



# Coronavirus Disease 2019 in Children Cared for at Texas Children's Hospital: Initial Clinical Characteristics and Outcomes

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We describe the clinical course of 57 children with coronavirus disease 2019 (COVID-19) cared for through a single hospital system. Most children were mildly symptomatic, and only a few patients with underlying medical conditions required hospitalization. Systemwide patient evaluation processes allowed for prompt identification and management of patients with COVID-19.

**Key words.** children; coronavirus disease 2019; COVID-19; SARS-CoV-2.

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was declared a pandemic by the World Health Organization on March 11, 2020 [1]. As of June 3, 2020, the Centers for Disease Control and Prevention (CDC) reported > 1.8 million COVID-19 cases and 106 202 total deaths in the United States [2]. Early reports have provided critical insights on the clinical manifestations of the disease in children [3–7]. Most children appear to have asymptomatic or mild to moderate respiratory illness, whereas adults, especially the elderly, are more likely to suffer severe respiratory illness and a higher case fatality rate [3–7]. Given the rapidly evolving nature of the COVID-19 pandemic, data on

the epidemiology and clinical course of pediatric patients with COVID-19 in the United States are lacking. We reviewed Texas Children's Hospital's (TCH) integrated system approach to the evaluation and management of patients during the COVID-19 pandemic and performed a retrospective assessment of all pediatric patients with COVID-19 cared for through the TCH system.

## METHODS

### Study Design and Population

Patients were identified through the TCH Infection Control and Prevention line list of COVID-19 cases. Pediatric patients < 21 years of age with SARS-CoV-2 detected in nasopharyngeal swab specimens by reverse-transcription polymerase chain reaction (RT-PCR) between the dates of March 10 and April 18, 2020 were included in this study. The TCH system includes 3 pediatric hospitals (Medical Center, West, and Woodlands), 11 urgent care centers, and 50 Texas Children's Pediatrics practices in the greater Houston area. TCH systemwide COVID-19 exposure- and symptom-based algorithms were utilized to guide clinical practice for SARS-CoV-2 testing, but testing was at provider discretion. During this time frame, neither emergency department (ED) patients nor admitted patients were uniformly tested. Effective March 22, 2020, surveillance testing for SARS-CoV-2 was implemented for all patients admitted to a pediatric intensive care unit or undergoing a procedure requiring intubation.

Demographic and clinical information collected through review of the electronic medical record included age, sex, ethnicity, underlying medical conditions, exposure to household members with laboratory-confirmed COVID-19, sick household contacts, travel history, presenting symptoms, radiologic findings, laboratory findings including repeat SARS-CoV-2 testing, and need for hospital admission, supportive treatments, COVID-19 therapies, complications, and outcomes. Medical records were reviewed for repeat presentation to the TCH system through day 10 of illness, with day 0 of illness defined as the date of collection of the first positive COVID-19 test. The Baylor College of Medicine Institutional Review Board approved this study. Cases were also entered in the USA Pediatric COVID-19 registry coordinated by the Pediatric Infectious Diseases Transplant Network (<https://www.pedscovid19registry.com/>).

### Laboratory Methods

Nasopharyngeal specimens were tested for SARS-CoV-2 by RT-PCR at the TCH Molecular Microbiology Laboratory (n = 49) or at a national reference laboratory (n = 8). Molecular-based testing for co-viral pathogens included influenza A and

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B, respiratory syncytial virus A and B, parainfluenza virus types 1–4, human metapneumovirus (hMPV), rhinovirus, and adenovirus [8].

### Statistical Analysis

Fisher exact test was used for analyses of demographic and clinical data (Stata version 11 software; StataCorp, College Station, Texas). A 2-tailed *P* value of <.05 was considered statistically significant.

## RESULTS

We identified 57 pediatric patients with COVID-19 in the first 5 weeks of the outbreak in Houston (Table 1). Pre-procedural surveillance testing identified 3 patients (3/57 [5%]) who had no respiratory symptoms. Fifty-six percent were male and the median age was 10.7 years (range, 0.1–20.2 years). Asthma (7/57 [12%]) was the most common underlying condition, followed by sickle cell disease (4/57 [7%]). More than half of the cases (54%) reported a laboratory-confirmed COVID-19 household contact, and the majority (71%) of these cases presented in the ambulatory setting (*P* = .008). International travel was reported in 2 cases (Mexico and Commonwealth of Dominica) and interstate travel in 1 case (New Jersey).

Most patients (83%) presented with either fever or cough, including all of the patients who presented to the ED. Fever was reported in 53% of ambulatory patients, 90% of ED patients, and 25% of hospitalized patients (*P* = .002).

Nineteen patients (19/57 [33%]) had testing for additional viral pathogens. Three patients had co-viral pathogens identified: hMPV (*n* = 2) and rhinovirus (*n* = 1). Six patients had blood cultures performed; all were negative. Four patients underwent repeat testing for SARS-CoV-2. One remained positive 11 days after onset of illness, while 2 patients had negative repeat tests on days 4 and 12 of illness, respectively. One patient undergoing asymptomatic surveillance had negative testing on day 11 and positive testing on day 14.

All admitted patients had additional diagnoses: 2 had diabetic ketoacidosis and 1 each had vaso-occlusive crisis, acute chest syndrome, asthma exacerbation, altered mental status from hypernatremia, reactive arthritis, and appendicitis. The last 2 patients were identified through pre-procedural surveillance screening. Six patients were cohorted in the Special Isolation Unit at West Campus. Half of the hospitalized patients (4/8 [50%]) required supplemental oxygen via nasal cannula, and 1 patient was on home bilevel positive airway pressure without supplemental oxygen. No patients required mechanical ventilation. The median length of stay was 2 days (range, 1–10 days). No patients died.

None of the 57 patients received therapeutic agents to treat COVID-19. However, 3 patients received azithromycin for possible atypical pneumonia or acute chest syndrome, 3 patients

received dexamethasone for asthma exacerbation, and 1 hypogammaglobulinemic patient received scheduled intravenous immune globulin.

## DISCUSSION

We describe the characteristics and outcomes of the first 57 children with COVID-19 cared for within our hospital system in the early phase of the epidemic. The first documented case of COVID-19 in the greater Houston area occurred on March 4, 2020, and our first COVID-19 pediatric case occurred on March 23, 2020. An epidemic curve of COVID-19 cases at TCH and the distribution by age are provided in [Supplementary Figures 1 and 2](#). Public health measures for social distancing and canceling of large events, including the Houston Rodeo, were implemented in mid-March.

We found that most children were mildly symptomatic, similar to other reports [3–7, 9]. Dong and colleagues described the epidemiologic characteristics of 2143 pediatric patients with suspected (65.9%) or laboratory-confirmed (34.1%) COVID-19 in China [5]. They found less severe COVID-19 manifestations in children than adults, though select subpopulations, especially infants, were more susceptible to infection [5]. In our study, 11 (19%) patients were < 1 year of age, 1 of whom was hospitalized with sickle cell disease and co-detection of hMPV. More than a third of our cohort had underlying conditions, most frequently asthma. While Ogimi et al found that non-COVID-19 coronaviruses cause more severe outcomes in children with immunocompromising conditions, our immunocompromised patients (1 with malignancy and 1 with primary immunodeficiency) did not require admission [10]. In our study, fever (61%) and cough (67%) were the most frequently reported symptoms. Similarly, the CDC recently published data on COVID-19 in a large cohort of children (*n* = 2572) across the United States, with most cases reported from the Northeast. In this study, 56% and 54% of children reported fever and cough, respectively, though symptom data were available for only a small portion of cases (11%) [9].

Through the TCH Infection Control and Prevention infrastructure and the availability of testing through the TCH laboratory, we were able to capture and describe the course of COVID-19 illness in patients presenting in different settings. Importantly, most cases presented in the ambulatory setting (30/57 [53%]), and the yield of positive tests was greater in the outpatient setting (22/230 [9.6%]) than in the hospitals (27/1693 [1.6%]). The reason for this is likely multifactorial. A known household exposure may have lowered the threshold for testing in outpatients. In contrast, hospitals were more likely to perform pre-procedural surveillance testing. Most patients reported household members diagnosed with COVID-19, suggesting that infection in children occurred after exposure to an adult in their own home during a time of social distancing.

**Table 1. Clinical Characteristics and Outcomes of Children With Coronavirus Disease 2019 by Location Within the Texas Children's Hospital System, March 10–April 18, 2020 (N = 57)**

Demographic or Characteristic	Total Cases, No. (%)	Ambulatory, No. (%)	Emergency Department <sup>a</sup> , No. (%)	Hospitalized, No. (%)	P Value
Total patients	57 (100)	30 (52.6)	19 (33.3)	8 (14)	NA
Race/ethnicity					
White non-Hispanic	4 (7)	3 (10)	1 (5.3)	0	.4
Black non-Hispanic	21 (36.8)	7 (23.3)	10 (52.6)	4 (50)	
Hispanic	26 (45.6)	15 (50)	8 (42.1)	3 (37.5)	
Other/unspecified	6 (10.3)	5 (16.7)	0	1 (12.5)	
Male sex	32 (56.1)	16 (53.3)	13 (68.4)	3 (37.5)	.3
Age, y, median (range)	10.7 (0.1–20.2)	10.6 (0.4–20.2)	8.5 (0.1–18.6)	14.1 (0.38–18.9)	NA
Underlying conditions					
None	36 (63.2)	25 (83.3)	9 (47.4)	2 (25)	.003*
Asthma	7 (12.3)	3 (10)	3 (15.8)	1 (12.5)	
Sickle cell disease	4 (7)	0	2 (10.5)	2 (25)	
DM (type 1)	2 (3.5)	0	0	2 (25)	
Trisomy 21	2 (3.5)	1 (3.3)	1 (5.3)	0	
Immunocompromised	2 (3.5)	1 (3.3)	1 (5.3)	0	
Prematurity <sup>b</sup>	2 (3.5)	1 (3.3)	1 (5.3)	0	
Other <sup>c</sup>	4 (7)	0	3 (15.8)	1 (12.5)	
Weight percentile <sup>d</sup>					
<85th	33 (57.9)	18 (60)	10 (52.6)	5 (62.5)	1.0
85th–95th	10 (17.5)	5 (16.7)	4 (21.1)	1 (12.5)	
>95th	14 (24.6)	7 (23.3)	5 (26.3)	2 (25)	
COVID-19–positive household member	31 (54.4)	22 (73.3)	7 (36.8)	2 (25.0)	.008*
Reported sick household member	39 (68.4)	23 (76.7)	12 (63.2)	4 (50)	.3
Symptoms					
Fever <sup>e</sup> or cough	47 (82.5)	22 (73.3)	19 (100)	6 (75)	.02*
Fever <sup>e</sup>	35 (61.4)	16 (53.3)	17 (89.5)	2 (25)	.002*
Cough (n = 51)	34 (66.7)	16 (64)	14 (73.7)	4 (57)	.7
Congestion (n = 35)	21 (60)	8 (61.5)	11 (64.7)	2 (40)	.7
Rhinorrhea (n = 30)	16 (53.3)	7 (70)	6 (46.2)	3 (42.9)	.5
Sore throat (n = 24)	11 (45.8)	6 (66.7)	4 (36.4)	1 (25)	.4
Headache (n = 20)	14 (70)	6 (85.7)	7 (70)	1 (33.3)	.3
Vomiting (n = 43)	10 (23.3)	1 (6.3)	4 (21.1)	5 (62.5)	.01*
Diarrhea (n = 41)	8 (19.5)	5 (31.3)	2 (10.5)	1 (16.7)	.3
Any GI complaint <sup>f</sup> (n = 46)	21 (45.7)	9 (47.4)	7 (36.8)	5 (62.5)	.5
Imaging					
No CXR	43 (75.4)	29 (96.7)	11 (57.9)	3 (37.5)	<.001*
Normal CXR	8 (14)	0	6 (31.6)	2 (25)	
Abnormal CXR	6 (10.5)	1 (3.3)	2 (25)	3 (37.5)	
Viral testing					
No other viral testing	38 (66.7)	30 (100)	5 (26.3)	3 (37.5)	<.001*
Detection of co-viral pathogen (n = 19)	3 (5.3)	0	2 (10.5)	1 (12.5)	

**Table 1. Continued**

Demographic or Characteristic	Total Cases, No. (%)	Ambulatory, No. (%)	Emergency Department*, No. (%)	Hospitalized, No. (%)	P Value
WBC count, cells/ $\mu$ L, median (range) (n = 13)	8.5 (3.0–16.2)	NA	7.7 (3.0–9.8)	8.7 (5.4–16.2)	NA
ANC, cells/ $\mu$ L, median (range) (n = 13)	5.5 (2.6–14.3)	NA	4.3 (2.6–6.5)	5.8 (3.1–14.3)	NA
ALC, cells/ $\mu$ L, median (range) (n = 13)	1.3 (0.2–5)	NA	1.2 (0.2–5)	1.9 (0.9–3.9)	NA
Supplemental oxygen requirement	4 (7)	0	0	4 (50)	<.001*
Repeat presentation to TCH system within 10 d <sup>†</sup>	5 (8.8)	3 (10)	1 (5.3)	1 (12.5)	.8

Data are presented as No. (%) unless otherwise indicated.  
Abbreviations: ALC, absolute lymphocyte count; ANC, absolute neutrophil count; COVID-19, coronavirus disease 2019; CXR, chest radiograph; DM, diabetes mellitus; NA, not applicable; TCH, Texas Children's Hospital; WBC, white blood cell.  
\*Patients were evaluated in the emergency department and discharged.  
<sup>†</sup>Birth before 37 weeks of gestation.  
<sup>‡</sup>Includes children with adrenal insufficiency (n = 1), muscular dystrophy (n = 1), and acquired brain injury (n = 2).  
<sup>§</sup>Based on last recorded weight.  
<sup>||</sup>Fewer includes patients with subjective fever (n = 5).  
<sup>¶</sup>GI complaint included any of the following: abdominal pain, nausea, vomiting, or diarrhea.  
<sup>\*\*</sup>Three patients had repeat evaluation on days 1, 2, and 5 of illness and were diagnosed with sinusitis, tonsillitis, and conjunctivitis, respectively. Two patients re-presented to the emergency department, where 1 was discharged and 1 was admitted (classified as a hospitalized patient).  
<sup>\*\*\*</sup>Statistically significant at  $P < .05$ .

Given the relatively mild disease presentation of COVID-19 in children, reopening of daycares and schools could significantly impact disease transmission and community spread.

During the pandemic, TCH employed strategies to enable continued delivery of pediatric care in multiple settings. Implementation of patient/family and employee screening, visitor restriction policies, appropriate personal protective equipment use algorithms, increased telemedicine visits, and drive-through COVID-19 testing for patients enabled our healthcare workforce to safely care for patients both with and without COVID-19. Drive-through testing at the medical center equipped TCH to manage an anticipated patient surge, though none occurred. TCH used a similar approach during the 2009 H1N1 pandemic [11]. Additionally, our Special Isolation Unit located at West Campus was effective in cohorting hospitalized COVID-19 patients.

This retrospective study has several limitations. Limited clinical documentation precluded analysis of certain variables. We likely underestimate the total number of COVID-19 cases in children in the Houston area as children who are mildly symptomatic or asymptomatic may not present for or have needed testing. While TCH is the largest pediatric medical network in the area, we would not have captured patients presenting outside our institution.

Overall, children with COVID-19 had mild illnesses with good outcomes. All admitted patients also had non-COVID diagnoses contributing to the need for admission, which highlights the importance of testing broadly for implementation of appropriate infection control measures. Given the challenges posed by COVID-19, strategies to ensure that children and their families can continue to safely access routine medical care need to be further developed.

### Supplementary Data

Supplementary materials are available at the *Journal of The Pediatric Infectious Diseases Society* online (<http://jpid.oxfordjournals.org>). Supplementary materials consist of data provided by the author that are published to benefit the reader. The posted materials are not copyrighted. The contents of all supplementary data are the sole responsibility of the authors. Questions or messages regarding errors should be addressed to the author.

### Notes

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**Potential conflicts of interest.** All authors: No reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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