COVID-19 in Children and the Dynamics of Infection in Families

Klara M. Posfay-Barbe, MD,[a] Noemie Wagner, MD,[a] Magali Gauthey, MD,[b] Dehlia Moussaoui, MD,[c] Natasha Loevy, MD,[d] Alessandro Diana, MD,[e,f] Arnaud G. L'Huillier, MD[a,g]

Since the onset of coronavirus disease (COVID-19) pandemic, children have been less affected than adults in terms of severity[1–3] and frequency, accounting for <2% of the cases.[2–5] Unlike with other viral respiratory infections, children do not seem to be a major vector of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission, with most pediatric cases described inside familial clusters[6] and no documentation of child-to-child or child-to-adult transmission.[7,8] The aim of this work was to describe the clinical presentation of the first 40 pediatric cases of COVID-19 in our city and the dynamics of their familial clusters.

METHODS

From March 10 to April 10, 2020, all patients <16 years old with SARS-CoV-2 infection were identified by means of the Geneva University Hospital's surveillance network (Switzerland). The network notifies the institution's pediatric infectious diseases specialists about results of nasopharyngeal specimens tested for SARS-CoV-2 by reverse-transcription polymerase chain reaction. This study was approved by the Regional Ethics Committee. After informed oral parental consent and its documentation in the medical charts, chart reviews were used to retrieve clinical data, and parents were called for patients and household contacts (HHCs) follow-up. HHCs were considered suspect if they had fever or acute respiratory symptoms, as per the Swiss Federal Office for Public Health's case definition[9] (Supplemental Information).

Categorical data were compared using the χ^2 test, with P values <.05 considered significant. Statistics were performed using SPSS version 23.0 (IBM SPSS Statistics, IBM Corporation).

RESULTS

Among a total of 4310 patients with SARS-CoV-2, 40 were <16 years old (0.9%). One patient for which telephone follow-up was not possible was excluded because of the inability to evaluate clinical evolution and HHC symptoms. The median follow-up of the households was 18 days (interquartile range [IQR]: 14–28).

Clinical Presentation, Diagnosis, and Management

Demographics, clinical presentation, and diagnosis of the study children are detailed in Table 1. Of note, 29 (74%) patients were previously healthy; the most frequently reported comorbidities were asthma (10%), diabetes (8%), obesity (5%), premature birth (5%), and hypertension (3%). Seven patients (18%) were hospitalized to the ward, for a median duration of 3 days (IQR: 2–4); reasons for admission were surveillance for nonhypoxemic viral pneumonia (n = 2), fever without source (n = 2), apparent life-threatening event (n = 1), and sepsis-like event (n = 1); 1 paucisymptomatic child admitted because both parents had severe COVID-19 (n = 1). No patient required ICU admission or SARS-CoV-2–specific therapies. The

[a]Pediatric Infectious Diseases Unit, [c]Division of General Pediatrics, and [d]Pediatric Platform for Clinical Research, Department of Woman, Child and Adolescent Medicine, Geneva University Hospitals and Faculty of Medicine, University of Geneva, Geneva, Switzerland; [b]Pediatric Department, Hôpital de La Tour, Geneva, Switzerland; [e]Primary Care Unit, University of Geneva, Geneva, Switzerland; [f]Clinique des Grangettes, Geneva, Switzerland; and [g]Division of Infectious Diseases and Laboratory of Virology, Division of Laboratory Medicine, Geneva University Hospitals and Medical School, Geneva, Switzerland

Drs Posfay-Barbe, Wagner, and L'Huillier conceived and designed the study, designed the data collection instruments, conducted the initial analyses, drafted the initial manuscript, and reviewed and revised the manuscript. Drs Gauthey, Moussaoui, Loevy, and Diana critically reviewed the manuscript for important intellectual content and reviewed and revised the manuscript; and all the authors coordinated and supervised data collection and approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

DOI: https://doi.org/10.1542/peds.2020-1576

Accepted for publication May 12, 2020

Address correspondence to Arnaud G. L'Huillier, MD, Pediatric Infectious Diseases Unit, Department of Woman, Child and Adolescent Medicine, Geneva University Hospitals and Medical School, 6 rue Willy-Donze, 1211 Geneva 14, Switzerland.
E-mail: arnaud.lhuillier@hcuge.ch

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2020 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

To cite: Posfay-Barbe KM, Wagner N, Gauthey M, et al. COVID-19 in Children and the Dynamics of Infection in Families. *Pediatrics*. 2020;146(2): e20201576

Downloaded from www.aappublications.org/news at University of North Texas--Denton on January 20, 2021

TABLE 1 Demographics and Clinical Presentation of Study Patients

	n = 39
Demographics	
Median age, y (IQR)	11.1 (5.7–14.5)
Female sex, No. (%)	22 (56)
Clinical presentation	
Median time between symptom onset and diagnosis, d (IQR)	2 (1–3)
Reported symptoms, No. (%)	
Cough	32 (82)
Fever	26 (67)
Nasal discharge	25 (64)
Headache	22 (56)
Sore throat	14 (36)
Shortness of breath	13 (33)
Myalgia	13 (33)
Abdominal pain	11 (28)
Anosmia	8 (21)
Arthralgia	7 (18)
Diarrhea	7 (18)
Fatigue	5 (13)
Rash	5 (13)
Dysgueusia	4 (10)
Nausea	4 (10)
Vomiting	3 (8)
Thoracic pain	2 (5)
Conjunctivitis	1 (3)
Diagnosis, No. (%)	
Upper respiratory tract infection	27 (69)
Influenza-like illness	2 (5)
Fever without source	2 (5)
Pneumonia	2 (5)
Obstructive bronchitis	2 (5)
Sepsis-like event	1 (3)
Croup	1 (3)
ALTEs	1 (3)
Asymptomatic	1 (3)

ALTE, apparent life-threatening event.

others 32 patients were managed as outpatients. All patients had a complete resolution of symptoms by day 7 after diagnosis.

Familial Clusters

Familial cluster evaluation revealed a *t* number of 4 household members per family (IQR: 3–4). Among the 111 HHCs of study children, mothers predominated (n = 39), followed by fathers (n = 32), pediatric siblings (n = 23), adult siblings (n = 8), and grandparents (n = 7) (Fig 1). Adult HHCs were suspected or confirmed with COVID-19 before the study child in 79% (31/39) of cases. In only 8% (3/39) of households did the study child develop symptoms before any other HHC (Fig 1). Interestingly, 85% (75/88) of adult HHCs developed symptoms at some point, compared with 43% (10/23) of pediatric HHCs ($P < .001$). Also, 92% (36/39) of mothers developed symptoms, compared with 75% (24/32) of fathers ($P = .04$).

DISCUSSION

Most children in our study had mild or atypical presentations: headache and nasal discharge were described in more than half of cases, and anosmia and abdominal symptoms were described in <20%, which is more frequent than previously described.[2] Some of these symptoms might be underreported because younger children may not be able to describe them.

In 79% of households, ≥1 adult family member was suspected or confirmed for COVID-19 before

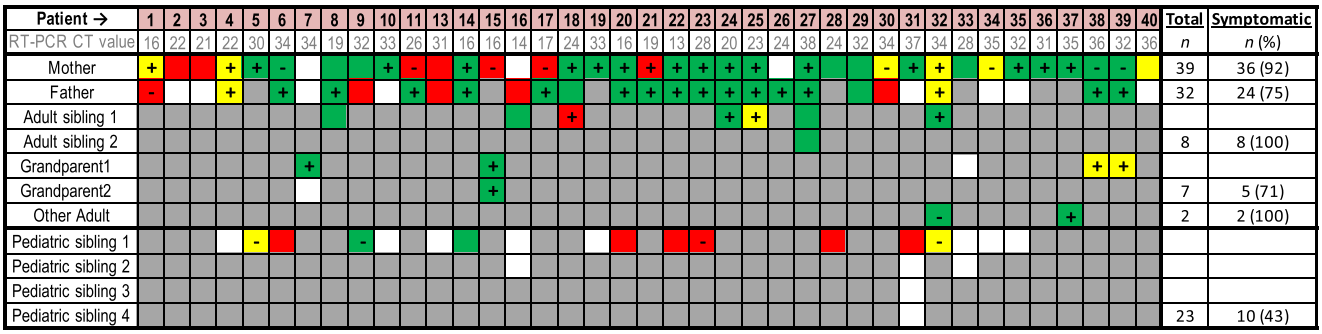

FIGURE 1

Description of individual household clusters with asymptomatic, suspected, and confirmed SARS-CoV-2 cases. Green, yellow, and red squares correspond to symptomatic HHCs who developed symptoms, respectively, before, simultaneously to, and after study patients. White squares correspond to asymptomatic HHCs. The "+" and "−" signs correspond to the results of SARS-CoV-2 nasopharyngeal reverse-transcription polymerase chain reaction (RT-PCR); patients without testing have an empty square. The absence of a family member inside a given household cluster is shown in gray. The study patient was the first to develop symptoms in cluster numbers 2, 3, and 13 only. Cycle threshold (CT) values correspond to the number of polymerase chain reaction cycles required to amplify the virus; hence the CT value is inversely proportional to the viral load.

Downloaded from www.aappublications.org/news at University of North Texas--Denton on January 20, 2021

symptom onset in the study child, confirming that children are infected mainly inside familial clusters.[6] Surprisingly, in 33% of households, symptomatic HHCs tested negative despite belonging to a familial cluster with confirmed SARS-CoV-2 cases, suggesting an underreporting of cases. In only 8% of households did a child develop symptoms before any other HHC, which is in line with previous data in which it is shown that children are index cases in <10% of SARS-CoV-2 familial clusters[10]; however, with our study design, we cannot confirm that child-to-adult transmission occurred.

This study has some limitations. The study sample likely does not represent the total number of pediatric SARS-CoV-2 cases during this time period. Indeed, patients with milder or atypical presentation might not have sought medical attention. Moreover, the recall of symptom onset among HHCs might be inaccurate, although this seems for once less likely because of the confinement measures and anxiety in the community.

The results of this study are important because of the extensive HHC tracing and the almost absence of loss to follow-up. Extended diagnostic screening of suspected cases and thorough contact tracing are needed to better understand the dynamics of transmission within households.

ABBREVIATIONS

COVID-19: coronavirus disease
HHC: household contact
IQR: interquartile range
SARS-CoV-2: severe acute respiratory syndrome coronavirus 2

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

REFERENCES

1. Dong Y, Mo X, Hu Y, et al. Epidemiology of COVID-19 among children in China. *Pediatrics*. 2020;145(6):e20200702
2. CDC COVID-19 Response Team. Coronavirus disease 2019 in children - United States, February 12–April 2, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(14):422–426
3. Livingston E, Bucher K. Coronavirus Disease 2019 (COVID-19) in Italy. *JAMA*. 2020;323(4):1335
4. Tagarro A, Epalza C, Santos M, et al. Screening and severity of coronavirus disease 2019 (COVID-19) in children in madrid, Spain [published online ahead of print April 8, 2020]. *JAMA Pediatr*:doi: 10.1001/jamapediatrics.2020.1346
5. Wu Z, McGoogan JM. Characteristics of and important lessons from the Coronavirus Disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese center for disease control and prevention. *JAMA*. 2020;323(13):1239–1242
6. Lu X, Zhang L, Du H, et al; Chinese Pediatric Novel Coronavirus Study Team. SARS-CoV-2 infection in children. *N Engl J Med*. 2020;382(17):1663–1665
7. World Health Organization. *Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19)*. Geneva: World Health Organization; 2020
8. Danis K, Epaulard O, Bénet T, et al; Investigation Team. Cluster of coronavirus disease 2019 (Covid-19) in the French Alps, 2020 [published online ahead of print April 11, 2020]. *Clin Infect Dis*. 2020. doi:10.1093/cid/ciaa424
9. Federal Office of Public Health. Available at: https://www.bag.admin.ch/bag/en/home.html. Accessed April 22, 2020
10. Zhu Y, Bloxham CJ, Hulme KD, et al Children are unlikely to have been the primary source of household SARS-CoV-2 infections. Available at: https://www.medrxiv.org/content/10.1101/2020.03.26.20044826v1. Accessed June 15, 2020

Downloaded from www.aappublications.org/news at University of North Texas--Denton on January 20, 2021

Supplemental Information

SUPPLEMENTAL METHODS

STUDY SETTING

The study was performed while schools, daycares, restaurants, bars, and shops were closed. Citizens were allowed to circulate outside their housing in groups of ≤5 while respecting social distance measures.

REVERSE-TRANSCRIPTION POLYMERASE CHAIN REACTION TESTING CRITERIA

For epidemiological purposes and to maximize contact tracing, every patient with respiratory symptoms or fever who came to the hospital was tested for SARS-CoV-2 by reverse-transcription polymerase chain reaction (RT-PCR), independently of epidemiological links. There was no significant shortage of testing capacity in our institution during this time period. The data and results of HHC RT-PCR testing was available to the study team through the hospital's surveillance network.

DEFINITIONS

HHCs were defined as persons living in the same housing as the SARS-CoV-2 RT-PCR–positive study patient. HHCs were asked whether they developed symptoms before, after, or at the same time as the study patient; no minimal threshold was used for this definition.

Downloaded from www.aappublications.org/news at University of North Texas--Denton on January 20, 2021

COVID-19 in Children and the Dynamics of Infection in Families

Klara M. Posfay-Barbe, Noemie Wagner, Magali Gauthey, Dehlia Moussaoui, Natasha Loevy, Alessandro Diana and Arnaud G. L'Huillier

Pediatrics 2020;146;
DOI: 10.1542/peds.2020-1576 originally published online May 26, 2020;

Updated Information & Services	including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/146/2/e20201576
References	This article cites 6 articles, 1 of which you can access for free at: http://pediatrics.aappublications.org/content/146/2/e20201576#BIBL
Subspecialty Collections	This article, along with others on similar topics, appears in the following collection(s): **Infectious Disease** http://www.aappublications.org/cgi/collection/infectious_diseases_sub **Epidemiology** http://www.aappublications.org/cgi/collection/epidemiology_sub
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://www.aappublications.org/site/misc/Permissions.xhtml
Reprints	Information about ordering reprints can be found online: http://www.aappublications.org/site/misc/reprints.xhtml

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®

Downloaded from www.aappublications.org/news at University of North Texas--Denton on January 20, 2021

PEDIATRICS®
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

COVID-19 in Children and the Dynamics of Infection in Families

Klara M. Posfay-Barbe, Noemie Wagner, Magali Gauthey, Dehlia Moussaoui, Natasha Loevy, Alessandro Diana and Arnaud G. L'Huillier

Pediatrics 2020;146;
DOI: 10.1542/peds.2020-1576 originally published online May 26, 2020;

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/146/2/e20201576

Data Supplement at:
http://pediatrics.aappublications.org/content/suppl/2020/07/09/peds.2020-1576.DCSupplemental

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 345 Park Avenue, Itasca, Illinois, 60143. Copyright © 2020 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN®

Downloaded from www.aappublications.org/news at University of North Texas--Denton on January 20, 2021