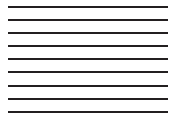




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Original Contributions

Use of an Asymptomatic COVID-19 Testing Protocol in a Pediatric Emergency Department

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Abstract—Background: High rates of asymptomatic infections with COVID-19 have been reported. **Objective:** We aimed to describe an asymptomatic COVID-19 testing protocol in a pediatric emergency department (ED). **Methods:** This was a retrospective cohort study of pediatric patients (younger than 18 years) who were tested for COVID-19 via the asymptomatic testing protocol at a single urban pediatric ED between May 2020 and January 2021. This included all pediatric patients undergoing admission, urgent procedures, and psychiatric facility placement. The primary outcome was the percentage of positive COVID-19 tests. COVID-19 testing was performed via real-time polymerase chain reaction RNA assay testing. County-level COVID-19 data were used to estimate local daily COVID-19 cases/100,000 individuals (from all ages). Data were described with simple descriptive statistics. **Results:** There were 1459 children tested for COVID-19 under the asymptomatic protocol. Mean \pm standard deviation age was 8.2 ± 5.8 years. Two tests were inconclusive and 29 (2.0%; 95% confidence interval [CI] 1.3–2.8%) were positive. Of the 29 positive cases, 14 (48%; 95% CI 29–67%) had abnormal vital signs or signs and symptoms of COVID-19, on retrospective review. A total of 15 truly asymptomatic infections were identified. On the days that asymptomatic cases were identified, the lowest average daily community rate was 7.67 cases/100,000 individuals. **Conclusions:** Asymptomatic COVID-19 positivity rates in the pediatric ED were low when the average daily

community rate was fewer than 7.5 cases/100,000 individuals. In the current pandemic, ED clinicians should assess for signs and symptoms of COVID-19, even when children present to the ED with unrelated chief symptoms. © 2022 Published by Elsevier Inc.

Keywords—COVID-19; SARS-CoV-2; Asymptomatic; Public health; Pediatrics; Emergency medicine

Introduction

As of January 2022, more than 293 million cases of COVID-19 have been reported globally, with children comprising an estimated 13% of all cases in some regions (1,2). Diagnosing COVID-19 in children is notoriously difficult, owing to the heterogeneous symptomatology elicited by the virus in this population (3). The rate of asymptomatic SARS-CoV-2 infection in all patients is estimated to be between 1.6% and 56.5% (4–6). Asymptomatic carriage may be more common in high-endemicity regions (5,7). Asymptomatic transmission is thought to be an important mechanism of viral dissemination, as there often exists a delay in SARS-CoV-2 polymerase chain reaction (PCR) RNA positivity and symptom onset, with one study suggesting that 44% of

new cases occur after exposure to an asymptomatic individual (8,9). The infection reproductive number, R_0 , which represents the average number of new individuals an infected individual will in turn infect, was estimated at 2.2–2.7 during the early COVID-19 pandemic (10,11). However, SARS-CoV-2 asymptomatic spread has been implicated in why R_0 estimates from the early pandemic did not sufficiently explain the rampant spread of the virus; new studies indicate that the R_0 may be twice as high as initially predicted ($R_0 = 5.7$; 95% confidence interval [CI] 3.8–8.9) (12). With an R_0 of 5.7, the threshold for “herd immunity” is $> 82\%$ of the population (12). As of January 2022, only 62.3% of the U.S. population had been fully vaccinated (13). Even with an aggressive U.S. national vaccination campaign, it may be several months before this goal is realized (14). In the interim, continued epidemiological surveillance will be essential to identifying asymptomatic infections and controlling the spread of the virus.

Children may be important vectors of asymptomatic disease due to the logistical difficulties of mask wearing in younger children, as well as a perceived lower risk of transmission (15). As such, identifying asymptomatic children represents a key opportunity to control the spread of the virus. With many ambulatory care settings being closed temporarily, or having moved to telemedicine visits, the emergency department (ED) has become integral in the delivery of COVID-19–related care in many communities.

Previous studies have found that between 4% and 28% of pediatric patients with documented SARS-CoV-2 infections were asymptomatic (3,16–19). However, few studies have reported rates of SARS-CoV-2 positivity in an asymptomatic pediatric population (6). In the present study, we aimed to describe screening for COVID-19 in asymptomatic pediatric patients in the ED, and sought to describe the clinical characteristics of positive cases that were identified via asymptomatic testing.

Materials and Methods

Study Design and Setting

This was a retrospective cohort study of data from the University of California Health system’s electronic health record. This study was approved by the study site’s Institutional Review Board. The study site is an urban, level I trauma center and tertiary referral center with an annual pediatric ED volume of 16,000 patients. The study site resides in a county with a population of 1,527,718 people. We included all pediatric (i.e., younger than 18 years) ED patients who had a COVID-19 test ordered under the site’s asymptomatic screening protocol, either in the ED

or within 24 h of admission from the ED. Data were collected from May 1, 2020 to January 31, 2021.

Overview of the Pediatric Asymptomatic Testing Protocol

The asymptomatic testing protocol was established due to concerns that SARS-CoV-2 infections would be difficult to control in the close living environments of psychiatric hospitals. The study site wanted to ensure patients did not have COVID-19 before transfer to these facilities. The program was later expanded to include testing for all patients admitted to the hospital from the ED, all patients awaiting placement in other close living environments (i.e., skilled nursing facility, jail, or other congregate living facility), and patients undergoing procedures. All patients undergoing asymptomatic testing were required to wear surgical masks, and all ED providers were also required to wear surgical masks. At the time of test ordering, the provider was required to enter the indication for asymptomatic testing, including “other.” Test samples were obtained by nasopharyngeal swabbing and samples underwent detection of SARS-CoV-2 using a reverse transcriptase PCR assay. Two assays were used during the study period including a high-throughput platform (Cobas 6800; Roche Diagnostics) and a medium-throughput platform (BDMax; Becton Dickinson). Both assays were sanctioned by the U.S. Food and Drug Administration’s Emergency Use Authorization and validated for use with nasopharyngeal swab samples.

Measurements and Key Outcome Measures

For each patient meeting eligibility criteria, the following data were explicitly defined and collected from the electronic health record: age, sex, Emergency Severity Index (ESI) triage criteria, triage vital signs, indication for asymptomatic COVID-19 testing, COVID-19 test result, and admission team. ESI is a triage scheme that stratifies patients into 5 categories from 1 (most severe) to 5 (least severe) (20). Data on history of sick contacts or recent COVID-19 exposure were not available. The primary outcome measure was COVID-19 test result (i.e., positive or negative).

In patients with positive test results, clinical data were abstracted. These data included signs or symptoms of possible COVID-19 infection (as defined by the Centers for Disease Control and Prevention) (21). Additional data abstracted included vital signs, chest radiography results, infectious diseases service consultation, administration of COVID-19–specific therapy and COVID-19–related complications. The study followed methodological recommendations for retrospective studies when appropriate (22).

Table 1. Characteristics of Pediatric Patients Tested under the Asymptomatic Pathway.

Characteristic	Negative Test (n = 1428)	Positive Test (n = 29)
Age, y	8.2 ± 5.8	8.7 ± 5.9
Sex, male	804 (56); 54–59	16 (55); 36–74
Indication for test*		
Admission	996 (70); 68–73	17 (59); 39–76
Pre-procedural	269 (19); 17–21	9 (31); 15–51
Psychiatric hold	89 (6); 5–8	1 (3); 0.1–18
Placement	14 (1); 0.5–2	2 (7); 0.9–23
Other	49 (3); 3–5	0
Emergency Severity Index triage category*		
1	113 (8); 7–10	2 (7); 0.9–24
2	721 (53); 50–56	15 (54); 34–72
3	464 (34); 32–37	9 (32); 16–52
4	57 (4); 3–5	2 (7); 0.9–24
5	3 (0.2); 0–0.6	0
Abnormal vital signs*		
Fever	56 (4); 3–5	1 (4); 0.1–18
Tachycardia	438 (31); 28–33	7 (24); 10–44
Tachypnea	104 (7); 6–9	2 (7); 0.8–23
Hypoxia	28 (2); 1–3	0 (0); 0.1–18
Any abnormal vital sign	514 (36); 33–38	7 (24); 10–44

Continuous variables are presented as mean ± standard deviation and categorical variables are presented as n (%); 95% confidence interval. Two patients had inconclusive test results and are not included in this table.

* Data missing in 11 cases for indication for test, 71 cases for Emergency Severity Index triage category, 14 cases for fever, 3 cases for tachycardia, 14 cases for tachypnea, and 3 cases of hypoxia.

Any patients found to have any signs or symptoms of COVID-19 on retrospective analysis were later reclassified as symptomatic. Additionally, because abnormal vital signs (e.g., hypoxia, tachycardia, and fever) could be plausibly related to an occult COVID-19 infection, patients with abnormal vital signs were also retrospectively reclassified as symptomatic. Tachycardia was defined by age as follows: 0–1 years, heart rate (HR) > 160 beats/min; 1–6 years, HR > 130 beats/min; 7–12 years, HR > 110 beats/min; and older than 12 years, HR > 100 beats/min. Fever was defined as an initial temperature > 38.0°C. Tachypnea was defined by age as follows: 0–1 year, respiratory rate (RR) > 50 breaths/min; 1–12 years of age, RR > 30 breaths/min; and older than 12 years, RR > 25 breaths/min (23). Hypoxia was defined as an oxygen saturation < 92%. Signs and symptoms of possible COVID-19 infection included any of the following: fever (subjective or objective), chills, cough, shortness of breath, fatigue, myalgias, headache, loss of taste or smell, sore throat, nasal congestion, runny nose, or diarrhea (21).

County-level COVID-19 data were collected from the Sacramento County Public Health Epidemiology COVID-19 Dashboards. Daily COVID-19 rates were calculated by taking the number of positive daily cases

divided by the estimated Sacramento County population as of January 1, 2020 (n = 1,555,365) (24,25). The community COVID-19 rate was calculated as a 7-day daily average (Sunday through Saturday). A daily average was necessary to provide a more accurate representation of COVID-19 positivity in the community, as COVID-19 testing availability varied by day of the week (many Sacramento County COVID-19 testing locations were closed on Saturday and Sunday). Data regarding the county of residence for individual patients were not available.

Data Analysis

Data were described with simple descriptive statistics. Continuous data were described with mean ± 1 standard deviation (SD) and 95% CIs were presented when appropriate. Data analysis was conducted using Stata 15 (StataCorp, 2017).

Results

A total of 1,459 pediatric ED patients were tested for COVID-19 under the asymptomatic testing protocol. The

Table 2. Signs and Symptoms Missed During Initial Evaluation in Patients Who Were Tested Under the Asymptomatic Protocol but Who Were Later Reclassified as Symptomatic

Signs and Symptoms	n*
Fever	3
Tachycardia	7
Tachypnea	2
Cough	2
Fatigue	3
Diarrhea	3
Headache	4
Nasal discharge	1

* 14 patients who were initially screened under the asymptomatic protocol were later found to have symptoms. Some patients had more than one sign or symptom.

mean \pm SD age of patients was 8.2 ± 5.8 years and 56% (n = 820) of patients were male. The most common indication for asymptomatic testing was hospital admission (70%, n = 1,011). Full patient characteristics, stratified by COVID-19 test result, are available in [Table 1](#).

A total of 29 patients (2.0%; 95% CI 1.3–2.8%) tested positive for COVID-19. Two patients had inconclusive test results. Patients' sex and age were similar between those who tested positive for COVID-19 and those who tested negative. Of the 29 positive patients, upon retrospective review, 14 (48%; 95% CI 29–67%) had signs or symptoms of COVID-19, abnormal vital signs, or altered mental status, indicating that the patient was not truly asymptomatic (Table 2). One patient was on total parenteral nutrition and thus potentially immunocompromised, otherwise no patient was considered high risk for COVID-19. SARS-CoV-2 S1/S2 IgG antibody testing was negative in the single patient who was tested. In COVID-19-positive children who were found to be symptomatic on retrospective analysis, chest radiography was performed in 11 patients (38% of all positives; 95% CI 21–58%) and was abnormal in 4 patients (14%; 95% CI 4–32%). Findings on chest radiography included small airway disease, consolidation or opacity, pleural effusion, and ground glass attenuation. The pediatric infectious diseases service was consulted for a single patient admitted for wound care. This patient subsequently required supplemental oxygen and was treated with i.v. immunoglobulin and steroids (solumedrol followed by a prednisone taper) for possible multisystem inflammatory syndrome in children. No patients in the asymptomatic testing protocol died.

The weekly average community COVID-19 infection rate ranged from 0.4 to 57.3 cases/100,000, with the

largest spikes in positive cases occurring mid-June 2020 to September 2020 and between late November 2020 and early January 2021 ([Figure 1](#)) (24). No asymptomatic positive cases occurred when the weekly average community rate was fewer than 7.67 cases/day per 100,000 residents.

Discussion

As data continue to emerge on the asymptomatic transmissibility of SARS-CoV-2, the necessity of establishing testing protocols to identify these cases is paramount in preventing inpatient disease outbreaks. In this study, we describe the largest cohort, to our knowledge, of asymptomatic pediatric COVID-19 testing in the ED.

In one multicenter study, 3.7% of asymptomatic patients (10 of 264) who were tested for SARS-CoV-2 were positive (6). In one large German study conducted during a time period similar to our study, COVID-19 positivity for all asymptomatic children who were admitted or underwent hospital procedures was 0.4% (26). During our 9-month study period, 2% of patients (29 of 1459) tested via the asymptomatic testing protocol were found to be positive, however, on further review, only 1% of patients (15 of 1549) were truly asymptomatic. However, because the asymptomatic protocol only tested children who were being admitted, undergoing an urgent procedure, or were being placed in another inpatient setting (i.e., psychiatric facility or detention facility), our positivity rate may not represent the asymptomatic rate of children from the surrounding community. The high rate of symptomatic or asymptomatic misclassification among COVID-19-positive patients highlights the difficulty in assessing symptomatology in pediatric populations. If these patients had not been tested, their infection status likely would have remained unknown, posing a nosocomial infection risk to health care staff and other patients.

During the study period, there were two large spikes in case positivity in Sacramento County, which occurred between mid-June 2020 and late September 2020 (7-day rolling average positivity rate range 5–8.4%) and between early November 2020 and late January 2021 (7-day rolling average positivity rate range 5–11.9%) (27). The magnitudes of these spikes in SARS-CoV-2 test positivity were similar to those seen in the national data over the same time frames, suggesting that the study institution resided in a moderate-endemicity region during the study period (28). In our study, most of the asymptomatic cases occurred during these local spikes in SARS-CoV-2 positivity, and no asymptomatic cases were identified when the case rate was fewer than 7.67/day per 100,000 or when overall local test positivity was < 3.3% (24,27). However, the local case rate was > 7.67/day per 100,000 most of our study, so low asymptomatic positivity during this time period may be due to sampling bias. These data suggest

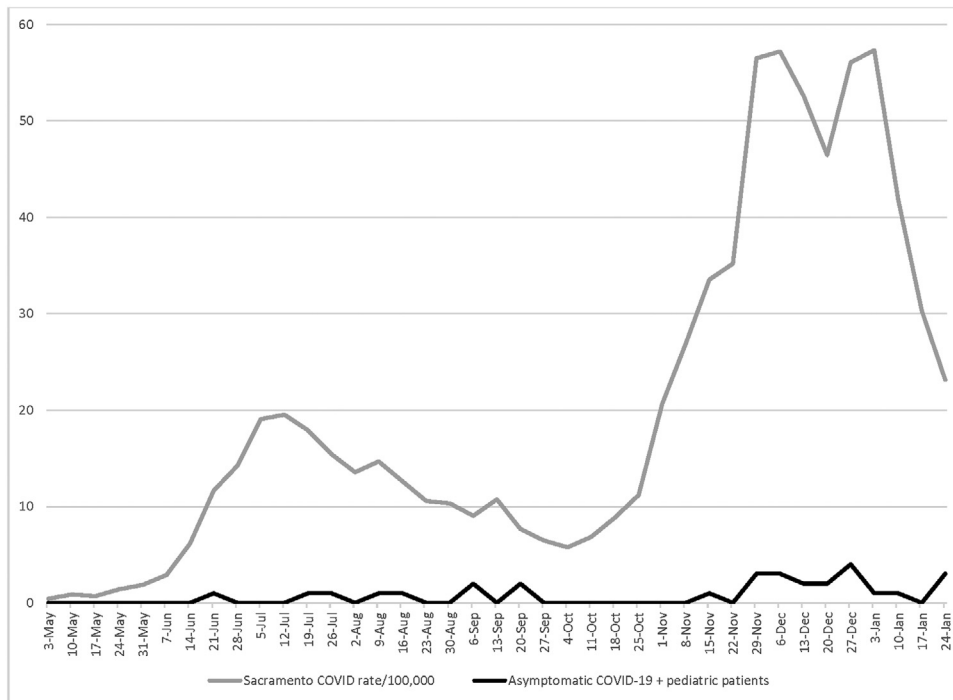


Figure 1. Rate of asymptomatic pediatric emergency department patients with COVID-19 compared with the community rate (May 2020–January 2021).

that the risk of asymptomatic infection appears correlated with local disease burden. It also may provide guidance for asymptomatic testing when testing resources are limited.

Limitations

The present study must be interpreted in the setting of its limitations. As this was a single-center study, our results may not be generalizable to other settings. Our study provides data from a moderate-endemicity region, so may not reflect the asymptomatic testing conditions of low- or high-endemicity regions. This study was retrospective and limited by the data available in the electronic health record and subject to the limitations of a retrospective study. As the data were digitally abstracted from the electronic health record, we minimized errors in manual data abstraction. Thresholds for considering vital signs abnormal were liberal. Using more conservative vital sign thresholds would have increased the number of children with abnormal vital signs and likely decreased the total number of truly asymptomatic cases.

Conclusions

Although the overall prevalence of asymptomatic SARS-CoV-2 infections was low, an asymptomatic screening protocol detected unknown infections in patients, includ-

ing those who ED providers misclassified as asymptomatic. The rate of asymptomatic SARS-CoV-2 infections may be correlated with local prevalence of disease.

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ARTICLE SUMMARY

1. Why is this topic important?

High rates of asymptomatic infections with COVID-19 have been reported, and asymptomatic transmission is thought to be an important mechanism of viral dissemination.

2. What does this study attempt to show?

This study attempts to demonstrate the utility of a COVID-19 asymptomatic screening protocol in a pediatric emergency department.

3. What are the key findings?

Both truly asymptomatic and symptomatic patients thought to be asymptomatic were identified using the testing protocol.

4. How is patient care impacted?

Asymptomatic testing protocols for patients with inpatient dispositions can help prevent placing infected patients in communal living spaces, potentially avoiding nosocomial transmission.