The Journal of Emergency Medicine, Vol. ■, No. ■, pp. 1–5, 2022

0736-4679/$ - see front matter

https://doi.org/10.1016/j.jemermed.2022.09.036

Brief Report

COVID-19 CROUP IS OBSERVED IN OLDER CHILDREN DURING THE OMICRON WAVE IN NEW YORK CITY

Q1 Nisha Narayanan, MD,[*,†] Samantha Langer, MD,[†] Karen P. Acker, MD,[†] Steven D. Rosenblatt, MD,[‡] Will Simmons, MPH,[§] Alan Wu, MS,[§] Jin-Young Han, MD, PHD,[†] Erika L. Abramson, MD, MSC,[†,§] Zachary M. Grinspan, MD, MS,[†,§] and Deborah A. Levine, MD[*,†]

*Department of Emergency Medicine, †Department of Pediatrics, ‡Department of Otolaryngology, NewYork-Presbyterian/Weill Cornell Medicine, New York, and §Department of Population Health Sciences, Weill Cornell Medicine, New York, New York

Corresponding Address: Nisha Narayanan, Department of Emergency Medicine, Weill Cornell Medicine, 525 E 68th St, M130, New York, NY, 10021.

□ **Abstract—Background: The Omicron variant of SARS-CoV-2 has a predilection for the upper airways, causing symptoms such as sore throat, hoarse voice, and stridor. Objective: We describe a series of children with COVID-19–associated croup in an urban multicenter hospital system. Methods: We conducted a cross-sectional study of children ≤18 years of age presenting to the emergency department during the COVID-19 pandemic. Data were extracted from an institutional data repository comprised of all patients who were tested for SARS-CoV-2. We included patients with a croup diagnosis by *International Classification of Diseases, 10th revision* code and a positive SARS-CoV-2 test within 3 days of presentation. We compared demographics, clinical characteristics, and outcomes for patients presenting during a pre-Omicron period (March 1, 2020–December 1, 2021) to the Omicron wave (December 2, 2021–February 15, 2022). Results: We identified 67 children with croup, 10 (15%) pre-Omicron and 57 (85%) during the Omicron wave. The prevalence of croup among SARS-CoV-2–positive children increased by a factor of 5.8 (95% confidence interval 3.0–11.4) during the Omicron wave compared to prior. More patients were ≥6 years of age in the Omicron wave than prior (19% vs. 0%). The majority were not hospitalized (77%). More patients ≥6 years of age received epinephrine therapy for croup during the Omicron wave (73% vs. 35%). Most patients ≥6 years of age had no croup history (64%) and only 45% were vaccinated against SARS-CoV-2. Conclusion: Croup was prevalent during the Omicron wave, atypically affecting patients ≥6 years of age. COVID-19–associated croup should be added to the differential diagnosis of children with stridor, regardless of age. © 2022 Elsevier Inc. All rights reserved.**

□ **Keywords—COVID-19; croup; laryngotracheitis; SARS-CoV-2**

Reprints are not available from the authors.

INTRODUCTION

Understanding how COVID-19 affects children is important, as is understanding the changing clinical landscape as new variants of the virus emerge. Compared with previous variants of SARS-CoV-2, the Omicron variant has shown a predilection for the upper airways, manifesting as sore throat and hoarse voice in adults and croup in children (1,2). Croup is a clinical syndrome characterized by inspiratory stridor, barking cough, and hoarseness due to the added narrowing of small subglottic airways by viral-induced inflammation. It typically occurs in children between 6 months and 3 years of age, and is rare in children ≥6 years of age old because of the larger diameter of their airways (3,4). Here, we describe the

RECEIVED: 7 July 2022; FINAL SUBMISSION RECEIVED: 16 August 2022;
ACCEPTED: 4 September 2022

Please cite this article as: N. Narayanan et al., COVID-19 CROUP IS OBSERVED IN OLDER CHILDREN DURING THE OMICRON WAVE IN NEW YORK CITY, Journal of Emergency Medicine, https://doi.org/10.1016/j.jemermed.2022.09.036

Table 1. Demographic Characteristics of Patients With SARS-CoV-2 Croup[a]

Characteristic	Pre-Omicron, n = 10	Omicron, n = 57	*p* Value
Median age, years (IQR)	2.00 (1.00–3.00)	2.00 (1.00–5.00)	0.7
Age, years, n (%)			
<3	5 (50)	36 (63)	
3 to <6	5 (50)	10 (18)	
6 to <12	0 (0)	11 (19)	
Sex, n (%)			>0.9
Female	3 (30)	20 (35)	
Male	7 (70)	37 (65)	
Race/ethnicity, n (%)			0.5
White	2 (20)	21 (37)	
Hispanic or Latino or Spanish origin	3 (30)	20 (35)	
American Indian or Alaska Native	0 (0)	1 (1.8)	
Asian	2 (20)	4 (7.0)	
Black or African American	0 (0)	2 (3.5)	
Other combinations not described	1 (10)	3 (5.3)	
Unknown	2 (20)	6 (11)	
Admission status, n (%)			0.5
Not admitted	8 (80)	44 (77)	
Admission to floor	1 (10)	11 (19)	
Admission to PICU	1 (10)	2 (3.5)	
Medical complexity,[b] n (%)			0.4
No chronic disease	9 (90)	39 (68)	
Noncomplex chronic disease	0 (0)	10 (18)	
Complex chronic disease	1 (10)	8 (14)	

IQR = interquartile ratio; PICU = pediatric intensive care unit.
[a] Patients ≤18 years of age with 1+ emergency department visit with 1) 1+ croup diagnosis within 24 h after presentation and 2) 1+ positive SARS-CoV-2 polymerase chain reaction laboratory assessment ±3 days from presentation.
[b] Defined using the Pediatric Medical Complexity Algorithm (8).

clinical characteristics and disease course of a pediatric case series of COVID-19–associated croup from a multicenter hospital system in a large urban center during the COVID-19 pandemic in New York City.

METHODS

We conducted a cross-sectional study of patients ≤18 years old who presented to 3 affiliated urban pediatric emergency departments (EDs) during the COVID-19 pandemic. This study was approved by the Weill Cornell Medicine Institutional Review Board. Data were extracted from the Weill Cornell Medicine COVID-19 Institutional Data Repository, which aggregates data on patients tested for SARS-CoV-2 from electronic health records of NewYork-Presbyterian/Weill Cornell Medical Center (5). Patients were divided into pre-Omicron (March 1, 2020–December 1, 2021) and Omicron waves (December 2, 2021–February 15, 2022). Cohort date ranges were selected based on the prevalence of SARS-CoV-2 variants as reported by the New York City Department of Health and Mental Hygiene data (6). We included ED patients with a croup diagnosis within 24 h of presentation (*International Classification of Diseases, 10th revision* codes J05.0, R06.1, 464.2, and J04.2), and a positive nasopharyngeal reverse transcription polymerase chain reaction SARS-CoV-2 test within 3 days of presentation (7). Repeat visits within 3 days of a previous visit were considered a single clinical course. Abstracted data were corroborated with manual chart review. We reported patient demographic and clinical characteristics, including age, sex, race, ethnicity, vaccination status, and medical complexity as defined using the Pediatric Medical Complexity Algorithm (8). We also reported clinical outcomes such as disposition, medication administration, and need for respiratory support.

Please cite this article as: N. Narayanan et al., COVID-19 CROUP IS OBSERVED IN OLDER CHILDREN DURING THE OMICRON WAVE IN NEW YORK CITY, Journal of Emergency Medicine, https://doi.org/10.1016/j.jemermed.2022.09.036

Table 2. Clinical Characteristics of Patients With Croup[a] During the Omicron Wave

Characteristic	<6 mo, n = 2	3 y to <6 y, n = 10	6 mo to <3 y, n = 34	6 y to <12 y, n = 11
Median age, years (IQR)	0.00 (0.00–0.00)	4.00 (4.00–5.00)	1.00 (1.00–2.00)	8.00 (6.50–9.00)
Vaccines, n (%)				
0	2 (100)	7 (70)	34 (100)	5 (45)
1	0 (0)	2 (20)	0 (0)	1 (9.1)
2	0 (0)	1 (10)	0 (0)	5 (45)
History of croup, n (%)	0 (0)	4 (40)	3 (8.8)	4 (36)
Steroid, n (%)	2 (100)	10 (100)	33 (97)	11 (100)
Racemic epinephrine, n (%)	1 (50)	2 (20)	13 (38)	8 (73)
Racemic epinephrine doses, n (%)				
1	0 (0)	2 (100)	6 (46)	7 (88)
2	0 (0)	0 (0)	5 (38)	0 (0)
3	1 (100)	0 (0)	1 (7.7)	0 (0)
4	0 (0)	0 (0)	0 (0)	1 (12)
5	0 (0)	0 (0)	1 (7.7)	0 (0)
Intramuscular epinephrine, n (%)	0 (0)	1 (10)	0 (0)	1 (9.1)
Respiratory support, n (%)	0 (0)	0 (0)	2 (5.9)	1 (9.1)
Admitted, n (%)	1 (50)	2 (20)	8 (24)	1 (9.1)
Admission location				
Floor	1 (100)	2 (100)	7 (88)	0 (0)
ICU	0 (0)	0 (0)	1 (12)	1 (100)
Median inpatient LOS, days (IQR)	1.10 (1.10–1.10)	0.90 (0.50–2.15)	1.20 (1.10–2.60)	1.50 (1.50–1.50)
Median ICU LOS, days (IQR)	NA	NA	4.10 (4.10–4.10)	NA

ICU = intensive care unit; IQR = interquartile ratio; LOS = length of stay; NA = not available.
[a] Patients ≤18 years of age with 1+ emergency department visit with (1) 1+ croup diagnosis within 24 h after presentation and (2) 1+ positive SARS-CoV-2 polymerase chain reaction laboratory assessment ±3 days from presentation.

RESULTS

Our cohort included 1751 pediatric patients in the ED who tested positive for SARS-CoV-2, of which 865 (49%) were during the Omicron wave. We identified 67 of these children with croup; 10 (15%) in the pre-Omicron period and 57 (85%) during the Omicron wave. The prevalence of croup among COVID-19–positive children increased by a factor of 5.8 (prevalence ratio = 5.8, 95% confidence interval 3.0–11.4) during the Omicron wave compared with the pre-Omicron period. Table 1 describes patient demographics and disposition. The median age was similar for both groups, but more patients ≥6 years of age were in the Omicron group (0 vs. 19%). Most patients were not hospitalized (80% in pre-Omicron vs. 77% in Omicron wave). Comprehensive viral testing was performed in 34% of patients with croup, with only 4 coinfections noted.

Table 2 describes the clinical characteristics of the 57 patients with croup in the Omicron wave.

The majority affected were <3 years of age (61%), and 19% were ≥6 years of age. All patients ≥6 years of age presented during the Omicron period. Though most children received steroids, more patients ≥6 years of age received racemic epinephrine, suggesting a more severe initial presentation with stridor at rest than in younger children (73% vs. 35%). No patients were given remdesivir. The most severe case was a 10-year-old who required multiple doses of racemic and intramuscular epinephrine, oxygen, and admission to the intensive care unit. Most older patients (64%), including the aforementioned patient, had no history of croup. All of these patients demonstrated significant improvement in their stridor with ED intervention and no additional work-up, such as radiography, otolaryngology consult, or laryngoscopy was performed. In this ≥6 years of age group,

Please cite this article as: N. Narayanan et al., COVID-19 CROUP IS OBSERVED IN OLDER CHILDREN DURING THE OMICRON WAVE IN NEW YORK CITY, Journal of Emergency Medicine, https://doi.org/10.1016/j.jemermed.2022.09.036

in which all patients were eligible for the COVID-19 vaccine, only 45% were fully vaccinated with 2 doses.

DISCUSSION

We found an increased prevalence of croup during the COVID-19 Omicron wave, notably among an older cohort of children than were affected in the pre-Omicron period. Most older children had no history of croup and were undervaccinated for COVID-19. Although few patients were hospitalized, most required steroids and racemic epinephrine, suggesting a more severe ED presentation than in younger children.

The association of the Omicron variant and croup has been previously described (2,9). We identified an older subgroup of croup patients who, historically, have rarely been affected (3). Animal models have demonstrated the Omicron variant's predilection for the upper respiratory tract compared with lung parenchyma (10). This variant has also been associated with acute odynophagia and severe sore throat in adults (11). It is unclear whether the variant's direct effects on the upper airways or a host inflammatory response accounts for the clinical presentation of croup in this unusual age group. Further investigations are needed to understand the mechanisms driving this association.

Limitations

The study is limited by its small sample size and data from a single urban health care system. Although we cannot confirm the SARS-CoV-2 variant causing infection, the time periods in this study were based on New York City Omicron variant testing (6). The impact of viral coinfection is unclear because of a lack of comprehensive viral testing. In addition, our database may not have captured all vaccination data external to our hospital system.

CONCLUSIONS

In summary, we found an increased prevalence of COVID-19–associated croup during the Omicron wave atypically affecting older children. COVID-19–associated croup should now be considered in the differential diagnosis of older children presenting with stridor. Further investigation is needed to elucidate the pathophysiology of COVID-19–associated croup to assist with diagnosis and management of these children.

ACKNOWLEDGMENTS

This work was supported by the RTW Charitable Foundation and by NewYork-Presbyterian Hospital and Weill Cornell Medical College, including the Clinical and Translational Science Center (UL1 TR000457) and Joint Clinical Trials Office. The RTW Charitable Foundation, NewYork-Presbyterian Hospital, and Weill Cornell Medical College had no role in the design and conduct of the study. N.N., K.A., and D.L. conceptualized and designed the study, coordinated and supervised data collection, drafted the initial manuscript, and reviewed and revised the manuscript. S.L., W.S., and A.W. designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript. S.R., E.A., Z.G., and J-Y.H. conceptualized and designed the study and critically reviewed the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

REFERENCES

1. Menni C, Valdes AM, Polidori L, et al. Symptom prevalence, duration, and risk of hospital admission in individuals infected with SARS-CoV-2 during periods of omicron and delta variant dominance: a prospective observational study from the ZOE COVID Study. Lancet 2022;399:1618–24.
2. Brewster RCL, Parsons C, Laird-Gion J, et al. Covid-19-associated croup in children. Pediatrics 2022;149.
3. Johnson DW. Croup. BMJ Clin Evid 2014;2014:0321.
4. Smith DK, McDernott AJ, Sullivan JF. Croup: diagnosis and management. Am Fam Physician 2018;97:575–80.
5. Sholle ET, Kabariti J, Johnson SB, et al. Secondary Use of Patients' Electronic Records (SUPER): an approach for meeting specific data needs of clinical and translational researchers. AMIA Annu Symp Proc 2018;2017:1581–8.
6. NYC.gov. COVID-19-data, variants. Available at: https://www1.nyc.gov/site/doh/covid/covid-19-data-variants.page. Accessed April 22, 2022.
7. Hanna J, Brauer PR, Morse E, Berson E, Mehra S. Epidemiological analysis of croup in the emergency department using two national datasets. Int J Pediatr Otorhinolaryngol 2019;126.
8. Simon TD, Haaland W, Hawley K, Lambka K, Mangione-Smith R. Development and validation of the Pediatric Medical Complexity Algorithm (PMCA) version 3.0. Acad Pediatr 2018;18:577–80.
9. Tunç EM, Shin CKJ, Usoro E, et al. Croup during the coronavirus disease 2019 Omicron variant surge. J Pediatr 2022;247:147–9. Q2
10. Hui KP, Ho JC, Cheung M-chun, et al. SARS-COV-2 Omicron variant replication in human bronchus and lung ex vivo. Nature 2022;603:715–20.
11. Piersiala K, Kakabas L, Bruckova A, Starkhammar M, Cardell LO. Acute odynophagia: a new symptom of COVID-19 during the SARS-CoV-2 Omicron variant wave in Sweden. J Intern Med 2022;292:154–61.

Please cite this article as: N. Narayanan et al., COVID-19 CROUP IS OBSERVED IN OLDER CHILDREN DURING THE OMICRON WAVE IN NEW YORK CITY, Journal of Emergency Medicine, https://doi.org/10.1016/j.jemermed.2022.09.036

ARTICLE SUMMARY

1. Why is this topic important?

Understanding how COVID-19 affects children is important, as is understanding the changing clinical landscape as new variants of the virus emerge. The Omicron variant of SARS-CoV-2 appears to cause croup in older children in which the disease rarely presents.

2. What does this study attempt to show?

This study describes the clinical characteristics and disease course of a pediatric case series of COVID-19 croup from a multicenter hospital system in a large urban center during the COVID-19 pandemic in New York City.

3. What are the key findings?

Children ≥6 years of age, in which croup is typically rare, presented with croup during the Omicron wave of SARS-CoV-2. Most of this older cohort required steroids and racemic epinephrine, suggesting a more severe ED presentation than in younger children.

4. How is patient care impacted?

COVID-19–associated croup should now be considered in the differential diagnosis of older children presenting with stridor and/or respiratory distress.

Please cite this article as: N. Narayanan et al., COVID-19 CROUP IS OBSERVED IN OLDER CHILDREN DURING THE OMICRON WAVE IN NEW YORK CITY, Journal of Emergency Medicine, https://doi.org/10.1016/j.jemermed.2022.09.036