Children are less affected by COVID-19: a family case study

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Abstract

Background: Family clustering has facilitated the transmission of SARS-CoV-2, and the outflows of people from Wuhan to their hometown has become the most important transmission channel in China. The study aimed to investigate the SARS-CoV-2 infection of an entire family, especially children.

Methods: This family case study was conducted in General Mountain Hospital, Guizhou Province. In January 2020, we recruited a family of 13 members, including three children and nine adults, at different stages, from admission screening to discharge. We used standardized case report forms to collect clinical data between January 16, 2020 and March 1, 2020. These data included temperature, contact history, incubation period, laboratory test results, imaging results, length of hospital stay, and treatment outcomes.

Results: Eight cases had confirmed diagnoses of SARS-CoV-2 infection, including three mild cases (37.5%) and five common cases (62.5%). The child patient had the shortest length of hospital stay and less obvious symptoms. There was no significant difference between the laboratory test results and CT scans.

Conclusions: Children are not susceptible to virus infection in their families. Compared with adult patients, pediatric patients have milder symptoms, shorter hospital stays, and lower risk of lung infections. As this cannot confirm whether their nucleic acid amplification tests are negative or positive after discharge, the management and control of discharged patients should therefore be paid additional attention.

Background

In December 2019, unidentified pneumonia cases occurred in Wuhan, Hubei Province, China. On January 7, 2020, a new type of coronavirus, called SARS-CoV-2, was discovered.¹ The coronavirus is transmitted mainly through droplets and contact, and coronavirus disease 2019 (COVID-19) spread rapidly throughout China and other countries such as South Korea, Italy, Japan, and Singapore.² The East Asia region has now become an epidemic-affected area.

According to the latest statistics from the China National Construction Commission, as of February 29, 2020, the cumulative number of confirmed diagnoses in China was 79,968. The number of deaths reached 2,873, 83.66% of which occurred in Wuhan, Hubei Province. The cumulative number of confirmed diagnoses in other countries altogether was 7,045, and the corresponding number of deaths was 106.³ These statistics gradually increased daily, indicating that SARS-CoV-2 has become a global public health emergency.

Coronavirus (CoV) is a positive-stranded, single-stranded RNA virus with a diameter of 80 to 120 nm. There are four types of coronavirus, namely α -CoV, β -CoV (β -CoV), δ -CoV (Δ -CoV), and γ -coronavirus (γ -CoV).⁴ Prior to the discovery of the new coronavirus, six CoV strains had been confirmed to infect

humans. Coronaviruses are widely distributed and genetically variable, and their genomes are frequently recombined. Their range expansion is driven by human activities. This results in frequent transmission across species and makes it possible for new coronaviruses to attack the human body more frequently. SARS-CoV-2 is a new type of coronavirus discovered in Wuhan, China, and it is the seventh known coronavirus that can infect humans.⁵

Studies with large sample sizes have recently investigated clinical characteristics of the new coronavirus, whereas case reports are quite rare. A previous study conducted on 183 patients provided epidemiological results, clinical diagnosis, laboratory tests, and radiological characteristics as the basis for diagnosis and treatment of patients with COVID-19.

The outbreak of SARS-CoV-2 occurred in late January. During this time, Chinese people working in Wuhan were returning to their hometowns to celebrate the Chinese New Year holiday with their families. Family clustering facilitated the transmission of SARS-CoV-2, and the process of returning home from Wuhan has become the most important transmission channel in China. Children have also become victims of the new coronary pneumonia.⁷ However, very few studies on child patients have hitherto been conducted. Therefore, we aimed to better understand the situation of patients infected with SARS-CoV-2, especially children, from their family members returning from Wuhan. To this end, we described the transmission within a family with members returning from Wuhan, the transition of a suspected patient to a confirmed one, and the entire hospitalization period. We also analyzed the clinical characteristics and laboratory test results of all family members.

Methods

Aim, Design, and Setting

This family case study was conducted at the General Mountain Hospital, Guizhou Province to investigate the SARS-CoV-2 infection of an entire family.

Participants

As of March 1, 2020, among the confirmed cases in Guizhou Province, only one patient with a typical family-aggregated infection was discharged. This patient was in close contact with Wuhan people on his way back home from Hubei Province. He then had close contact with other members of his family through daily activities. His family of 13 members had three main pathways of the epidemiological contact history. Pathway A is the process in which patient P1 and his wife travelled from Chi bi, Hubei to Guizhou where they were in close contact with their family members. Pathway B is the process in which patient 1's family members, including his two daughters, son-in-law, and niece (his daughter and that son-in-law's daughter), returned to Guiyang from Chi bi, Hubei, without having close contact with people from

Wuhan. Nevertheless, this does not rule out that they could not be infected with SARS-CoV-2. Pathway C is the process in which the remaining family members were exposed to patient 1 in Guizhou (Fig. 1).

In January 2020, we recruited a family of 13 members, including three children and nine adults, at different stages, from admission screening to discharge. We used standardized case report forms to collect clinical data such as temperature, contact history, incubation period, laboratory test results, imaging results, length of hospital stay, and treatment outcomes. Data collection took place from January 16, 2020 to March 1, 2020.

Statistical analysis

The data were analysed using the SPSS, version 10.1 for Windows, we calculated the percentages of patients in each category.

Patient And Public Involvement

This was a retrospective case series study and no patients were involved in the study design, setting the research questions, or the outcome measures directly. No patients were asked to advise on interpretation or writing up of results.

Results

The study results showed that five out of the 13 family members are male (38.5%), while the other eight members are female (61.5%). Their ages range from 2 to 64 years, and the family has three children aged < 12 years. Eight out of 13 family members (61.5%) were diagnosed with COVID-19, including one 3-year-old girl (7.7%). Three members with confirmed diagnoses were male (37.5%), compared to five females (67.5%).

Clinical characteristics

Eight cases had confirmed diagnoses of SARS-CoV-2 infection, including three mild cases (37.5%) and five common cases (62.5%). Only one patient suffered from three basic diseases, namely hypertension, fatty liver, hyperuricemia (12.5%). Three patients had one underlying disease (i.e., hypertension or fatty liver), accounting for 37.5%, whereas five patients had no underlying disease (62.5%). Six patients (75%) developed 1–3 initial symptoms (fever, cough, and sputum), one patient (12.5%) did not experience any symptoms on admission, and five initial symptoms occurred within one week after admission (i.e., fever, cough, sputum, chest tightness, and digestive symptoms). During the treatment period, one patient presented several symptoms, including cough, expectoration, fever, and fatigue (12.5%). The 3-year-old child was the only asymptomatic patient (Table 1).

Results of laboratory tests and CT inspection

At admission, one patient (12.5%) had a blood count of leukocytopenia ($< 4 \times 10^9 / L$). There was no evidence of lymphocytes, neutrophils, and platelets in 8 patients. One patient showed abnormal biochemical serum indicators of liver function, considering the possibility of patients with original fatty liver (12.5%). Five patients showed abnormal renal function biochemical serum indicators because the globulin count showed an increase and the white-globule ratio decreased significantly (62.5%). Increased levels of uric acid were found in the biochemical serum samples of three patients ($> 420 \text{ umol/L}$ for men and $> 360 \text{ umol/L}$ for women). Only one patient showed a significant increase in C-reactive protein and a significant inflammatory response ($> 8 \text{ mg/L}$) (Table 2).

In five cases, we found flake-like, patchy-shaped "frosted glass," mixed "frosted glass," and substantial changes in lesions in different areas of the lungs (bilateral lobular, multiple lobular, or subsegmental). The density of these lesions was uneven. Obvious changes were observed in those with unclear edges. Some lesions were located around the lungs, and there was a slight pleural reaction. Chest CT scans of the parents and their daughter showed no abnormalities (Fig. 2).

These five cases showed different CT scans. Patient 1 had patchy ground glass opacity in the subpleural region of the right upper lobe. Patient 2 had a flaky ground glass shadow in the right lower lobe and a visible ground glass shadow. Cloud-like high-density shadows were seen in the lower lobe of the left lung, with diffuse distribution and unclear borders. For patient 3, the bronchi of the right upper lobe were expanded in a tubular sac-like shape, and the lumen widened. Adjacent tube walls thickened, and bronchi became dilated. Patient 4 had ground-glass-like shadows in the upper part of the pleura in the posterior lower lobe of the right lung. Patient 5 had patchy ground glass opacity in the right superior lobe subpleural region (Fig. 3).

Outcome of hospitalization

No patients required admission to the intensive care unit because they experienced no further deterioration. All patients received antiviral therapy, and 7 (87.5%) of the adult patients were mainly treated with lopinavir / ritonavir + interferon alpha aerosol doses, combined with Chinese traditional medicine. The child patient (12.5%) was treated with Abidol as the main medicine, assisted with Chinese traditional medicine. In all cases, radiological results of the lower respiratory tract chest showed improved clearance of SARS-CoV-2, and their body temperatures were normalized for three consecutive days. According to the discharge standards of the "New Coronavirus Infected Pneumonia Diagnosis and Treatment Scheme (Trial Version 6)," the patients' conditions had stabilized. They were therefore discharged from the hospital. Six patients stayed at the hospital for ≥ 10 days, whereas the other two patients stayed for < 10 days. The child patient had the shortest length of hospital stay (8 days) (Table 3).

Discussion

In late February, more than 70,000 confirmed cases of COVID-19 were reported in various countries. To date, China has had the largest proportion of cases (90%). The Chinese New Year occurs during the Spring Festival, and many people return to work in Wuhan from various provinces and regions. Family

clustering has become the main route of SARS-CoV-2 transmission. The results of this study have also been confirmed by other studies.⁸ South Korea is among the countries with the highest numbers of infections possibly because Korean and Chinese citizens have similar traditions and cultures. Like Chinese people, Koreans also prefer living in family clusters; this might lead to an increase in the number of SARS-CoV-2 infections.⁹

Guizhou Province currently has 146 confirmed patients, 95% of whom are mild cases with fever, cough and sputum as the main symptoms. Dyspnea occurred only in a few cases and developed into acute respiratory distress. Family clustering has become the main transmission route in confirmed cases in the province. According to the media and state advocacy, individuals returning to Guizhou Province from Wuhan are separated from their homes for 14 days. And patients with fever, cough, sputum, and upper respiratory tract infections are required to go to the hospital as soon as possible. The grassroots community strictly implements family follow-ups and checks the travel history of each family member. Such preventive measures have achieved great results.¹⁰ As of early March, no new cases have occurred in Guizhou Province for eight consecutive days.

Only one patient (Patient 1) in Hubei had a history of contact with people from Wuhan. Although this patient had close contact with his wife though eating, sleeping, and talking with each other, she was not infected with the new coronavirus. One child was infected with the new coronavirus. That child was three years old, while the other two were about 10 years old. Other studies proved that the duration of hospital stay among mild cases in China was about 10 days. The child patient in our present study stayed at hospital for a shorter period and did not have either obvious symptoms or clear CT scans. The pediatric patients in this study were slightly different from those in the previous studies with large sample sizes in Wuhan.⁷ They only showed symptoms related to positive nucleic acid amplification tests (NAAT). However, clinical diagnosis could be deviated because the children were younger and could not clearly feel the physical symptoms.

However, note that patients with new coronaviruses without obvious symptoms are the main route of transmission of new coronaviruses. According to the treatment plan, all patients received antiviral therapy, mainly lopinavir / ritonavir + interferon alpha nebulization inhalation, combined with traditional Chinese medicine.^{11,12} CT scan results showed that the lung lesions significantly improved. Chinese traditional medicine has played a crucial role in the fight against COVID-19 in China. However, it is unclear whether the eight patients would experience repeated symptoms after discharge. Some patients had negative NAAT; thus, the follow-up of prognosis is of great importance.

Wuhan city, Hubei province is far from Guizhou province, and returnees have become the main source of infection. The number of new cases in Guizhou reduced mainly because the Provincial Government has implemented strong prevention and control measures. Patients with confirmed diagnoses of COVID-19 have uniformly been managed. They are admitted to designated hospitals and isolated at designated sites after discharge. This measure effectively stopped the spread of the virus. Patients with false-positive results in NAAT after discharge will have to return to the hospital for further treatment.

Our research has some limitations. First, the number of confirmed cases in Guizhou Province is relatively small, and the number of confirmed families has also decreased. This study only investigated one family case. Second, although all patients were included from the incubation period to discharge, they were not followed up after discharge. We thus could not confirm whether the patients had false-negative results in NAAT.¹³

Conclusion

Familial clustering has become one main route of SARS-CoV-2 transmission in China. Compared with other large sample studies, this study demonstrated that children were less susceptible to viral infection than adult family members. Pediatric patients had milder symptoms, shorter durations of hospital stays, and a lower likelihood of pulmonary infection. However, this did not confirm whether their NAAT were negative or positive after discharge. Therefore, the management and control of discharged patients should be paid sufficient attention.

List Of Abbreviations

Computed tomography, CT

Coronavirus, CoV

Coronavirus disease 2019, COVID-19

Nucleic acid amplification tests, NAAT

Severe acute respiratory syndrome coronavirus 2, SARS-CoV-2

Declarations

Ethics approval and consent to participate

Ethical approval: This study was approved by the Ethics Committee of the Affiliated Hospital of Zunyi Medical University (KLL-2020-010).

Consent to participate:

All authors confirm the consent obtained from study participants was written.

Consent for publication:

All patients give my consent and authorize the photograph(s) and/or video featuring my likeness to be published in BMC Infectious Diseases.

All patients understand that such imaging records may be published by BMC Infectious Diseases and/or any party acting under the license and authority of BMC Infectious Diseases in any print, visual, electronic or broadcast media, specifically including, but not limited to, medical journals and textbooks, scientific presentations and teaching courses and Internet websites, for the purpose of informing the medical profession or the general public about COVID-19 methods, results, issues, trends, concerns and similar matters.

All patients further understand that the imaging records shall become the property of BMC Infectious Diseases.

Availability of data:

Competing interests: All authors no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Availability of data and materials:

This manuscript appears to report data on patients with COVID-19, these patients have not been reported in any other submission .

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Authors' contribution: DH analysed the data, with input from JS, J-H Y, R-J H and K-X H. DH wrote the initial draft with all authors providing critical feedback and edits to subsequent revisions. All authors approved the final draft of the manuscript. Z-X J is the guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Tables

Due to technical limitations, Tables 1-3 are provided in the Supplementary Files section.

Figures

Figure 1

Chronology of symptom onset of the family cluster and their contacts in Guizhou. Dates filled in red are the dates on which patients 1 had close contacts with their relatives (relatives his wife). The boxes with an internal red cross are the dates on which patients 1 and wuhanese intimate contact. Dates filled in orange are the dates on which patients 2–5 stayed with patient 1. Dates filled yellow are the dates on which patients 6–8 and Other relatives stayed with patient 1.

Figure 2

Analysis of serial RT-PCR assays in correlation with serial chest CT scans. The subgroup of positive to negative RT-PCR results (n = 8).

Figure 3

Representative images of the thoracic CT scans showing multifocal ground-glass changes in the lungs of patient 1 (A), patient 2 (B), patient 3 (C), and patient 4 (D), patient 5 (E). No abnormalities in the lungs of the remaining 3 patients.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Table3.xlsx](#)
- [Table1.xlsx](#)
- [Table2.xlsx](#)