Characterization of a big family cluster infection associated with SARS-Cov-2 in Nanjing district

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Abstract

Background: Outbreak of COVID-19 has brought catastrophe to huge numbers of families. However, even though numerous tragedies occurred, there were few reports about family cluster infection in the academic journals.

Methods: The electronic medical records of 10 COVID-19 patients in a big family were retrospectively reviewed and analyzed.

Results: These 10 patients, 4 males and 6 females, were infected through two successive family feasts during Spring Festival. The infection source was a family member at asymptomatic state, who lived in Hubei but travelled to Nanjing. The median age of these 10 patients was 61.5, with the oldest 95 and youngest 38. The incubation period varied from 3 to 17 days, with the median of 5.5. Of them, 2 patients were asymptomatic. The most common symptoms at onset were fever (6/10) and dry cough (6/10). All of them displayed lesions on the chest CT. 40% of them had leukopenia, neutropenia and lymphopenia. After anti-virus treatment, all the patients significantly improved and were discharged.

Conclusions: SARS-Cov-2 was highly contagious and so crafty that a varied incubation period did exist. Part of patients might be asymptomatic, which was the potential source of transmission. More measures for protection or quarantine should be taken at home if family member had travel history nearby the epidemic area.

Background

Since an outbreak of pneumonia caused by severe acute respiratory syndrome coronavirus-2 (SARS-Cov-2) was firstly reported in the city of Wuhan, Hubei province, China in December 2019, the disease associated with this novel coronavirus (COVID-19) spread nationwide very quickly [1]. As of Feb 28, 2020, National Health Commission reported 78,632 confirmed patients in China, with 2747 death. Not far from the epidemic center, Nanjing is a very important metropolis within Yangtze River Delta, southeast China, with population of 8,335,000. The first case of COVID-19 in Nanjing was diagnosed on Jan 23, which was an imported one from Wuhan. At the beginning, only a few imported sporadic cases were observed, followed by appearance of the second or even third generation of patients, who had neither history of living or travelling in the epidemic area and nor history of close contact with related personnel. The pneumonia cases dramatically increased, up to 93 on Feb 28, which were characterized by crowd aggregation, especially family cluster. Our hospital, the second hospital of Nanjing, is the designed hospital for treatment of COVID-19 patients in Nanjing district. Here, we presented a case involved in 10 members in a big family, by analyzing the epidemiological, clinical, laboratory, radiological, and microbiological data, which outlined the epidemic characteristics of COVID-19 in Nanjing district during the change from imported case to local transmission.

Methods

The electronic medical records of 10 COVID-19 patients belonging to a big family were retrospectively reviewed and analyzed. All of them reached the criteria of “confirmed cases” by Chinese Center for Disease Control and Prevention.

Results

On Jan 30 and Jan 31, 2020, we enrolled a family of 6 patients who were delivered by emergency ambulance. Their relations were summarized in Fig. 1. Patient 1 was the mother of Patient 2, 3, and 5. Patient 4 and Patient 6 were wife of Patient 3 and Patient 5, respectively. All the 6 patients did not leave Nanjing at least half a month before onset. Nothing special happened except that they held a family welcome banquet with Patient A on Jan 23, who was another daughter of Patient 1. Patient A lived in a city of Hubei province, Xiaogan, and travelled back to Nanjing for Spring Festival via high-speed rail on Jan 21, when Patient 3 (her brother) picked her up by the private car and delivered her to home of Patient 1, where Patient 2 (daughter of Patient 1) temporarily stayed to take after her mother. Patient 1, 2 and A stayed together for two days until the family banquet mentioned above, where all the patients (1–6) celebrated the new year. After that, Patient A continued her journey to Zhejiang province to visit her son. The whole family did not take any measures for protection or quarantine when staying with Patient A, since she had no symptom and felt very well. On Jan 24, Patient 5 and 6 went to joined the party with their relatives, Patient 7, 8, 9, and 10 (Fig. 1).

At the midnight of Jan 24, one day later than Wuhan, Xiaogan was declared as epidemic aera and blocked. Patient A started to have fever on Jan 26 and was diagnosed as COVID-19 in a Zhejiang hospital on Jan 29. Once upon confirmation of infection, Patient A immediately informed her family in Nanjing. Unfortunately, it was too late. Actually, on Jan 25, Patient 2 (sister of Patient A) had already had fever. Patient 3 had cough on Jan 26 and Patient 4, 5, 6 and 7 started to feel out of sorts on Jan 27. What's worse, Patient 8 and 9 were also successively symptomatic. All the patients went to hospital and were admitted since nucleic acid detection of SARS-Cov-2 from throat swab specimens was positive. To our interest, Patient 1 was asymptomatic and did not fell any uncomfortable consciously. However, considering that she was 95-year old and very inconvenient if at home alone, she decided to go to hospital with her family. Patient 10 was also asymptomatic and stayed at the designed place for quarantine until a screening action for close contact person on Feb 11, when she was confirmed by nucleic acid test. Luckily, before the onset of symptoms, all those patients did not go out and contact with others except Patient 3, who went out for shopping shortly with mask.

The median age of these 10 patients was 61.5, with Patient 1 the oldest (95) and Patient 10 the youngest (38) (Table S1). There were four men and six women. Patient 1 and Patient 8 had hypertension and diabetes. Patient 7 had idiopathic thrombocytopenia and hypertension. Patient 9 suffered from relative serious underlying disease, including chronic hepatitis B, cirrhosis, and postoperative hepatocellular carcinoma. The incubation period of these 10 patients spanned from 3 to 17 days, with the median of 5.5. The symptoms at onset were varied, including fever (6/10), dry cough (6/10), fatigue (3/10), chest tightness (1/10), muscle pain (1/10). During the course of disease, the following symptoms were

presented: fever (7/10), cough (7/10), chest tightness (4/10), fatigue (4/10), shortness of breath (2/10), poor appetite (1/10), expectoration (2/10), muscle soreness (1/10), nausea (1/10) and diarrhea (1/10). 7 patients had low to middle fever, between 37.3°C and 38.2°C. Their oxyhemoglobin saturation varied from 94–98% (Table S1).

At admission, Chest CT examination revealed visible lung lesions. All the patients except Patient 9 and 10 had multiple lesions in both lungs, mainly located in the peripheral lung field, near the subpleural area, which presented small patches or large ground-glass opacity, or increased microvascular shadows partly (Fig. 2). For Patient 9 and 10, only a few isolated patches in the dorsal segment of the right lower lung were observed (Fig. 2). The laboratory test results of blood specimens were the followings: leukocyte count decreased (40.0%, 4/10), neutrophils count decreased (40.0%, 4/10), lymphocyte count decreased (10.0%, 1/10), C reactive protein increased (40.0%, 4/10), erythrocyte sedimentation rate (ESR) accelerated (30.0%, 3/10), lactic dehydrogenase (LDH) elevated (40.0%, 4/10), alanine transaminase (ALT) elevated (10.0%, 1/10) and aspartate aminotransferase (AST) elevated (10.0%, 1/10), erythrocyte potassium decreased (30.0%, 3/10), D-dimer elevated (40.0%, 4/10) (Table S2). The traditional inflammatory markers procalcitonin and IL6 were normal. Remarkably, Patients 2 had all the abnormal signs above. After 3 days of hospitalization, his fever and cough aggravated, and wheezing and tightness in chest were more obvious after activity. Analysis of blood gas indicated 1-respiratory failure and reexamination of chest CT found obvious progress of lesions. Analysis of immune function revealed CD3+, CD4+, CD8 + lymphocyte cell count decreased (Table S2).

According to the diagnosis and treatment plan for SARS-Cov-2 pneumonia, recommended by National Health Commission of the People's Republic of China, all patients accepted anti-virus regimens, including aerosol inhalation of IFN- α (5 million unit, BID), Lopinavir/Ritonavir (400/100 mg, po, BID), and Arbidol (0.2 g, po, TID). Since Patient 2 had aggravated symptoms and hypoxemia, we added methylprednisolone through intravenous drip (40 mg, QD) for 5 days, together with anti-virus treatment. Her symptoms improved and the lung lesions were absorbed. To monitor the effect of treatment, qRT-PCR was performed every one day to monitor the virus (Table S3). Fortunately, the clinical symptoms of all the 10 patients were improved after treatment and their specimens of throat swap had become negative. At present, all of them were discharged but asked to stay at the designed site for observation for another 14 days (Fig. 1). Although Patient 1 reached the discharge standard, she was transferred to Department of Rehabilitation for more convenient care.

Discussion

The epidemic of COVID-19 have swept across the globe and brought catastrophe to innumerable families worldwide [2], which becomes a common threat to human being. Even though similar to SARS-Cov and MERS-Cov, significant evolution of SARS-Cov-2 has been found by scientist [3] and it seems more contagious than the two predecessors [4]. Transmit from person to person has been confirmed, as well as via contact [5]. The terrible point is, COVID-19 emerged and prevailed around Spring Festival, which is the most important holiday for all Chinese. As a tradition, all the family members get together to celebrate the

new year. So many people travelled back home or visit friends, causing huge migration of population, which highly increased the risk of virus transmission. What's worse, COVID-19 had a median incubation time of 3 days (ranging from 0 to 24 days) [1, 6, 7]. For patient with no travel history to Hubei, the incubation time might be longer and more volatile [8]. Even at incubation stage, patients were still infectious [9, 10]. Therefore, illness came along with family reunion unconsciously. As of now, there were only a few reports about family cluster infection in the academic journals, even though numerous similar tragedies occurred. Chan et al. at the earliest reported a family cluster infection case, in which family members travelled to Wuhan from Shenzhen and were infected in Wuhan, most probably via close contact with their relatives, who were in hospital and diagnosed as COVID-19 [11]. Yu et al revealed an interesting case about family cluster infection in Shanghai, where a 88-year old man with moving difficulties stayed home and became infected by his asymptomatic family members [12]. Wang et al. focused on the children associated with COVID-19 and found that 82% of child infection was related with the family cluster outbreak [13].

In our case, Patient A was the source of infection, who was from the epidemic center, Hubei province, and diagnosed on Jan 29. However, she never felt abnormal before Jan 26. When she stayed with her family, she did not take any protective measures, causing Patient 1 to 6 infected in the first welcome party. Then, Patient 5 and patient 6 infected more family members in the second dinner party, within 24 hours after contacting with Patient A. This infection of family cluster suggested that SARS-Cov-2 was highly contagious through human-to-human transmission, especially in closed rooms. Li et al. estimated that the basic reproductive number was ca. 2.2 based on the early transmission dynamics [7]. However, according to this case, the condition might be seriously underestimated. The clinical characteristics of COVID-19 patients mainly manifested as fever, dry cough and fatigue[1], which was consistent with our finding. Our concern was these asymptomatic patients, who may be easily neglected and become a potential source for transmission. In our study, 20% of patients asymptomatic patients, which was consistent with our colleague's finding [10].

Conclusion

Here, we reported a case of family cluster infection associated with COVID-19 in Nanjing district. SARS-Cov-2 was highly contagious and had variable incubation period. Part of patients were asymptomatic. Therefore, during clinical diagnosis and treatment, we should collect and review the epidemiological data and medical history, isolate close contacts with confirmed patients, and perform nucleic acid test at different times to avoid missed diagnosis.

Declarations

Ethics approval and consent to participate

Ethical approval for this study was reviewed by Institutional Review Board of the Second Hospital of Nanjing (2020-LS-ky003).

Consent to publication

Written consent to publication was signed by all the 10 patients.

Availability of data and materials

Data relating to this study are contained and presented in this document. Other materials are available from the corresponding authors on reasonable request.

A short “correspondence” has been published on the LANCET infectious disease [14] only reporting the fact of household transmission about the 10 patients in Nanjing Drum Tower Hospital where these patients were diagnosed. However, these patients were transferred and treated in our hospital. Therefore, we had the whole epidemiological and clinical data and follow up.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

WC and CMH wrote the draft. LLH summarized all the clinical data. YCZ provided laboratory data. ZLH and YZ provided epidemiological and clinical data. WXW analyzed the qPCR data. XZ and YXY conceived the study and approved the manuscript.

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Figures

Figure 1

Chronology of the family cluster infection associated with COVID-19 in Nanjing. Dates filled in white are the dates on which patients were normal or nucleic acid test negative. Dates with the internal car were the dates on which Patient 3 picked up Patient A. The red boxes indicated close contacts between Patient A with their relatives (Patient 1 and 2). Dates filled in yellow were the dates on which the first dinner party were hold. Dates filled in blue were the dates on which the second dinner party were hold. Dates filled in grey were the dates on which the patients were symptomatic. Dates filled in dark grey were the dates on which the nucleic acid test were positive. Dates with the internal red cross were the dates on which patients were hospitalized. Dates with the green arrow were the dates on which patients were discharged.

Figure 2

Chest CT images of patients with COVID-19 at admission.

Supplementary Files

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