JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Coronavirus Pandemic

Travel-associated outbreak of COVID-19 in a departmental store, Wenzhou, China

Yiwei Zhou[1], Fanglv Xiang[2], Chaorong Ni[3], Xiaoming Zhang[3], Haibin Xie[2], Haishen Zhu[2], Zumu Zhou[3,4]

[1] Business School, University of Shanghai for Science and Technology, Shanghai, China
[2] Lucheng Center for Disease Control and Prevention, Wenzhou, China
[3] Wenzhou Center for Disease Control and Prevention, Wenzhou, China
[4] The Affiliated Kangning Hospital of Wenzhou Medical University, Wenzhou, China

Abstract

Introduction: A local outbreak of coronavirus disease 2019 (COVID-19) has rapidly evolved into a global pandemic and the number of cases and deaths has increased exponentially. In this study, we report a COVID-19 outbreak that occurred in a departmental store, between January and February 2020, in Wenzhou, China and investigated the reasons for the outbreak.

Methodology: An outbreak investigation was initiated after the index case was diagnosed as COVID-19. Cases (confirmed and suspected) and close contacts were defined. Their pharyngeal swabs were collected and examined with real-time polymerase chain reaction (RT-PCR) for nucleic acid. All investigations of the confirmed and suspected cases were carried out by epidemiologists and the source of infection was tracked by using big data.

Results: Thirty-nine COVID-19 cases and one asymptomatic individual were found in this outbreak, as determined by clinical manifestations, epidemiological investigation, and RT-PCR. Majority of COVID-19 cases occurred in a departmental store, three of whom traveled to participate in a meeting held in H city. After disease outbreak in the departmental store, intra-family transmission of COVID-19 occurred in five families. Two clusters of the COVID-19 outbreak were identified. One cluster was attributed to the family party, while another was attributed to a hotel party, which was responsible for transmission across three generations, infecting five family members.

Conclusions: This was travel associated COVID-19 outbreak in a departmental store in Wenzhou, China. High infectivity of COVID-19 was observed. A departmental store, especially without recirculation of the air, was a high-risk site for the transmission of COVID-19. The use of big data and related information was very useful in epidemiological investigation of cases and contacts.

Key words: COVID-19; cluster; outbreak; travel.

J Infect Dev Ctries 2022; 16(5):752-758. doi:10.3855/jidc.15670

(Received 27 July 2021 – Accepted 24 January 2022)

Copyright © 2022 Zhou *et al*. This is an open-access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Introduction

A local outbreak of coronavirus disease 2019 (COVID-19), caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) [1] has rapidly evolved into a global pandemic. It mainly spreads via airborne transmission, particularly when an infected person is in close contact with another person [1-2]. Consequently, a number of confirmed cases of COVID-19 have been reported in several countries [3-7]. The outbreaks or clusters of the disease are frequently reported in different settings including families, hospitals, local gatherings, public transportation, conferences, tourists, and others [1,8-12]. During the Chinese spring festival 2020, earlier stage of the pandemic, a travel-associated COVID-19 outbreak occurred in a departmental store. The present study reports the epidemiological features of COVID-19 outbreak, amongst 40 cases (including an asymptomatic case), in a departmental store located in a downtown of Wenzhou, China.

Methodology

Definitions

Suspected case: A patient with at least two of the following clinical features and at least one epidemiological risk factor was considered as the suspected case. Clinical features included fever, radiological findings of pneumonia, normal or reduced white blood cell (WBC) count, or reduced lymphocyte count in the early stages of the disease. While, the epidemiological risk factors included a history of travel to or residence in Wuhan city, China or other cities with continuous transmission of cases in the last 14 days before the onset of symptoms; close contact with

confirmed cases; or epidemiologically connected to SARS-CoV-2 infections or clustered onsets.

Confirmed case: A suspected case with positive evidence for the SARS-CoV-2 infection by the real-time polymerase chain reaction (RT-PCR) for nucleic acid in the respiratory samples [13].

Close contacts: Individuals who have been exposed to a confirmed COVID-19 case within 2 days prior to the onset of symptoms [14].

Pharyngeal swabs of cases and contacts were collected and examined. Within 24 hours, the presence of SARS-CoV-2 nucleic acid in the samples was detected with the help of RT-PCR. All the laboratory-confirmed cases followed the case definition issued by the National Health Commission (NHC), China.

All the confirmed cases were isolated in the hospital and were interviewed by a team designated by the authorities to carry out an epidemiological investigation and track the source of infection. The cases were inquired about the symptoms and their onset, history of recent travels, and previous contacts with suspected COVID-19 cases. Moreover, they were asked to identify everyone with whom they had been in contact up to 48 hours before the onset of the first symptom and to indicate the duration and degree of intimacy with the contacts. All identified contacts were investigated by telephonic or face-to-face interview, asked about their symptoms, and instructed to remain in quarantine for two weeks. Contacts with symptoms and in whom symptoms developed during the quarantine period were tested for SARS-CoV-2 infection.

As the COVID-19 outbreak in a departmental store was an emergency public health issue, data were collected as a part of the public health response and not considered as research. Thus, the present study was not subjected to review by the institutional review board.

Results

Index Case finding

On 20th January 2020, at around 14:30 hours, a comprehensive hospital in Wenzhou reported a suspected case of COVID-19 with fever to the local Center for Disease Control and Prevention (CDC). On receiving the information, local CDC immediately sent an emergency team to carry out an epidemiological investigation of the suspected case.

Case 1 (index patient): On 14th January 2020, a 28-year-old female, a departmental store administrator in the downtown of Wenzhou, Zhejiang, China, developed fever (39.5 °C), cough with expectoration, chest pain, headache, and diarrhea in the morning. In the evening of the same day, she was sent to the emergency department of the hospital by her elder sister. On admission, laboratory investigations revealed a WBC count of 4.89×10^9/L and C-reactive protein (CRP) levels of 5.11 mg/L. Following the symptomatic treatment, her condition did not improve. On 19th January, computed tomography (CT) of the chest suggested an infectious focus in both the lungs. Thus, she was diagnosed with a case of infectious lung disease and transferred to the isolation ward of the hospital and treated further. On 20th January, at around 11:00 hours, her pharyngeal samples were collected and sent to CDC, Wenzhou for testing the SARS-CoV-2 nucleic acid. On the same day, at around 12:30 hours, the hospital notified the local CDC about the index case, following which local CDC sent an emergency investigation team to carry out a field investigation related to the patient. At 23:00 hours, her sample was reported to be positive for SARS-CoV-2 nucleic acid.

Epidemiological investigation revealed that she had no history of travel to Wuhan or contact with a wild animal in the two weeks prior to the onset of symptoms. After the onset of symptoms, she continued to work in the departmental store until admitted to the hospital.

Outbreak detection and investigation

After the index case was reported, an epidemiological investigation involving the index case, her family members, their contacts, and their place of work was carried out.

Case 2 (first case): A 31-year-old female, a colleague of the index case working in the same departmental store, developed a low-grade fever with occasional cough on 6th January 2020. On 23rd January 23, a routine blood examination revealed a WBC count of 5.79×10^9/L, lymphocyte ratio of 0.249, and CRP levels of 0.31 mg/L. CT chest revealed infectious focus in the middle lobe of the right lung and the lower lobes of both the lungs. On 23rd January, her RT-PCR was positive for SARS-CoV-2 nucleic acid.

She (first case) lived with her parents, and they did not have any symptoms at that time. She had a history of travel to H city (around 310 km from the outbreak site) on 3rd January for an annual meeting from 3rd-4th January 2020. After coming back, she contacted her family members and friends. She held a family get-together and invited 12 members for dinner on the evening of 9th January. Those who attended the party and contracted the disease included her father, grandmother, grandmother's housekeeper, and three friends (including a married couple). All contacts developed symptoms successively on 10th January (N = 1, friend), 12th January (N = 1, her father), 15th January

Table 1. Case distribution in different exposed populations of COVID-19 outbreak in the departmental store.

	Type of exposed population					
	Administrators	**Sales assistant and salesperson**	**Family members and friends who attended party dinner**	**Family contacts**	**Non-family contacts**	**Customers**
Number of exposed individuals	76	1254	28	85	626	--
Number of patient	7	9	9	5	4	5
Attack rate (%)	9.21	0.72	32.14	5.88	0.64	--

(N = 1, her grandmother), 16th January (N = 2, grandmother's housekeeper and friend), and 22nd January (N = 1, friends). Amongst the individuals who did not develop disease were the wives of two friends and two couple friends (four friends). She continued to work in the departmental store until the epidemiological investigations were carried out.

Investigation revealed that the first case and the other three colleagues participated in the annual meeting in H city. Following the meeting, three of four participants developed symptoms between 8th and 16th January. Moreover, more than ten participants, belonging to other areas in the same province, who attended the same meeting, developed symptoms successively and RT-PCR for SARS-CoV-2 nucleic acid was found to be positive.

Investigations revealed that Case 1 (index case) frequently contacted the other three administrators, especially Case 2 (first case), who participated in the annual meeting held in H city. All 3 administrators underwent RT-PCR for SARS-CoV-2 nucleic acid and were found to be positive. All of them had no history of travel to Wuhan, contact with wild animals, or visiting marketplace for agricultural products. Once these three administrators developed symptoms, the other three individuals sharing their office also started exhibiting symptoms.

Further investigations demonstrated that the annual meeting held in H city resulted in a COVID-19 outbreak involving more than ten participants except those affected in the departmental store of Wenzhou. These patients were traced based on an epidemiological survey and laboratory confirmation was provided by the local CDC.

The departmental store where these patients worked was located in the bustling downtown in Wenzhou. The departmental store had 9 floors including 76 administrators and 1254 salespersons. On each floor, there were many cashier desks and service counters. Before the outbreak, the centralized air conditioning was working, but the ventilation of the building was poor. Moreover, a large number of customers visited the departmental store daily.

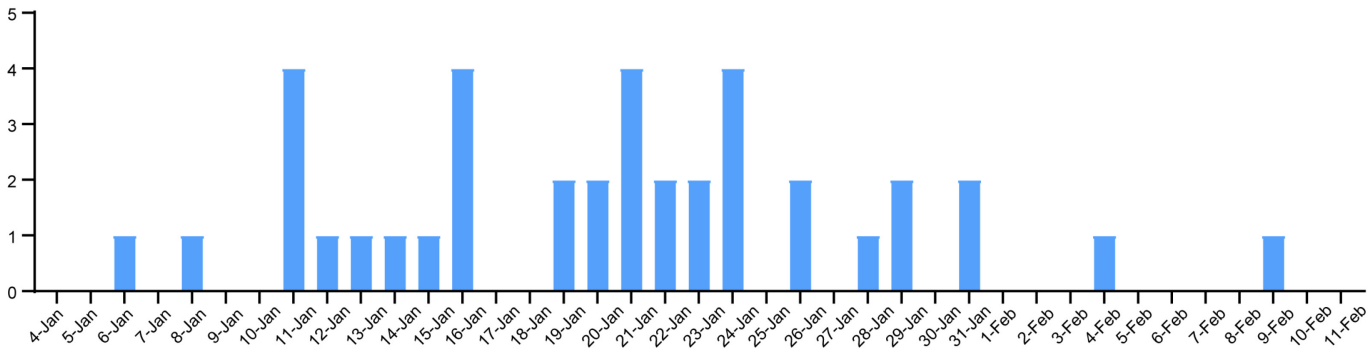
Epidemiological characteristics

Following the diagnosis of the index case, her colleagues, family members, clients, and friends were investigated by epidemiologists. A total of 40 cases (including one asymptomatic case) were identified. The time distribution of patients during the outbreak is illustrated in Figure 1.

Between 11th and 31st January 2020, four salespersons and five sales assistants working in the departmental store developed symptoms.

After the index case and three administrators came back from the annual meeting, their colleagues, family members, friends, and clients successively developed the COVID-19 symptoms. Seven of 76 administrators

Figure 1. Time distribution of patients in COVID-19 outbreak.



developed COVID-19. The attack rate of family members and friends was distinct in different population, with highest amongst those who attended the dinner party with the first case. Five out of 85 family contacts and four out of 626 non-family contacts developed COVID-19. Thus, disease attack rate was higher amongst the family contacts than non-family contacts. Distribution of the confirmed COVID-19 outbreak cases in different exposed population is depicted in table 1. Distribution of cases according to the date of symptom onset amongst COVID-19 outbreak exposed individuals is illustrated in Figure 2.

Amongst 39 symptomatic cases, 15 were males, and remaining were females. Amongst them, those aged 20-29, 30-39, 40-49, 50-59, and >60 years included 6, 8, 8, 12, and 5 cases, respectively. All the cases had mild disease. No death was reported. Moreover, one female case, aged 24 years, had asymptomatic disease.

Intra-family transmission of COVID-19 occurred in five families. In three families, disease transmission was attributed to the husband in the family. While, in the other two, transmission was attributed to the wife or mother respectively.

Two clusters of the COVID-19 outbreak were identified. One cluster was attributed to the family party (on 9th January) involving 12 members, amongst which six (excluding first case) developed COVID-19. Another cluster was attributed to a hotel party (on 16th January) involving 18 members, amongst which five developed COVID-19. This cluster in disease transmission involved five members of a family across three generations.

Exact exposure time could be determined only in 21 cases. The incubation time in these cases ranged from 1 to 14 days, with a median of 5.5 days.

Outbreak control measures

1. All the symptomatic and asymptomatic cases were admitted to the designated local hospitals for isolation and treatment. All 40 cases (including one asymptomatic case) were immediately reported to local CDC and public health authority via the web-based system, after being diagnosed as a case of COVID-19.

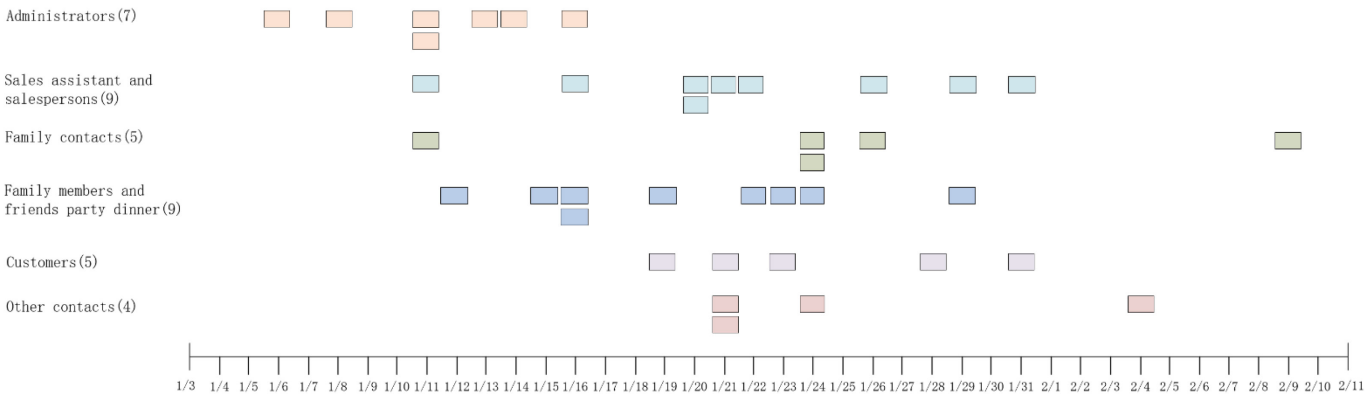
2. The departmental store was immediately closed after the discovery of COVID-19 outbreak, and the entry of any individual in the departmental store was strictly forbidden. Disinfection of the outbreak sites, including the departmental store building, living quarters and activity sites of the patients was carried out with chlorine-containing disinfectants.

3. All close contacts of 40 diagnosed cases (including one asymptomatic case) were isolated for 14 days, and observed for fever and respiratory symptoms by healthcare workers in designated hotels. Healthcare workers were instructed to report to a doctor immediately if the patients faced any discomfort, and collect the pharyngeal swabs for RT-PCR of SARS-CoV-2 nucleic acid. On 9th February, the last case was detected amongst the contacts following which no further secondary transmission was observed.

4. A collaborative inspection system was initiated to trace and screen the potentially exposed sales assistants and salespersons. Five hundred and twenty-five sales assistants and salespersons were identified in the local area and isolated in shift quarantine camps, while remaining (N = 729) were not residents of the local area and thus, their local CDC was informed. These individuals were traced and isolated in their native places.

5. Big data analysis was used to perform the epidemiological investigation involving the customers. Customer data between 14th January and 23rd January was screened and it was observed that 37,265 customers stayed for more than one hour in the departmental store. These customers received text messages regarding the

Figure 2. Distribution of cases according to the date of symptom onset amongst COVID-19 outbreak exposed individuals.



prevention and control of COVID-19 and were advised self-isolation at home for 14 days.

6. Individuals coming in contact with COVID-19 cases and their close contacts were asked to wash their hands frequently, open the windows so as to increase the ventilation, and wear a mask.

Discussion

Index case developed fever and respiratory symptoms on 14th January. She was a suspected case of COVID-19 and confirmed on 20th January. Although index case was notified earlier than first case, onset of symptoms was earlier in the first case i.e., on 6th January. Investigation revealed that both index and first case shared the same office and contacted each other frequently. Index case had obvious clinical signs and symptoms of COVID-19, and the history of contact with patients. Her pharyngeal swabs were positive for SARS-CoV-2 nucleic acid. Thus, the index case was diagnosed as COVID-19 following the case definition suggested by NHC, China [13]. Thus, it was concluded that index case was not the first case during the outbreak.

Conferences involve gathering of individuals that favors the transmission of SARS-COV-2. A typical case was reported in Singapore, where 109 individuals from various countries attended an international conference, which resulted in at least seven confirmed cases [1]. Our investigation suggested that three administrators had symptom onset 4-12 days after visiting H city for an annual meeting held on 3rd and 4th January. More than 10 participants of the annual meeting, residing in other areas, successively developed the symptoms. Pharyngeal swabs of these individuals were subjected to RT-PCR and were found to be positive for SARS-CoV-2 nucleic acid. All the three administrators had a common exposure history of participating in the meeting and similar clinical symptoms. Thus, it was concluded that the source of infection in these cases were the participants of the annual meeting held in H city.

Prior to the H city visit, the departmental store had no suspected or confirmed cases of COVID-19. Following the visit, the index case and three administrators of the departmental store resumed their official work and infected five other colleagues in same office through close contact. Further, they transmitted the infection to sales assistants, salespersons, and customers of departmental store. The infection in the departmental store was transmitted through air droplets and close contacts. Subsequently, these infected cases transmitted the infection through family and hotel dinner parties. One of the three administrators infected six family members and friends through family dinner party, resulting in a cluster of patients. Moreover, five cases occurred in an additional cluster through dinner party organized at a hotel.

The SARS-CoV-2 can spread from an infected person's mouth or nose in the form of tiny droplets that are released when an infected person coughs, sneezes, speaks, sings, or breathes heavily. Furthermore, foodborne transmission has been postulated as a risk factor in an early scholarly discussions on COVID-19 [15]. At present, various countries have reported the presence of SARS-CoV-2 in a variety of food items, especially in sea foods. It is recognized that contaminated cold-storage foods, including packaging materials, and storage environments, may present a systematic risk for transmission of SARS-CoV-2 between countries and regions. Moreover, some people have the practice of consuming raw or half-cooked sea food in local area. Thus, food as a vehicle of spreading COVID-19 was taken seriously. In our investigation, some patients in two small clusters of outbreak were attributed to a dinner party. However, no retrospective study has conclusively reported the foodborne transmission of SARS-CoV-2 [15]. As a precautionary measure, during outbreak, management and surveillance of dinner parties, and the processing method of raw sea food should be improved.

SARS-CoV-2 appears to be highly contagious with human-to-human transmission most frequently occurring through the airborne route [2]. Increasing evidence suggests that mild clinical symptoms could be more frequent in COVID-19 cases and asymptomatic cases can act as carrier of SARS-CoV-2. In our investigation, all 39 cases had mild disease, and one case was asymptomatic. All patients recovered from illness. High infectivity of COVID-19 was identified. Moreover, the transmission across three generations was observed in this outbreak.

The chances of transmission are greater in the crowded places with several individuals nearby for a prolonged duration. Indoor areas, compared to outdoor, especially those with poor ventilation and where people have conversations very near to each other pose high risks for transmission. The risk of COVID-19 spread is greater in the places with aforementioned characteristics. Supermarkets and grocery stores are amongst the places with the highest risks of COVID-19 transmission due to the concurrent presence of multiple risk factors including an enclosed environment, difficulty in maintaining physical distance, and many commonly touched surfaces and objects by different

individuals [15]. Moreover, over-crowding as a risk factor can also play a significant role in the transmission. Temporary crowding in public areas such as departmental stores can transmit an outbreak [16]. Similarly, during the 10 days (between 14th and 23rd January), 37,265 customers had visited the departmental store for more than one hour each.

Use of big data and related information was very useful in epidemiological investigation of cases and contacts. Artificial intelligence (AI) can be successfully employed for the purpose of tracing, identifying, and monitoring the contacts of the suspected or confirmed cases [17]. Contact with the contaminated surfaces has been reported to be responsible for transmitting the virus [18]. While investigating the outbreak, we found that a case had pushed an elevator button that was used by another case. Further investigation failed to demonstrate any other route of transmission. Thus, it is recognized that the buttons of an elevator can act as a vehicle for transmission of COVID-19. To break the chain of transmission, individuals should avoid touching the public surfaces, and such surfaces should be cleaned regularly with standard disinfectants.

Decisive control measures taken immediately were critical to stop the spread of outbreak. Epidemiological investigation was initiated after the index case was notified. Following the identification of COVID-19 outbreak, control and preventive measures were immediately implemented including closure of departmental store; hospitalization and isolation of cases; designating hotels to quarantine the close contacts; notifying the exposed individuals regarding the ways of prevention; and tracing, identifying, and monitoring contacts with the help of big data, if necessary. After implementing the above measures, the outbreak was controlled effectively. Following the confirmation of last COVID-19 case on 9th February, no new case was found.

In semi-enclosed environment, airborne transmission of SARS-CoV-2 has been documented to play an important role in real-life spread of COVID-19 [19-21]. Many studies showed that COVID-19 can be transmitted by respiratory droplets and close contacts [1,18]. Contact of contaminated goods can also transmit the infection to other individuals. Some studies confirmed that aerosol transmission is possible in individuals that are exposed to highly concentrated aerosol for a long duration of time in a relatively closed environments [1,16,18]. The possible role of aerosol transmission in this outbreak is suspected amongst the workforce of departmental store. Moreover, the role of respiratory droplets and close contacts is suspected in cluster outbreaks that occurred in dinner parties at home and hotel.

The departmental store is a place with high density of people, which can increase the risk of SARS-COV-2 transmission. Some COVID-19 cases may have spread the disease in the departmental store via fomites (such as elevator buttons) or virus aerosolization in confined spaces (such as elevators). Nucleic acid of SARS-COV-2 has been reported on the doorknob of a patient's residence [1]. Aerosolized SARS-COV-2 remain viable in the air for up to three hours [4]. Thus, it is critical to stay at home and avoid gatherings with individuals from other households during the epidemic of disease.

Indoor gathering could also lead to outbreaks of COVID-19. Family clusters usually have a higher risk of infection due to their close and frequent contacts [22,23]. Two family clusters of five cases occurred in this outbreak. Thus, prevention of infection amongst household members is an important strategy to contain the transmission of COVID-19 globally. For example, in families with confirmed COVID-19 cases, it is crucial to quarantine their close contacts and perform a RT-PCR, as early as possible [7].

Poor ventilation has been implicated in numerous cluster transmission, including those in bars, churches, and other locations [24-27]. Ventilation is an important factor in preventing the indoor spread of SARS-COV-2. The departmental store has confined space, with several customers visiting and leaving the premises frequently. Moreover, the departmental store had poor ventilation. As soon as the infected individuals visited the store, aerosol transmission could have occurred. Thus, increasing the chances of transmission. The World Health Organization (WHO) recommends that ventilation rate should be increased through either natural or mechanical means, preferably without recirculation of the air. In case of air recirculation, filters should be cleaned regularly, especially for jobs that place an individual at a medium or high risk of exposure to COVID-19.

References

1. Liu T, Gong D, Xiao J, Hu J, He G, Rong Z, Ma W (2020) Cluster infections play important roles in the rapid evolution of COVID-19 transmission: A systematic review. Int J Infect Dis 99: 374-380.
2. Raoult D, Zumla A, Locatelli F, Ippolito G, Kroemer G (2020) Coronavirus infections: Epidemiological, clinical and immunological features and hypotheses. Cell Stress 4: 66-75.
3. Bernard Stoecklin S, Rolland P, Silue Y, Mailles A, Campese C, Simondon A, Mechain M, Meurice L, Nguyen M, Bassi C, Yamani E, Behillil S, Ismael S, Nguyen D, Malvy D, Lescure FX, Georges S, Lazarus C, Tabaï A, Stempfelet M, Enouf V,

Coignard B, Levy-Bruhl D; Investigation Team (2020) First cases of coronavirus disease 2019 (COVID-19) in France: Surveillance, investigations and control measures. Euro Surveill 25: 2000094.
4. Ralph R, Lew J, Zeng T, Francis M, Xue B, Roux M, Toloue Ostadgavahi A, Rubino S, Dawe NJ, Al-Ahdal MN, Kelvin DJ, Richardson CD, Kindrachuk J, Falzarano D, Kelvin AA (2020) 2019-nCoV (Wuhan virus), a novel coronavirus: Human-to-human transmission, travel-related cases, and vaccine readiness. J Infect Dev Ctries 14: 3-17. doi: 10.3855/jidc.12425.
5. Pullano G, Pinotti F, Valdano E, Boëlle PY, Poletto C, Colizza V (2020) Novel coronavirus (2019-nCoV) early-stage importation risk to Europe. Euro Surveill 25: 2000057.
6. Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR (2020) Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. Int J Antimicrob Agents 55: 105924.
7. Burki T (2020) Outbreak of coronavirus disease 2019. Lancet Infect Dis 20: 292-293.
8. Wu P, Hao X, Lau EHY, Wong JY, Leung KSM, Wu JT, Cowling BJ, Leung GM (2020) Real-time tentative assessment of the epidemiological characteristics of novel coronavirus infections in Wuhan, China. Euro Surveill 25: 2000044.
9. Yu P, Zhu J, Zhang Z, Han Y (2020) A familial cluster of infection associated with the 2019 novel coronavirus indicating possible person-to-person transmission during the incubation period. J Infect Dis 221: 1757-1761.
10. Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, Xing F, Liu J, Yip CC, Poon RW, Tsoi HW, Lo SK, Chan KH, Poon VK, Chan WM, Ip JD, Cai JP, Cheng VC, Chen H, Hui CK, Yuen KY (2020) A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: A study of a family cluster. Lancet 395: 514-523.
11. She J, Jiang J, Ye L, Hu L, Bai C, Song Y (2020) 2019 novel coronavirus of pneumonia in Wuhan, China: Emerging attack and management strategies. Clin Transl Med 9: 19.
12. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, Ren R, Leung KSM, Lau EHY, Wong JY, Xing X, Xiang N, Wu Y, Li C, Chen Q, Li D, Liu T, Zhao J, Liu M, Tu W, Chen C, Jin L, Yang R, Wang Q, Zhou S, Wang R, Liu H, Luo Y, Liu Y, Shao G, Li H, Tao Z, Yang Y, Deng Z, Liu B, Ma Z, Zhang Y, Shi G, Lam TTY, Wu JT, Gao GF, Cowling BJ, Yang B, Leung GM, Feng Z (2020) Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med 382: 1199-1207.
13. National health commission of the People's Republic of China. Guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (4th edition). Available: http://www.nhc.gov.cn/yzygj/s7653p/202001/4294563ed35b43209b31739bd0785e67.shtml. Accessed: 17 May 2022.
14. World Health Organization (2021) Contact tracing in the context of COVID-19. Available: http://www.who.int/publications/i/item/contact-tracing-in-the-context-of-covid-19. Accessed: 17 May 2022.
15. Han J, Zhang X, He S, Jia P (2021) Can the coronavirus disease be transmitted from food? A review of evidence, risks, policies and knowledge gaps. Environ Chem Lett 19: 5-16.
16. von Seidlein L, Alabaster G, Deen J, Knudsen J (2021) Crowding has consequences: Prevention and management of COVID-19 in informal urban settlements. Build Environ 188: 107472.
17. Vaishya R, Javaid M, Khan IH, Haleem A (2020) Artificial intelligence (AI) applications for COVID-19 pandemic. Diabetes Metab Syndr 14: 337-339.
18. Swelum AA, Shafi ME, Albaqami NM, El-Saadony MT, Elsify A, Abdo M, Taha AE, Abdel-Moneim AE, Al-Gabri NA, Almaiman AA, Saleh Al-Wajeeh A, Tufarelli V, Staffa VN, Abd El-Hack ME (2020) COVID-19 in human, animal, and environment: A review. Front Vet Sci 7:578.
19. Ma J, Qi X, Chen H, Li X, Zhang Z, Wang H, Sun L, Zhang L, Guo J, Morawska L, Grinshpun SA, Biswas P, Flagan RC, Yao M (2021) COVID-19 patients in earlier stages exhaled millions of SARS-CoV-2 per hour. Clin Infect Dis 72: e652-e654.
20. Prather KA, Wang CC, Schooley RT (2020) Reducing transmission of SARS-CoV-2. Science 368: 1422-1424.
21. National Research Council (2020). Rapid expert consultation on the possibility of bioaerosol spread of SARS-CoV-2 for the COVID-19 pandemic. Available: https://www.nap.edu/read/25769/chapter/1. Accessed: 17 May 2022.
22. Bi Q, Wu Y, Mei S, Ye C, Zou X, Zhang Z, Liu X, Wei L, Truelove SA, Zhang T, Gao W, Cheng C, Tang X, Wu X, Wu Y, Sun B, Huang S, Sun Y, Zhang J, Ma T, Lessler J, Feng T (2020) Epidemiology and transmission of COVID-19 in 391 cases and 1286 of their close contacts in Shenzhen, China: A retrospective cohort study. Lancet Infect Dis 20: 911-919.
23. Zhou ZM, Zhou HZ, Lin XD, Su ZC, Zhao LS, Chen X (2020) Outbreak of COVID-19 in a family, Wenzhou, China. Epidemiol Infect 148: e103.
24. Meyerowitz EA, Richterman A, Gandhi RT, Sax PE (2021) Transmission of SARS-CoV-2: A review of viral, host, and environmental factors. Ann Intern Med 174: 69-79.
25. James A, Eagle L, Phillips C, Hedges DS, Bodenhamer C, Brown R, Wheeler JG, Kirking H (2020) High COVID-19 attack rate among attendees at events at a church - Arkansas. MMWR Morb Mortal Wkly Rep 69: 632-635.
26. Adam DC, Wu P, Wong JY, Lau EHY, Tsang TK, Cauchemez S, Leung GM, Cowling BJ (2020) Clustering and super spreading potential of SARS-CoV-2 infections in Hong Kong. Nat Med 26: 1714-1719.
27. Furuse Y, Sando E, Tsuchiya N, Miyahara R, Yasuda I, Ko YK, Saito M, Morimoto K, Imamura T, Shobugawa Y, Nagata S, Jindai K, Imamura T, Sunagawa T, Suzuki M, Nishiura H, Oshitani H (2020) Clusters of coronavirus disease in communities. Japan. Emerg Infect Dis 26: 2176–2179.

Corresponding author

Prof Zumu Zhou
The Affiliated Kangning Hospital of Wenzhou Medical University,
1 Shengjin Road, Huanglong Residential District,
Wenzhou, 325007, China
Phone: (86)13857709701
Fax: (86)577-88789117
E-mail:zhouzumu@126.com

Conflict of interests: No conflict of interests is declared.