windows. Their table was located in the center of the restaurant, and the distance between each table was less than 1.5 m. They sat around a round table at a distance of less than 1.5 m without wearing masks. They saw Case 1 cough several times during the meal. No family members met Case 1 after the meal, except for the two household contacts: Case 1's mother and brother. Another close contact reported seeing Case 1 once in the intensive care unit (ICU) between February 4 and February 15, and she was wearing a surgical mask and gloves during the hospital visit.

We identified 11 family close contacts of Case 1, including 10 family members who ate lunch with Case 1 and one family member who visited Case 1 in the hospital. All family close contacts were quarantined on February 16 to enable tracking of symptoms and testing for SARS-CoV-2. Five of the 11 family contacts of Case 1 developed respiratory symptoms within 14 days after their last contact with Case 1, which was at the family luncheon on January 27. Four (40%) of the 10 family contacts who had eaten lunch with Case 1 tested positive for SARS-CoV-2. We also contacted customers who ate lunch at adjacent tables at the same time on January 27, and none had symptoms. The floor plan of the restaurant and the seating arrangements for the family are shown in Fig. 1. The four secondary cases are hereafter referred to as Case 2 (younger brother of Case 1), Case 3 (mother of Case 1), Case 4 (niece of Case 1 and

son-in-law of Case 5), and Case 5 (younger sister of Case 1). Because Case 2 and Case 3 were also the household contacts of Case 1, the household secondary attack rate was 100%. The family tree of this familial cluster of COVID-19 is shown in Fig. 2.

The medical records of Case 1 showed that he sought medical treatment at a pharmacy on January 28 and visited a clinic on February 1, where the diagnosis was suspected influenza infection. Because his symptoms had not improved and he had developed shortness of breath, on February 3 he sought medical assistance at the outpatient department of a hospital. A chest X-ray was obtained and showed pneumonia with bilateral lower-lung-field alveolar process. The patient was transferred to the emergency room (ER). His condition worsened quickly, with unstable hemodynamics, and he was admitted to the ICU. On February 4 he was intubated for mechanical ventilation with a closed circuit. The index patient died of severe pneumonia and sepsis on the night of February 15.

Enhanced infection control measures for COVID-19 had been implemented in the hospital on January 1, 2020. These measures included reminding HCWs, patients, and accompanying persons to wear masks and disinfect their hands at the entrance. During the hospital stay of Case 1, airborne precautions were put in place (February 3–13), but surgical masks were used rather than N95 masks (February 14–15). Therefore, HCWs who wore surgical masks in the ER and ICU were listed as close contacts of Case 1. We identified 28 close contacts among HCWs in the hospital: one doctor, 21 nurses, three assistants, and three respiratory therapists. One nurse had developed respiratory symptoms within 14 days after last contact with Case 1. However, no close contacts of HCWs tested positive for SARS-CoV-2.

### Secondary cases

Among four secondary cases, there are two males and two females, with ages ranging from 31 to 88 years. One were asymptomatic (25%), two (50%) had fever (higher than 38 °C), two (50%) had cough, two (50%) had sore throat, two (50%) had rhinorrhea, one (25%) had headache, and one (25%) had general weakness. The symptom onset dates of the secondary cases were January 28, February 3, February 5 and February 15, respectively. A timeline showing epidemiological information for the COVID-19 patients in the cluster is shown in Fig. 3.

No secondary cases had a history of traveling abroad in recent months or of being in contact with any other confirmed or suspected COVID-19 patients. The only clear and common exposure of four secondary cases was eating lunch with Case 1.

In total, 84 close contacts of the four secondary cases were identified in different settings, including one funeral staff member, two relatives, three neighbors, two restaurant workers, two HCWs, and 74 colleagues. All close contacts were quarantined for 14 days to monitor whether they developed any symptoms. During the 14-day quarantine period, a total of seven close contacts developed respiratory symptoms and were tested for SARS-CoV-2. A total of 74 close contacts of secondary cases were tested whether

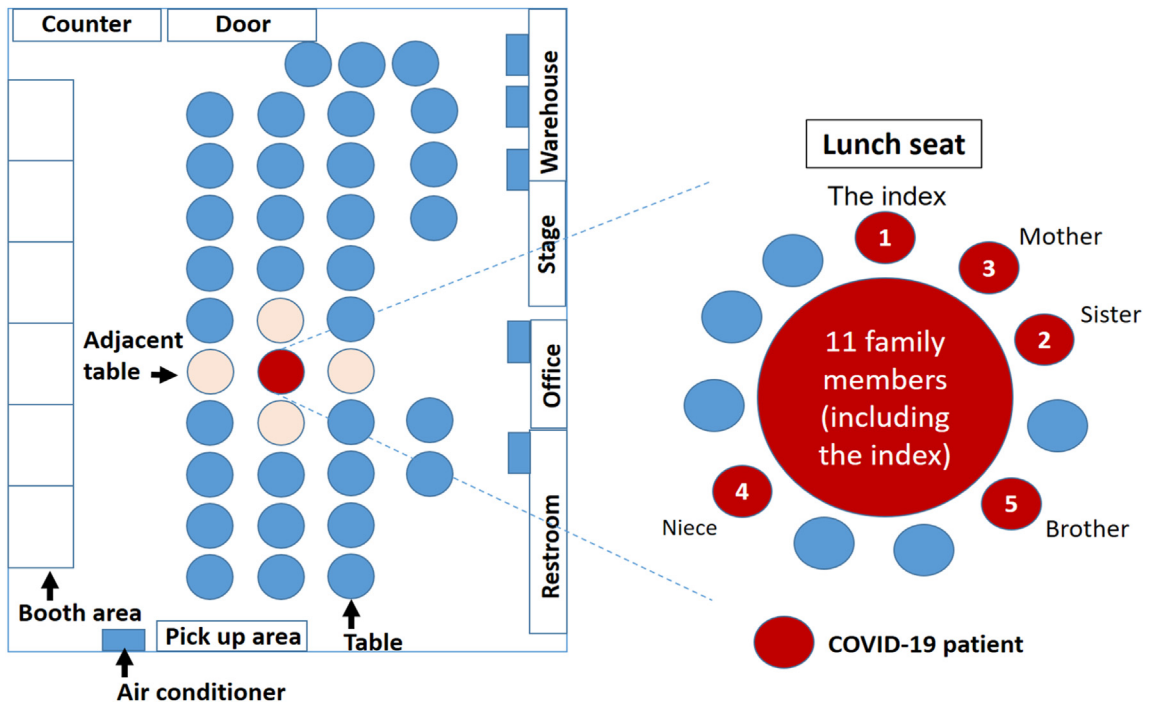
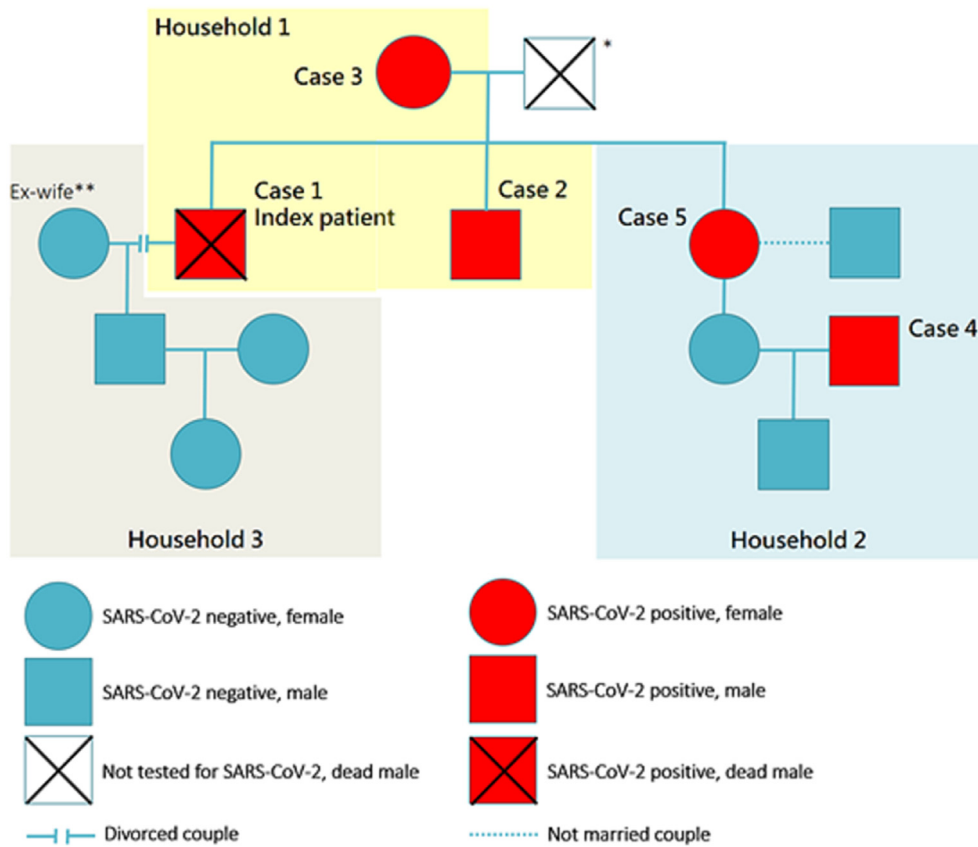
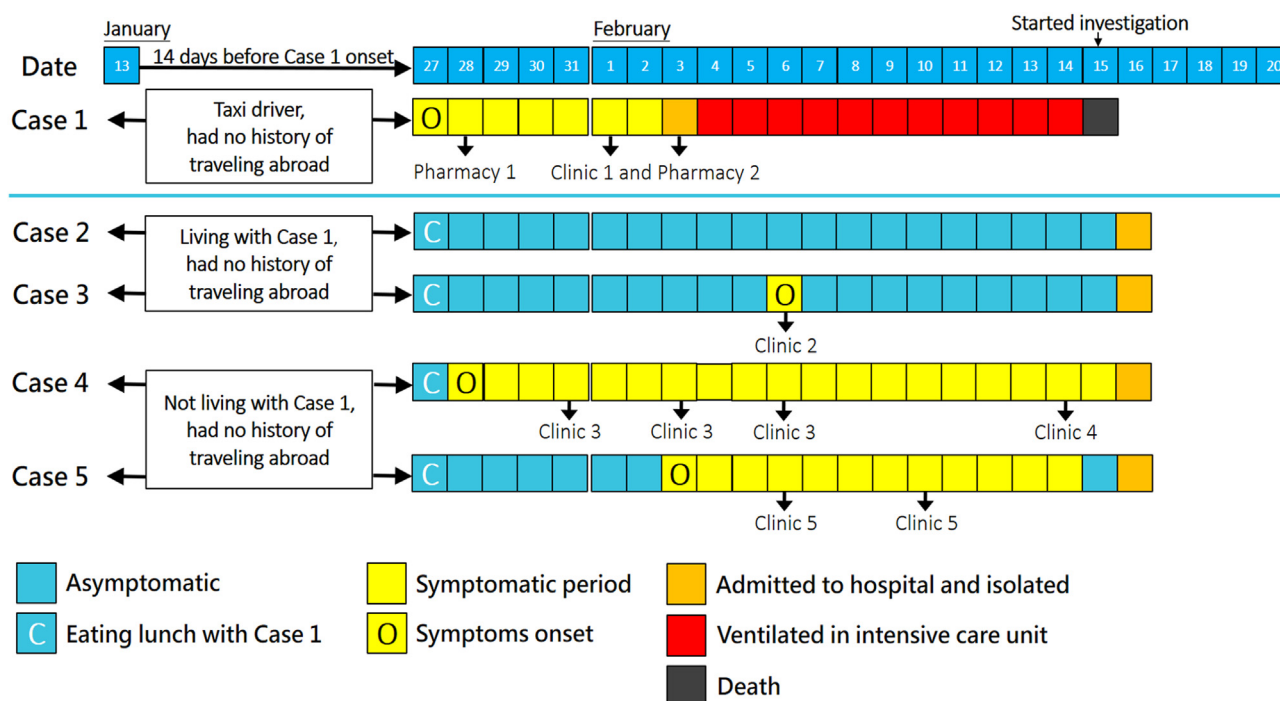


Figure 1. The floor plan of the restaurant and the family seating arrangement.



\*Family members who had passed away in the past.  
 \*\*Ex-wife didn't attend the lunch meal on January 27.

Figure 2. Family tree of this familial cluster of COVID-19.



**Figure 3.** Timeline with epidemiological information for COVID-19 patients in this familial cluster.

they were symptomatic or not; however, none of them was confirmed to have SARS-CoV-2 infection.

In summary, we identified 123 close contacts in this familial cluster, and 13 (10.6%) developed symptoms; however, only four family members of Case 1 (3.3%) were diagnosed with COVID-19.

A summary of close contacts for each COVID-19 patient is shown in Table 1.

## Discussion

We identified the first case of locally acquired COVID-19 through existing influenza surveillance in Taiwan. The index patient presented with ILI and the initial diagnosis was influenza. Because COVID-19 and influenza infection could have similar presentations – from mild to severe, some countries also identified COVID-19 patients earlier than official reports with retrospectively tested respiratory samples of patients with ILI or acute respiratory disease.<sup>2,11,12</sup> On the basis of our finding, we recommend enhancing COVID-19 surveillance by testing ILI patients with pneumonia for SARS-CoV-2.

We found the transmission of SARS-CoV-2 within the family occurred mainly through close contact with the symptomatic index patient in the absence of masks. All secondary cases were presumably infected by eating lunch with the index patient, with a secondary attack rate of 40%. However, there were two secondary cases among the luncheon attendees who were also household close contacts of Case 1. The household secondary attack rate was 100%, so we could not exclude the possibility of household transmission. Households have been reported to be the primary setting in outbreaks of SARS-CoV-1, MERS-CoV, and SARS-CoV-2 infection as a result of more frequent close

contacts.<sup>7,8,13–15</sup> We recommend that people keep social distance and wear a mask when having contact with a symptomatic person. In addition, we found one (25%) of the four secondary cases were asymptomatic in this familial cluster. It has been reported that presymptomatic and asymptomatic patients can transmit SARS-CoV-2.<sup>16,17</sup> Thus, family close contacts of a COVID-19 patient should be identified, tested, and quarantined early, regardless of symptoms.

All HCWs who had been exposed to the index patient were tested for SARS-CoV-2. However, none of them tested positive. We inferred that wearing a surgical mask still provides a certain degree of protection from infection for HCWs. Similar to other reports, all exposed HCWs also wore surgical masks during medical procedures, and no secondary infection was found to occur among them.<sup>18</sup> Some reports on nosocomial outbreaks of COVID-19 have demonstrated that HCWs have higher risk for COVID-19 infection and therefore could cause further transmission.<sup>9,10</sup> Our finding supported that HCWs should follow infection control measures, including using PPE and good hand hygiene when caring for patients with pneumonia, to prevent infection and further transmission.

In our investigation, all close contacts in the family and healthcare settings were tracked and tested for SARS-CoV-2 whether they were symptomatic or not, so we were able to determine the settings or exposure scenarios in which close contacts were more likely to acquire infection.

The first limitation of this investigation is recall bias. Because Case 1 died on the same day that our investigation started (on February 15), the exposure and contact history of Case 1 could be obtained only from his family members and medical records. The exact date of onset of his symptoms remained uncertain, and we may have missed some close contacts that were not identified, which implies that the risk



**Table 1** Characteristics of close contacts of patients with COVID-19.

Close contacts/contact roles	No. of contacts	No. with respiratory symptoms (%)	No. positive for COVID-19 (%)
Case 1	39	6 (15.4%)	4 (10.3%)
Family contacts			
Family luncheon <sup>a</sup>	10	5 (50.0%)	4 (40.0)
Hospital visit	1	0	0
Healthcare contacts			
Doctors	1	0	0
Nurses	21	1 (4.8%)	0
Respiratory therapists	3	0	0
Assistants	3	0	0
Case 2	1	0	0
Other contacts			
Funeral staff	1	0	0
Case 3	5	0	0
Family contacts			
Relatives visit	2	0	0
Other contacts			
Neighbors visit	3	0	0
Case 4 <sup>b</sup>	61	1 (1.6%)	0
Healthcare contact			
Clinic	1	0	0
Other contacts			
Occupational	58	1 (1.7%)	0
Restaurant workers	2	0	0
Case 5 <sup>b</sup>	17	6 (37.5%)	0
Healthcare contact			
Clinic	1	0	0
Other contacts			
Occupational	16 <sup>c</sup>	6 (37.5%)	0
Total	123	13 (10.6%)	4 (3.3%)

<sup>a</sup> Note: Four secondary cases (Case 2, Case 3, Case 4, and Case 5) are included in the number of family contacts for Case 1.

<sup>b</sup> Family members of Case 4 and Case 5 are included in the number of family contacts for Case 1 because they were also eating lunch with Case 1 on January 27.

<sup>c</sup> Among the 16 occupational close contacts of Case 4, six were in the same working group as Case 4, and 10 were in different working group.

of virus transmission in the community still existed. Second, among close contacts in this familial cluster, only HCWs and symptomatic persons needed to be retested for SARS-CoV-2; others were tested only once, at an early stage in our investigation. Thus, we were unable to identify other asymptomatic COVID-19 patients in this investigation. Third, the definition of close contact used in our investigation may be insufficient for subsequent epidemics due to SARS-CoV-2 variants. However, it was still a concise, clear definition for public health workers or the general public to identify close contacts rapidly and timely, especially during the early phase of the COVID-19 pandemic in Taiwan.

To prevent a COVID-19 outbreak, we recommend enhancing COVID-19 surveillance by testing ILI patients with pneumonia for SARS-CoV-2. In fact, TCDC continues to detect COVID-19 through the existing influenza surveillance system. Family close contacts of COVID-19 patients should be traced, tested, and quarantined as early as possible, whether they are symptomatic or not. HCWs should follow infection control practices and use appropriate PPE when caring for patients with pneumonia of unknown etiology.

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## Disclaimer

The findings and conclusions of this article are interpretations of the authors, and do not necessarily represent the official position of the TCDC.

## Declaration of competing interest

The authors declare that they have no conflicts of interest.

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