

# Pediatric COVID-19 Hospitalizations During the Omicron Surge

Svetlana Melamed, MD; Jacqueline Lee, MD; Alexandra Bryant, MD, MPH; Rosellen Choi, MD; Melodee Liegl, MA; Amy Pan, PhD

## ABSTRACT

**Background:** Treatment recommendations for children hospitalized with COVID-19 during the winter 2021-2022 omicron variant surge included remdesivir and dexamethasone for hypoxia and remdesivir for patients at risk of severe illness, including those with comorbidities. The omicron variant caused many otherwise-healthy children without hypoxia to be hospitalized for common viral syndromes like croup. This study aimed to characterize children hospitalized with COVID-19 during the omicron surge and describe their management and clinical trajectory.

**Methods:** This single-center retrospective study included patients under 19 years old with a COVID-19 discharge diagnosis on the Pediatric Hospital Medicine service in January and February 2022. Hypoxia was defined by sustained oxygen saturation greater than 90%. Primary outcome was return to emergency department or readmission within 14 days. Secondary outcomes were length of stay, multisystem inflammatory syndrome within 6 weeks, and death.

**Results:** During the study time frame, 111 children were hospitalized with COVID-19, including 35 who had an incidental COVID-19 result. In the remaining 76 patients, the median length of stay was 1.9 days (1.0–3.3). Eight patients (11%) returned to the emergency department or were readmitted within 14 days of discharge; 3 of the emergency department visits were related to ongoing COVID-19 infection. Of the 10 patients with croup, 1 received remdesivir due to prolonged illness, and none returned to the emergency department or were readmitted.

**Discussion:** Most children hospitalized with COVID-19 were young, previously healthy and unvaccinated for COVID-19 due to age-based ineligibility. Hypoxia was the most common indication for use of remdesivir/corticosteroids (25%). Return to the emergency department for ongoing COVID-19 symptoms was uncommon (4%). Patients with croup, a presentation seen more commonly with the omicron variant than previously, appeared to do well without remdesivir.

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**Author Affiliations:** Children's Minnesota, Section of Hospital Medicine, Minneapolis, Minnesota (Melamed); Children's Health of Orange County, Orange, California (Lee); Medical College of Wisconsin, Milwaukee, Wisconsin (Bryant, Choi, Liegl, Pan).

**Corresponding Author:** Svetlana Melamed, MD, Children's Minnesota, Section of Hospital Medicine, 2525 Chicago Ave, Minneapolis, MN 55404; phone 612.813.6000; email svetlana.melamed@childrensmn.org; ORCID ID 0009-0006-1660-8426

## BACKGROUND

While pediatric patients generally are less severely affected by COVID-19 than adults,<sup>11</sup> children with comorbidities, including cardiopulmonary disease, neurologic impairment, obesity, and immunocompromised state may develop more severe illness.<sup>2</sup> The National Institutes of Health treatment guidelines for hospitalized children with acute COVID-19 infection have continued to evolve. At the time of this study, dexamethasone and remdesivir were recommended for hypoxia; remdesivir also was recommended for patients known to be at risk of severe illness.<sup>3</sup> The omicron variant has unique considerations for pediatric patients. First, it preferentially targets the upper airway, thus predisposing otherwise healthy children to illness given the smaller and softer pediatric upper airway.<sup>4</sup> Second, the omicron variant is more transmissible than prior variants, and vaccination against COVID-19 was only available to children older than 5 years during the omicron peak, both of which

likely contributed to higher pediatric rates of infection and, proportionally, hospitalization.<sup>5,6</sup>

Literature is emerging regarding the connection between COVID-19 and common pediatric viral syndromes, such as croup and bronchiolitis. Patients with these syndromes may present with hypoxia, and their management typically does not vary by causative virus.<sup>7,8</sup> There has been an increase in croup diagnoses associated with the omicron variant, and prior studies demonstrate good clin-

ical outcomes with standard croup treatment.<sup>9</sup> Early pandemic isolation resulted in fewer bronchiolitis hospitalizations than in prior years, but less is known about lower respiratory tract illness such as bronchiolitis during the omicron period, and decision-making around COVID-specific treatment in these patients remains variable.<sup>10</sup>

This study aimed to characterize pediatric patients hospitalized with COVID-19 during the winter 2022 omicron peak and describe their management and clinical trajectory.

## METHODS

### Setting and Population

This was a retrospective study of patients at Children’s Wisconsin, an academic freestanding children’s hospital in southeastern Wisconsin. COVID-19 nasopharyngeal swabs were performed on all patients at the time of hospitalization during the study time frame. Patients less than 19 years old were included if they received care on the Pediatric Hospital Medicine service in January and February 2022 and had a COVID-19 discharge diagnosis. This included patients who were transferred to or from the pediatric intensive care unit (PICU). To focus on the population cared for by pediatric hospitalists, patients were excluded if they were exclusively cared for in the PICU or emergency department (ED). The study time frame was chosen based on omicron strain predominance from local health department data. If a patient had multiple encounters with a COVID-19 discharge diagnosis during the study time frame, only the first encounter was included in the study.

### Variables and Definitions

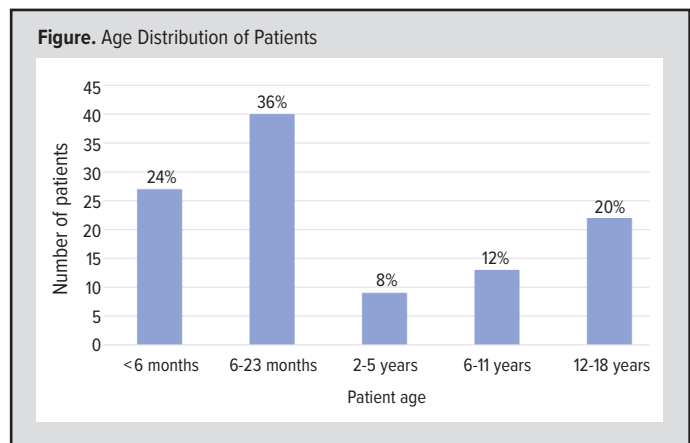
Patient characteristics collected included sex, race, ethnicity, age, comorbidities (prematurity, heart disease, chronic lung disease, immunodeficiency, neurodevelopmental disorder, other medical complexity including gastrostomy tube), reasons for hospitalization, interventions (including oxygen support and COVID-specific treatments), and clinical outcomes (below). A COVID-19 positive test was defined as incidental if this was specifically noted in the electronic medical record or if the patient lacked symptoms based on the Centers for Disease Control and Prevention definition. Hypoxia was defined by sustained oxygen saturation greater than 90% for more than 4 hours and/or needing nasal cannula or high flow nasal cannula (HFNC) with fraction of inspired oxygen (FiO<sub>2</sub>) greater than 21%.

### Outcomes

The primary outcome was return to the ED or readmission within 14 days. Secondary outcomes were length of stay (LOS), multisystem inflammatory syndrome (MIS-C) within 6 weeks, and death.

### Statistics

Deidentified patient information was stored in Redcap, a secure database. Categorical variables are reported as n (%), and con-



**Table 1.** Characteristics of Children Hospitalized With Nonincidental COVID-19, N = 76

Age, months (median, IQR)	12.2 (4.7 – 40.0)
Sex, male (n, %)	46 (61%)
Race <sup>a</sup> (n, %)	
White	50 (68%)
African American	19 (26%)
Asian	3 (4%)
Multirace	1 (1%)
Hispanic/Latino <sup>b</sup> (n, %)	12 (16%)
Comorbidities (n, %)	
Previously healthy	47 (62%)
At least 1 comorbidity	29 (38%)
Neurodevelopmental disorder	14 (18%)
Prematurity	11 (14%)
Asthma/bronchopulmonary dysplasia	5 (7%)
Heart disease	3 (4%)
Obesity	1 (1%)
Other complexity <sup>c</sup>	10 (13%)
Additional viral testing (n, %)	45 (59%)
Influenza co-infection <sup>d</sup>	4 (9%)
Other viral co-infection <sup>d</sup>	3 (7%)
Illness severity (n, %)	
Initial pediatric intensive care unit admission	9 (12%)
Hypoxia	19 (25%)
High flow nasal cannula	12 (16%)
COVID-specific treatment (n, %)	
Remdesivir	25 (33%)
Corticosteroids	36 (47%)
Clinical course	
Length of stay, days (median, IQR)	1.9 (1.0 – 3.3)
Returned to ED within 14 days of discharge (n, %)	8 (11%)
Returned to ED within 14 days due to illness caused by COVID-19 <sup>e</sup> (n, %)	3 (4%)
Readmitted within 14 days of discharge (n, %)	2 (3%)
Multisystem inflammatory syndrome (n, %)	0 (0%)
Death (n, %)	2 (3%)

Abbreviation: ED, emergency department.

<sup>a</sup>Race available for 73 patients.

<sup>b</sup>Ethnicity available for 74 patients.

<sup>c</sup>Includes immunodeficiency, diabetes, gastrostomy tube, ventriculoperitoneal shunt.

<sup>d</sup>Of patients who had additional viral testing.

<sup>e</sup>None of these patients required readmission.

tinuous variables are reported as median (IQR). Data were analyzed using SPSS version 28 (Chicago, Illinois).

### Ethical Considerations

The Children's Wisconsin institutional review board deemed the study to be non-human subjects research, and patient consent was not required.

### RESULTS

This study included 111 hospitalized children with a median age of 17.2 months (6.4-124.7) (Figure 1). Thirty-five (32%) patients were found to have incidental COVID-19 and were hospitalized for other reasons, including ingestion (23%), behavioral health emergency (20%), and skin/soft tissue infection (14%). Further information on the 76 patients with non-incident COVID-19 is provided below.

#### Presentation

Sixty-two percent of patients with nonincident COVID-19 were previously healthy (Table 1). Only 3% of patients were fully vaccinated against COVID-19, largely due to ineligibility with age less than 5 years (79%). Of the 59% of patients who had additional viral testing, 16% were found to have an additional virus. Of these 7 patients with viral co-infection, 4 had influenza and 1 each had respiratory syncytial virus, parainfluenza, and rhinovirus/enterovirus. The most common nonincident reasons for hospitalization were dehydration (36%), bronchiolitis (24%), COVID-19 pneumonia (17%), croup (13%), and febrile neonate (12%). Twenty-five percent of patients were hypoxic. The rate of hypoxia in patients with a viral co-infection was not significantly different compared to that in patients who had additional viral testing and were negative for a viral co-infection (57% vs 39%,  $P=0.43$ ).

#### Management

All hypoxic patients received corticosteroids and remdesivir treatment. Twenty percent of patients were not hypoxic but received corticosteroids for asthma or croup. Other than hypoxia, reasons for prescribing remdesivir included severity of illness (12%) and complex medical history (8%). Median treatment durations were 3.0 days (2.5–5.0) for remdesivir and 2.0 days (1.0–5.3) for corticosteroids. One patient receiving remdesivir developed transaminitis. No patients received monoclonal antibodies.

#### Disease Course

The median LOS was 1.9 days (1.0–3.3). Five patients (7%) required transfer to the PICU; 11% of patients returned to the ED within 14 days of discharge, and 2.6% were readmitted. Three

**Table 2.** Children Who Returned to the Emergency Department Within 14 Days of Discharge for Ongoing COVID-19 Illness

	Patient 1	Patient 2	Patient 3
Demographics	10-year-old male with congenital heart disease, chronic lung disease on home oxygen, baclofen pump, gastrostomy tube	1-month-old previously healthy male	5-month-old previously healthy male
Hospitalization diagnoses	COVID-19 pneumonia, dehydration	Febrile neonate, dehydration	Bronchiolitis
Illness severity	Hypoxia requiring HFNC with FiO <sub>2</sub> 60%	No hypoxia or respiratory support	No hypoxia or respiratory support
COVID-specific treatment	5 days remdesivir, 6 days dexamethasone	Supportive	Supportive
Clinical course	LOS 5.99 days; required PICU transfer; returned to ED for irritability, new fever; MIS-C labs negative; not readmitted	LOS 1.52 days; returned to ED for ongoing diarrhea, did not require fluid resuscitation; not readmitted	LOS 3.16 days; returned to ED for fussiness, increased work of breathing; did not require respiratory support; not readmitted

Abbreviations: HFNC, high flow nasal canula; FiO<sub>2</sub>, fraction of inspired oxygen; LOS, length of stay; PICU, pediatric intensive care unit; ED, emergency department.; MIS-C, multisystem inflammatory syndrome.

of the ED visits were related to ongoing COVID-19 infection (Table 2). Two patients died. The first was a 7-month-old infant with methicillin-resistant *Staphylococcus aureus* septic shock and unclear role of COVID-19 infection. The second was a 5-month-old infant hospitalized for pulmonary hemorrhage who died of nonaccidental trauma 10 days after hospital discharge.

#### Patients With Croup

Ten patients with a median age of 9.9 months (8.1–16.9) were hospitalized for croup, two of whom had an underlying neurodevelopmental comorbidity. None of them had viral co-infection, hypoxia, or required PICU admission or HFNC. All were treated with dexamethasone, and 1 patient received remdesivir due to prolonged illness course. Median LOS was 1.0 day (0.6–1.2). No patients returned to the ED or were hospitalized within 14 days, developed MIS-C, or died.

### DISCUSSION

#### Presentation

The majority of patients hospitalized for COVID-19-related symptoms were young, previously healthy, and recovered without corticosteroids or remdesivir. Most patients were ineligible for the COVID-19 vaccine due to age at the time of the study, although vaccines are now available to younger children.

#### Management

At the time of our study, COVID-19 treatment guidelines recommended dexamethasone and remdesivir for patients with hypoxia, as well as remdesivir for patients known to be at risk of severe illness, including those with comorbidities.<sup>2</sup> Our local management guidelines reflected these recommendations and allowed case-by-

case decision-making around the use of remdesivir in nonhypoxic patients. In our study, nearly two-thirds of patients were previously healthy and the majority did not require respiratory support, compared to higher rates of hospitalized patients with comorbidities and rates of respiratory support earlier in the pandemic.<sup>1</sup> As a result, sustained hypoxia was the primary reason for remdesivir treatment. Patients rarely received treatment due to complex medical history or high level of respiratory support alone. Similar to prior studies, only 1 of the 30 patients who received remdesivir in our study developed transaminitis.<sup>2</sup>

### Clinical Course

We found a readmission rate of 2.6%, which is similar to both the overall readmission rate of 4.2% during the same time frame for all diagnoses at our institution and the 2.1% COVID-19-associated readmission rate in a large retrospective administrative database analysis.<sup>1</sup> None of the readmissions at our institution were related to ongoing COVID-19 infection, which may reflect a lower severity of the omicron variant.<sup>5</sup> Similar to other reports, mortality was low in our study, with 1 of 2 patient deaths potentially related to COVID-19.<sup>1</sup> None of our patients developed MIS-C, which may reflect our small sample size. Patients with croup appeared to have good clinical outcomes with standard corticosteroid treatment, which is consistent with prior studies.<sup>4,9</sup>

### Limitations

This single-site, retrospective study had several limitations including small sample size and potential selection bias as not all hospitalized patients with COVID-19 were cared for on the hospitalist service. Additionally, variant testing was not performed on our patients, so presence of the omicron variant was inferred based on local health department variant reporting. Future studies should include a larger sample size, consider variant testing on all patients to assess variant-specific rates of rare outcomes such as MIS-C, and investigate the rate of bacterial superinfection and antibiotic prescribing in patients with COVID-19.

**Funding/Support:** None declared.

**Financial Disclosures:** None declared.

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*WMJ* (ISSN 1098-1861) is published through a collaboration between The Medical College of Wisconsin and The University of Wisconsin School of Medicine and Public Health. The mission of *WMJ* is to provide an opportunity to publish original research, case reports, review articles, and essays about current medical and public health issues.

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