



Epidemiologic and clinical characteristics of 10 children with coronavirus disease 2019 in Changsha, China

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ABSTRACT

Background: The outbreak of a new coronavirus, first reported in Wuhan, China, is spreading around the world. Information on the characteristics of children with Coronavirus Disease 2019 (COVID-19) is limited.

Methods: In this retrospective study, we recruited 10 children infected with SARS-COV-2 from January 27 to March 10, 2020, in Changsha, China. We report the epidemiological, clinical, laboratory, and high-resolution CT findings for these children. Qualitative descriptive analysis was used to describe the key results.

Results: Ten children were included. Three were male and seven were female. Three were from Wuhan, Hubei Province, and seven were from Changsha. All had a history of close contact with adults with COVID-19 before the onset of disease. Clinical manifestations included fever in four cases, respiratory symptoms in three cases, febrile convulsions in one case, vomiting in one case, abdominal pain in one case, and asymptomatic infection in two cases. All the children tested positive for nucleic acid in throat swabs at admission. Stool swabs of three cases were positive for nucleic acid after several days of fever. In nine children, blood routine results were normal, whereas in one case the white blood cell count was elevated. In four cases, CT findings of the lungs showed light ground-glass opacities, one case showed changes similar to bronchopneumonia, and the remaining cases were normal. All were treated with symptomatic support without complications.

Conclusion: Our findings indicate that intrafamily transmission may be the main form of transmission of COVID-19 in children, and persistent intestinal excretion of virus is another characteristic among children. The results of stool swab tests should be considered for discharge and release from isolation.

1. Introduction

In December 2019, a new coronavirus pneumonia outbreak emerged in Wuhan city, Hubei Province, and rapidly spread across China and 109 countries or regions around the world [1,2]. The World Health Organization (WHO) officially named the disease caused by the novel coronavirus as Coronavirus Disease 2019 (COVID-19). As of March 10, 2020, COVID-19 had affected 113702 patients, causing 4012 deaths, constituting a major global health concern [2]. With the spread of the epidemic, the etiology, epidemiology, and clinical characteristics of COVID-19 have gradually been recognized, but information about the early diagnosis and treatment of COVID-19 has derived mainly from adult cases. The clinical characteristics and epidemiological information of COVID-19 in children is still limited, with only sporadic

literature reported [3–5], and more medical case information is required. Here, we summarize the clinical data from 10 confirmed cases of COVID-19 in children.

2. Methods

2.1. Study design and participants

This study's protocol was established according to the ethical guidelines of the Helsinki Declaration and was approved by the Human Ethics Committee of the First Affiliated Hospital of Hunan Normal University. Jia Pan and Pinyu Tan had authorized access to the medical record data (approval no. 2020-09). We obtained verbal consent from children's parents. Patient records/information were anonymized and

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de-identified prior to analysis. For this retrospective, single center study, we recruited hospitalized children who were diagnosed with COVID-19 from January 27 to March 10, 2020 in the First Affiliated Hospital of Hunan Normal University and Changsha Public Health Treatment Center of Hunan Province (North Hospital of Changsha First Hospital).

2.2. Data collection

Information recorded includes epidemiological and demographic information, signs and symptoms on admission, laboratory results, information on coinfection with other respiratory pathogens, CT findings, treatment measures, and outcome data from patients' medical records. Clinical outcomes were followed up to March 10, 2020. A confirmed case of COVID-19 was defined as a positive result on high-throughput sequencing or real-time RT-PCR of nasal and pharyngeal swab specimens.

2.3. Diagnostic criteria

All patients infected with COVID-19 enrolled in this study were diagnosed and treated according to the National Clinical guidelines (edition 6) released by the China National Health Commission (NHC) [6]. Those with evidence of one of the following pathogenic characteristics was considered a confirmed case: (1) positive for SARS-CoV-2 by the real-time PCR test for nucleic acid in respiratory or blood samples; (2) viral gene sequencing shows high homogeneity to SARS-CoV-2 in respiratory or blood samples.

2.4. Statistical analysis

Continuous variables were expressed as medians and interquartile ranges or simple ranges, as appropriate. Categorical variables were described as counts and percentages. For laboratory results, we evaluated whether the measurements were outside of the normal range. All of the analyses were performed using R software, version 3.6.2 (R Foundation for Statistical Computing).

3. Results

3.1. Demographic and clinical characteristics

This study included 10 children with confirmed COVID-19, with an average age of 7 years (range, 1–12 years), including seven females and three males. All of the children were previously healthy, and had undergone routine vaccination. Among the 10 patients, two children (patients G, J) were asymptomatic, five children (patients A, B, D, F, I) had respiratory symptoms (one or more symptoms of sore throat, dry cough, itchy throat, cough and phlegm), and three children (patients C, E, H) showed mild symptoms. The detailed clinical features of patients are shown in Table 1.

3.2. Laboratory findings

There were no abnormalities in hemoglobin or platelets. At the time of admission, the leukocyte counts (range, $4.98\text{--}8.34 \times 10^9/\text{L}$) and lymphocyte counts (range, $1.15\text{--}4.05 \times 10^9/\text{L}$) of the children were normal, with the exception of one child who had an elevated white blood cell count ($16.31 \times 10^9/\text{L}$). On rechecking 3 days after admission, the blood test results of all patients were within the normal range. The functions of the liver, kidney, and myocardial enzymes, coagulation, and the indexes of blood glucose and serum ferritin were normal. Three children were positive for *Mycoplasma pneumoniae* antibodies, and one of them was positive for *Mycoplasma* and *Chlamydia* antibodies. All of the children gave negative results on sputum culture and blood culture, and were negative for respiratory virus antigens (including

influenza A and B virus, respiratory syncytial virus, parainfluenza virus, and adenovirus). Three patients tested positive for SARS-CoV-2 by the real-time PCR test for nucleic acid in stool swab samples, one of which was confirmed 16 days after onset.

3.3. CT findings

CT images showed multiple ground-glass opacities in the inferior lobe of patients A, C, and I; Patient E showed increased lung markings, bronchial wall thickening, and mottling and bronchopneumonia-like changes in the bilateral lungs; Patient H showed ground-glass opacities in the unilateral lower lung and multiple nodule shadows (Fig. 1). The remaining cases were normal.

3.4. Treatment

All patients received treatment that included bed rest and symptomatic treatment with no need for oxygen. One patient with pneumonia received empirical antibiotic therapy. As of March 10, 2020, all of the children had been discharged when they recovered uneventfully and met de-isolation and discharge criteria [7].

3.5. Epidemiological history

Detailed epidemiological history information is summarized in Fig. 2. Of the 10 children included in this study, three children were from Wuhan, the capital of Hubei, and seven were from the local area of Changsha. One patient (patient A) directly contracted COVID-19 from infected adults during a cruise. Six patients (patients D, E, F, G, H) were exposed to the virus via infected adults in their household, some via family members who had direct contact with COVID-19-infected persons or with those with a travel history to Wuhan. Three patients (patients B, C, I) followed familial members to visit relatives in Changsha from Wuhan. Patient I had a 16-day history of living in the endemic area (Wuhan). Two days after returning to Changsha, several family members showed the onset of symptoms and were confirmed positive for the virus. However, patient I underwent three throat swab nucleic acid tests at the designated hospital clinic, all of which were negative. It was only when fever symptoms began in this patient that a positive result in the throat swab nucleic acid test was obtained.

4. Discussion

Currently, there are few reports of children with COVID-19. From our results and from the literature, many differences are evident between child and adult cases in terms of the epidemiology and clinical characteristics [5,8–10]. Severe cases in adults usually result in dyspnea after 1 week of onset, which can quickly progress to acute respiratory distress syndrome (ARDS), septic shock, difficult to correct metabolic acidosis, and coagulation dysfunction [11]. The absolute value of lymphocytes in most patients decreases [12]. Another study reported that the most common laboratory abnormalities in critically ill adult patients were decreased lymphocyte count, prolonged prothrombin time, and elevated lactate dehydrogenase [8]. Compared with adults, pediatric cases have generally presented with mild clinical symptoms of short duration [5,13]. This result was also confirmed in our study in which two cases were asymptomatic, four cases presented a fever, three cases showed respiratory symptoms, one case showed fever convulsions, one case involved vomiting, and one case presented with abdominal pain. There were no severe cases. The results of this study showed that children with COVID-19 had no high-risk factors such as decreased lymphocyte counts, prolonged prothrombin time, or elevated lactate dehydrogenase. This also means that pediatric patients become less ill and recover faster. It is noteworthy that patient D was admitted to the hospital with a fever. After 6 days of treatment, the nucleic acid results from throat swab samples were negative twice consecutively

Table 1
Clinical characteristics and laboratory results of 10 children infected with COVID-19.

Characteristic	Patient A	Patient B	Patient C	Patient D	Patient E	Patient F	Patient G	Patient H	Patient I	Patient J
Age (year)	9 and 5 mo	11 and 8 mo	2	8 and 9 mo	1 and 1 mo	12 and 1 mo	8 and 10 mo	9 and 3 mo	3 and 7 mo	8 and 10 mo
Gender	Female	Female	Female	Male	Female	Male	Male	Female	Female	Female
Symptom onset date	2020-02-11	2020-01-27	2020-01-28	2020-02-06	2020-02-02	2020-02-06	2020-02-08	2020-02-05	2020-02-11	2020-02-13
Incharge date	2020-02-14	2020-01-30	2020-01-30	2020-02-06	2020-02-02	2020-02-08	2020-02-08	2020-02-06	2020-02-16	2020-02-13
Length of stay (days)	25	17	13	24	16	20	11	16	11	19
Body temperature (°C)	36.4	37.2	39.1	37.8	36.7	37.5	36.3	36.5	37.5	36.7
Oximetry saturation (%)	99	99	95	99	99	97	98	99	98	99
Signs and symptoms and at admission										
Fever	-	-	+	+	-	+	-	-	+	-
Cough	+	+	-	-	-	-	-	+	-	-
Abdominal Pain	+	-	-	-	-	-	-	-	-	-
Vomiting	-	-	+	-	-	-	-	-	-	-
Constipation	-	-	-	+	-	-	-	-	-	-
Convulsion	-	-	+	-	-	-	-	-	-	-
Laboratory findings										
White blood cell count ($\times 10^9$ cells per L); (normal range 4–10)	7.06	6.06	7.88	5.43	16.31 ↑	8.34	6.5	5.82	7.4	4.98
Lymphocyte count ($\times 10^9$ cells per L); (normal range 0.8–4.0)	3.7	2.65	4.05	1.15	9.54 ↑	3.81	2.46	2.36	3.1	2.38
Alanine aminotransferase (U/L); (normal range 0.0–42.0)	14.2	13.55	18.69	19.69	15.66	10.5	15.81	14.48	6.7	17.1
Aspartate aminotransferase (U/L); (normal range 0.0–37.0)	55.1 ↑	22.21	40.49 ↑	28.5	31.4	14.8	23.19	31.36	28.1	27.8
Globulin (g/L); (normal range 20.2–29.5)	24.6	21.7	27	20.9	20.7	22.2	21.2	20.1	17.7 ↓	24
Creatine kinase (U/L); (normal range 10.0–190.0)	92.3	38.2	246.8†	43.4	92	65.1	63.7	83.5	62.7	68
Cardiac creatine kinase (U/L); (normal range 0–24)	22	16.5	34.7	21.2	26	12.18	4.6	14.7	26.1	12.1
Lactate dehydrogenase (U/L); (normal range 135.0–225.0)	175	140.9	230.7	153.2	218	132.1	152.9	177.1	205.9	159.4
C reactive protein (mg/L); (normal range 0.0–8.0)	0.2	1.45	13.17	2.24	3.58	0.3	3.51	1.78	1.7	0.2
Ferritin (ng/mL); (normal range 4.63–204.0)	39.59	39.59	-	83.92	23.82	98.82	88.95	64.03	24.1	-
Mycoplasma	-	-	1:160 +	1:160 +	-	-	-	1:80 +	-	-
CT findings										
Mottling and ground-glass opacity	+	-	+	-	+	-	-	+	+	-

Note: + : positive. - : negative. † : above normal range. ‡ : below normal range. NA: not available. ND: not detected. mo: month.

(with an interval of 1 day). However, the child presented with bloating and constipation symptoms during this time. We further tested the nucleic acid from stool swabs (15 days after the onset), and the results were positive for 7 consecutive days. Two other children showed persistently positive stool swab samples. This means that even after removing the virus from the respiratory tract, viral gastrointestinal infection and potential fecal–oral transmission will continue. Therefore, hand hygiene is especially important for children, and routine detection of throat swabs and stool swabs should be more accurate than throat swabs alone.

To date, there are limited reports of children with severe COVID-19, and although severe complications (including ARDS and septic shock) have been reported, they seem to be uncommon [14]. A similar pattern was seen during the SARS and MERS epidemics, where ARDS and death occurred but were uncommon among infected children [15]. Therefore, pediatricians should be aware of the potential risks of lethality and fully grasp the clinical characteristics of COVID-19 in children.

During epidemiological investigations, we found that the 10 children each had a history of close contact with adults infected with COVID-19 before the onset of their disease, indicating that intrafamily transmission was the main route via which children become infected with the virus. This was consistent with a number of previous studies [5,16]. The grand-uncle of patient E was the first-generation case, and the maternal grandfather and father showed onset of disease after 4 days of exposure, but the maternal grand-uncle remained asymptomatic despite a positive nucleic acid test until 9 days later. Patients G and J from family clusters with COVID-19 were both asymptomatic. Based on these results, it appears that the infection rate in children is not lower than that in adults and that children are susceptible within families with clustered disease onset. Compared with adults, however, the clinical symptoms are generally mild and children recover faster. The low incidence among children may be related to local governments initiating the highest-level response to this public health emergency. During such a response, outdoor activities are limited, minimizing the likelihood of coming into contact with the virus. However, more data are needed on inference analysis to confirm this. Based on the existing evidence from SARS-COV-2 infections in children [16–18], it is necessary to close schools and childcare facilities within the endemic zone to reduce the exposure of children to the potential community spread of COVID-19.

This study has certain limitations. First, only 10 confirmed cases among children were included. Second, follow-up data were not available. More data on pediatric patients are expected in the future, which will help pediatricians develop a more comprehensive understanding of the characteristics of COVID-19 in children. In summary, SARS-COV-2 infection has distinctive characteristics in children, such as transmission among household family members and persistent excretion of SARS-COV-2 virus. We propose that the results of stool swab tests are included in the criteria for hospital discharge and release from isolation.

The symptoms of COVID-19 in children are mild and a small number of patients may present with gastrointestinal symptoms such as abdominal pain, bloating, and constipation. Pediatricians need to recognize the diversity of clinical characteristics of COVID-19 in children to identify suspected cases. Attention should also be paid to asymptomatic infections and to strengthening science education and preventive measures to reduce the risk of disease transmission.

CRedit authorship contribution statement

Yu-pin Tan: Investigation, Methodology, Data curation, Writing - review & editing. **Bo-yu Tan:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft. **Jia Pan:** Investigation, Methodology, Resources, Software, Supervision. **Jing Wu:** Investigation, Data curation. **Sai-zhen**

Zeng: Methodology, Writing - review & editing. **Hong-yan Wei:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

None declared.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.jcv.2020.104353>.

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