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Delayed presentation and sub-optimal outcomes of pediatric patients with acute appendicitis during the COVID-19 pandemic

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ABSTRACT

Objective: Early presentation and prompt diagnosis of acute appendicitis are necessary to prevent progression of disease leading to complicated appendicitis. We hypothesize that patients had a delayed presentation of acute appendicitis during the COVID-19 pandemic, which affected severity of disease on presentation and outcomes.
Patients and methods: We conducted a retrospective review of all patients who were treated for acute appendicitis at Morgan Stanley Children's Hospital (MSCH) between March 1, 2020 and May 31, 2020 when the COVID-19 pandemic was at its peak in New York City (NYC). For comparison, we reviewed patients treated from March 1, 2019 to May 31, 2019, prior to the pandemic. Demographics and baseline patient characteristics were analyzed for potential confounding variables. Outcomes were collected and grouped into those quantifying severity of illness on presentation to our ED, type of treatment, and associated post-treatment outcomes. Fisher's Exact Test and Kruskal-Wallis Test were used for univariate analysis while cox regression with calculation of hazard ratios was used for multivariate analysis.
Results: A total of 89 patients were included in this study, 41 patients were treated for appendicitis from March 1 to May 31 of 2019 (non-pandemic) and 48 were treated during the same time period in 2020 (pandemic). Duration of symptoms prior to presentation to the ED was significantly longer in patients treated in 2020, with a median of 2 days compared to 1 day ($p = 0.003$). Additionally, these patients were more likely to present with reported fever (52.1% vs 24.4%, $p = 0.009$) and had a higher heart rate on presentation with a median of 101 beats per minute (bpm) compared to 91 bpm ($p = 0.040$). Findings of complicated appendicitis on radiographic imaging including suspicion of perforation (41.7% vs 9.8%, $p < 0.001$) and intra-abdominal abscess (27.1% vs 7.3%, $p = 0.025$) were higher in patients presenting in 2020. Patients treated during the pandemic had higher rates of non-operative treatment (25.0% vs 7.3%, $p = 0.044$) requiring increased antibiotic use and image-guided percutaneous drain placement. They also had longer hospital length of stay by a median of 1 day ($p = 0.001$) and longer duration until symptom resolution by a median of 1 day ($p = 0.004$). Type of treatment was not a predictor of LOS (HR = 0.565, 95% CI = 0.357–0.894, $p = 0.015$) or duration until symptom resolution (HR = 0.630, 95% CI = 0.405–0.979, $p = 0.040$).
Conclusion: Patients treated for acute appendicitis at our children's hospital during the peak of the COVID-19 pandemic presented with more severe disease and experienced suboptimal outcomes compared to those who presented during the same time period in 2019.
Level of Evidence: III

Acute appendicitis is one of the most common abdominal emergencies affecting pediatric patients, accounting for 60,000–80,000 pediatric admissions in the United States per year [1–4]. Perforation of the appendix is a commonly associated complication with rates ranging from 10%

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-75% depending on the age of the patient population, with some studies noting 100% perforation in patients younger than 1 year of age [2,4–6]. Patients with perforated appendicitis have an increased risk of peritonitis, abscess formation, sepsis, wound infection, and bowel obstruction. Although multiple factors have been attributed to an increased risk of perforation, delayed diagnosis and therefore longer duration of symptoms before treatment is most often associated with the time-dependent progression from appendiceal inflammation to rupture [2–4,7–9].

Delay in diagnosis is typically more common in younger patients due to an inability to adequately describe their symptoms. Additionally, several non-surgical conditions such as constipation and gastroenteritis can mimic the symptoms of appendicitis, resulting in misdiagnosis and delay in treatment. Recently, it is believed that fear of traveling outside of the home during the pandemic and fear of contracting COVID-19 in the hospital setting has led to delay in seeking medical care, resulting in more complicated presentations of common pediatric pathologies [10,11]. In this study we present our experience with treating acute appendicitis in pediatric patients during the peak of the COVID-19 outbreak in New York City (NYC) and highlight the importance of providing patients with continued access to medical care during a pandemic when resources are limited and fear of infection is heightened. Institutional review board (IRB) approval was obtained for this study.

1. Patients and methods

1.1. Patient selection

Patients age 18 years and younger who were treated for acute appendicitis at Morgan Stanley Children's Hospital (MSCH) between March 1, 2020 and May 31, 2020 were compared to a cohort of appendicitis patients from March 1, 2019 and May 31, 2019. The first case of COVID-19 in NYC was diagnosed on March 1, 2020, with significant numbers of cases treated throughout May 2020. Presentation and outcomes of patients with acute appendicitis who were treated at our children's hospital during the peak of the COVID-19 pandemic were compared to those of patients treated during corresponding months in 2019, when there was no pandemic. Patients who were confirmed positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) during their presentation for appendicitis were excluded from this study as treatment algorithms differ for this patient population and the extent of gastrointestinal effects of the virus remain unknown. Our standard protocol for treatment of acute appendicitis consists of operative treatment for all non-perforated and for perforated appendicitis without abscess formation. Patients with abscess identified on radiographic imaging are treated non-operatively with antibiotics in addition to image-guided drain placement when accessible. We continued to follow our established treatment protocol during the pandemic for patients who were COVID-19 negative, which is the patient population studied in this retrospective review.

During the COVID-19 pandemic, pediatric care centers in the NewYork-Presbyterian (NYP) hospital system redirected the care of many pediatric patients to MSCH including all patients who required acute surgery or hospital admission out of the necessity to redirect resource availability for adult patients with COVID-19. Therefore, the pediatric appendicitis patients treated at our institution during the pandemic consisted of all pediatric patients with appendicitis within the NYP hospital system. In comparison, those treated for appendicitis in 2019 were most often patients who presented to our hospital directly.

1.2. Patient variables and outcomes

Demographic data and baseline patient characteristics were collected from patient charts, including patient's age, gender, race, body mass index (BMI), and other comorbidities. Collected outcomes were grouped into those quantifying severity of illness on presentation to our ED as well as type of treatment and associated post-treatment outcomes. Outcomes representing severity of illness on presentation include temperature, heart rate, mean arterial pressure (MAP), duration and type of symptoms before presentation, white blood cell count (WBC), suspected perforation, and diagnosis of intra-abdominal abscess on radiographic imaging. Treatment outcomes include type of treatment on initial presentation (operative vs non-operative), type of operative treatment (appendectomy only vs appendectomy and a course of antibiotics), and type of non-operative treatment (course of antibiotics only vs antibiotics and drain placement). Post-treatment outcomes consisted of diagnosis of perforation on pathology report, failure of non-operative treatment, post-operative complications, hospital length of stay (LOS) and number of days until symptom resolution. Non-operative failure and post-operative complications included return to the ED or need for readmission requiring antibiotics or drain placement on the subsequent presentation. Patients were grouped based on year of presentation and outcomes were compared between those treated in 2019 vs 2020.

1.3. Statistical analysis

Fisher's Exact Test was used to compare categorical variables while Kruskal-Wallis Test was used to compare continuous variables between the two groups of patients. Categorical variables are reported as frequency and percentage and continuous variables are reported as median with first and third quartile as well as overall range. A Kaplan–Meier curve was used to visualize the distribution for time to event outcomes while the log rank test was used to compare between groups. Multivariate analysis with hazard ratios calculated by cox regression was also performed.

2. Results

A total of 93 patients were treated for acute appendicitis at our institution between March 1 and May 31 of 2019 and 2020. Four patients who presented in 2020 tested positive for SARS-CoV-2 and were

Table 1
Demographic data and baseline clinical characteristics of pediatric patients presenting to Morgan Stanley Children's Hospital (MSCH) for acute appendicitis between March 1 and May 31 of 2019 and 2020. Median with first and third quartile as well as range are reported for continuous variables. Frequency and percentage are reported for categorical variables. p-Values from Fisher's exact test are reported for categorical variables while p-values from Kruskal-Wallis test are reported for continuous variables.

Demographic data				
Variable	2019 (N = 41)	2020 (N = 48)	Total (N = 89)	p-Value
Age (years)				0.153
-Median (Q1, Q3)	13.15 (8.36, 15.84)	11.07 (8.31, 14.08)	11.67 (8.34, 15.32)	
-Range	4.90–18.72	3.20–18.91	3.20–18.91	
Gender				0.071
-Female	17 (41.5%)	11 (22.9%)	28 (31.5%)	
-Male	24 (58.5%)	37 (77.1%)	61 (68.5%)	
Race				0.116
-N-miss	3	3	6	
-Hispanic/Latino	10 (26.3%)	22 (48.9%)	32 (38.6%)	
-African American	5 (13.2%)	4 (8.9%)	9 (10.8%)	
Asian				
-White	23 (60.5%)	19 (42.2%)	42 (50.6%)	
BMI				0.811
-N-miss	9	12	21	
-Median (Q1, Q3)	20.40 (17.08, 23.82)	19.60 (17.70, 21.73)	19.60 (17.08, 23.03)	
-Range	12.50–47.20	14.70–33.60	12.50–47.20	
Comorbidities				0.806
-No	30 (73.2%)	37 (77.1%)	67 (75.3%)	
-Yes	11 (26.8%)	11 (22.9%)	22 (24.7%)	

N-miss: number of patients for whom data is missing.

Table 2
Outcomes of pediatric patients presenting to Morgan Stanley Children's Hospital (MSCH) for acute appendicitis between March 1 and May 31 of 2019 and 2020. Median with first and third quartile as well as range are reported for continuous variables. Frequency and percentage are reported for categorical variables. p-Values from Fisher's exact test are reported for categorical variables while p-values from Kruskal-Wallis test are reported for continuous variables.

Outcomes			
Outcome	2019 (N = 41)	2020 (N = 48)	p-Value
Reported symptoms			
Abdominal pain			1.000
-Yes	41 (100.0%)	48 (100.0%)	
Fever			**0.009**
-No	31 (75.6%)	23 (47.9%)	
-Yes	10 (24.4%)	25 (52.1%)	
Nausea			1.000
-No	18 (43.9%)	20 (41.7%)	
-Yes	23 (56.1%)	28 (58.3%)	
Vomiting			0.268
-No	17 (41.5%)	14 (29.2%)	
-Yes	24 (58.5%)	34 (70.8%)	
Diarrhea			0.618
-No	30 (73.2%)	38 (79.2%)	
-Yes	11 (26.8%)	10 (20.8%)	
Decreased appetite			0.190
-No	29 (70.7%)	27 (56.2%)	
-Yes	12 (29.3%)	21 (43.8%)	
Duration of symptoms before presentation (Days)			**0.003**
-Median (Q1, Q3)	1.00 (1.00, 2.00)	2.00 (1.00, 4.00)	
-Range	0.50–10.00	0.50–14.00	
Findings on presentation			
Temperature			0.959
-Median (Q1, Q3)	37.15 (36.88, 37.53)	37.20 (36.85, 37.50)	
-Range	36.30–39.10	36.00–39.40	
Heart rate			**0.040**
-Median (Q1, Q3)	91.00 (79.50, 107.75)	101.00 (91.00, 113.50)	
-Range	64.00–131.00	69.00–148.00	
MAP			0.752
-Median (Q1, Q3)	82.00 (77.00, 87.50)	80.50 (76.00, 87.75)	
-Range	63.00–104.00	65.00–102.00	
WBC			0.099
-Median (Q1, Q3)	15.01 (11.20, 18.87)	17.79 (12.83, 20.45)	
-Range	3.78–31.00	5.71–30.90	
Suspicion for perforation on imaging			**< 0.001**
-No	37 (90.2%)	28 (58.3%)	
-Yes	4 (9.8%)	20 (41.7%)	
Abscess on imaging			**0.025**
-No	38 (92.7%)	35 (72.9%)	
-Yes	3 (7.3%)	13 (27.1%)	
Treatment			
Treatment on initial presentation			**0.044**
-Operative	38 (92.7%)	36 (75.0%)	
-Non-operative	3 (7.3%)	12 (25.0%)	
Type of non-operative treatment			0.505
-Antibiotics	3 (100.0%)	7 (58.3%)	
-Antibiotics and drain placement	0 (0.0%)	5 (41.7%)	
Type of operative treatment			**0.013**
-Appendectomy	33 (89.2%)	23 (63.9%)	
-Appendectomy and antibiotic course	4 (10.8%)	13 (36.1%)	
Post-treatment			
Failure of non-op treatment			1.000
-No	2 (66.7%)	6 (50.0%)	
-Yes	1 (33.3%)	6 (50.0%)	
Perforation on pathology			0.332
-No	36 (90.0%)	29 (80.6%)	
-Yes	4 (10.0%)	7 (19.4%)	
Post-operative complications			0.670
-No	36 (94.7%)	33 (91.7%)	
-Yes	2 (5.3%)	3 (8.3%)	
LOS (days)			**0.015**
-Median (Q1, Q3)	1.00 (1.00, 2.00)	2.00 (1.00, 7.00)	
-Range	0.50–9.00	0.50–22.00	
Number of days until symptom resolution			**0.003**
-Median (Q1, Q3)	1.00 (1.00, 2.00)	2.00 (1.00, 5.00)	
-Range	0.50–15.00	1.00–22.00	

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excluded. None of these four patients had respiratory symptoms, and all four were initially treated with non-operative management, with one patient requiring operative treatment on the same admission due to failed medical therapy. As a result, a total of 89 patients included in the study, 41 patients treated in 2019 and 48 treated in 2020. Demographic data and baseline characteristics of both groups of patients did not significantly differ, as seen in Table 1. Symptoms reported at presentation included fever, abdominal pain, nausea, vomiting, diarrhea and decreased appetite. Abdominal pain was reported in all patients while fever, nausea, vomiting and decreased appetite were more commonly reported in patients presenting in 2020, with fever being the only symptom significantly more prevalent (52.1% vs 24.4%, $p = 0.009$). Duration of symptoms prior to presentation to the ED was significantly longer in patients treated during the pandemic (median of 2 days vs 1 day, $p = 0.003$), with several patients waiting up to 14 days before seeking medical care. Additionally, heart rate on presentation was higher in patients in the 2020 group, with a median rate of 101 beats per minute (bpm) compared to 91 bpm in 2019 ($p = 0.040$). Although temperature and WBC were higher and MAP lower on presentation in 2020, these differences did not reach statistical significance.

As seen in Table 2, when comparing radiologic imaging results between patients diagnosed in 2019 and 2020, suspicion for perforation and diagnosis of an intra-abdominal abscess differed significantly. Suspicion for perforation on imaging was noted in 20 (41.7%) patients in 2020 compared to only 4 (9.8%) in 2019 ($p < 0.001$). Similarly, intra-abdominal abscess was diagnosed by radiologic imaging in 13 (27.1%) patients in 2020 compared to 3 (7.3%) in 2019 ($p = 0.025$).

Additionally, more patients received non-operative treatment during the pandemic compared to 2019 (25.0% vs 7.3%, $p = 0.044$). Of the 12 patients undergoing non-operative treatment in 2020, 5 (41.7%) patients required antibiotics and drain placement. A total of 6 (50.0%) patients returned to the ED for failure of treatment, 3 of which required drain placement on the second presentation. Conversely, in 2019, all 3 patients were treated with antibiotics alone with only 1 patient requiring an additional antibiotic course without drain placement. Of the patients undergoing operative treatment on initial presentation, 13 (36.1%) patients in 2020 required a course of antibiotics after their appendectomy compared to only 4 (10.8%) patients in 2019 ($p = 0.013$). Perforation confirmed on pathology was almost twice as prevalent in 2020, however this did not reach statistical significance. (19.4% vs 10.0%). Finally, LOS in days and number of days until reported symptom resolution after initial treatment were both significantly longer in patients treated during the pandemic ($p = 0.0012$ and $p = 0.0037$ respectively). After adjusting for type of treatment on initial presentation using cox model for these two outcomes, the year of treatment remained statistically significant for LOS (HR = 0.565, 95% CI = 0.357–0.894, $p = 0.015$) and duration until symptom resolution (HR = 0.630, 95% CI = 0.405–0.979, $p = 0.040$) as shown in Table 3.

Table 3
Multivariable cox regression analysis for length of stay and days until symptom resolution.

Length of stay			
Patient factors	**Hazard ratio**	**95% Confidence interval**	**p-Value**
Year (2020 vs 2019)	0.565	0.357–0.894	0.015
Type of Treatment (Non-operative vs Operative)	0.390	0.215–0.708	0.002
Days until symptom resolution			
Patient factors	**Hazard ratio**	**95% Confidence interval**	**p-Value**
Year (2020 vs 2019)	0.630	0.405–0.979	0.040
Type of treatment (Non-operative vs Operative)	0.438	0.242–0.791	0.006

3. Discussion

Appendicitis is a common indication for surgery in pediatric patients, with a lifetime risk of approximately 9% in males and 7% in females [12]. It is a time-sensitive condition with delayed diagnosis often leading to more severe disease including increased rates of perforation and intra-abdominal abscess formation [6,13]. Appendiceal perforation is associated with higher morbidity, increased postsurgical complications, as well as longer hospital LOS and higher rates of readmission. Additionally, roughly 20% of children with perforated appendicitis will develop a post-operative abscess compared to only 0.8% in those patients without perforation [14]. Delay in treatment due to misdiagnosis or delayed presentation increases the risk of perforation, with younger patients affected at higher rates due to the inability to adequately describe their pain as well as a higher incidence of generalized associated clinical symptoms which mimic nonsurgical diagnoses [15–19]. Socioeconomic factors also play a role in delayed presentation of pediatric patients as seeking medical care is dependent upon parents' knowledge of illness, availability of transportation, insurance status, and financial state [20,21].

During the peak of the pandemic, there were multiple additional sources of delay leading to more complicated presentations of acute appendicitis in pediatric patients of all ages. We hypothesize that the most significant source of delay was the fear of contracting COVID-19 in the hospital setting, resulting in parents delaying presentation to the ED. As discussed previously, several studies have described a fear that parents and patients have of presenting to the hospital during the COVID-19 pandemic, which may delay their time course to seek medical care. Lazzerini et al. found that pediatric emergency department (ED) visits in Italy were decreased during the peak of their COVID-19 outbreak by as much as 88% when compared to visits within the same time period in 2018 and 2019 [10]. Pediatric patients who presented to the ED during Italy's peak were noted to have overall worse outcomes while parents reported avoiding hospital care secondary to fear of infection with SARS-CoV-2. Additionally, Snapiri et al. reported on the experience of delayed diagnosis of acute appendicitis in pediatric patients in Israel during the pandemic, noting a complication rate twice as high (22% vs 11%) when compared to the same time period in 2019, with complications defined as perforation and abscess formation [11]. Although fear of contracting COVID-19 likely played a role, the delay in presentation is multifactorial. An increased reliance on outpatient care during a time when many clinics were not seeing patients most likely contributed to delays. Furthermore, as hospital systems were reaching capacity, a delay in presentation was created due to the need for transfer from one healthcare center to another.

At our institution, year of presentation correlated with increased severity of disease on presentation and higher rates of perforation and intra-abdominal abscess formation. Additionally, we noted increased use of antibiotics, longer LOS during initial admission, more frequent treatment failure or complications and longer duration until symptom resolution for patients treated during the pandemic. Our findings are consistent with current literature suggesting that delayed diagnosis is associated with higher incidence of complications [11,16–19]. As noted by Pham et al., pediatric patients with symptoms greater than 24 h were over five times more likely to have complicated appendicitis when compared to those with symptoms for 24 h or less [22]. Our data supports this as the median duration of symptoms before presentation for patients in 2019 was 1 day compared to 2 days in 2020, with 36.6% of patients in 2019 presenting after 24 h compared to 64.6% in 2020.

We suspect that delayed presentation during the pandemic affected the severity of disease on presentation, rates of non-operative management, and overall outcomes, which is supported by the recently published results from Italy, Israel and Colombia [10,11,23]. Although reported duration of symptoms before presentation is a subjective measure, our objective data shows that patients presented during the pandemic with more advanced disease, likely a result of delayed presentation to the ED. Post-operative outcomes including LOS and duration until symptom resolution may also be affected by type of treatment, with both outcomes often longer in patients treated non-operatively. For this reason, we excluded COVID positive patients from our analysis specifically to avoid confounding our results as our institutional practice was to treat COVID positive patients non-operatively. Although the management algorithm of acute appendicitis for COVID-negative patients was identical in 2020 to that provided in 2019, we suspect that surgeons may have been more inclined to treat appendicitis non-operatively during the pandemic - even in COVID-negative patients - independent of disease severity given the risk of false negative testing and viral transmission to healthcare workers in the operating room as well as to minimize hospital resource utilization. To take this into account, we performed a multivariate analysis adjusting for mode of treatment. LOS and number of days until symptom resolution remained significantly longer during the pandemic, further suggesting that the severity of disease patients presented with correlated with outcomes.

As hospitals and emergency departments were overwhelmed with COVID-19 patients and orders to stay at home were established, parents were understandably reluctant to seek medical care due to concern of contracting the virus in the hospital setting. Additionally, many outpatient clinics were temporarily closed to prevent spread of the virus as well as to better allocate resources to the hospitals, resulting in decreased ability to be evaluated by a primary care physician. Telemedicine has quickly been instituted as a means for providing healthcare while limiting exposure during the pandemic [24]. Although performing a physical exam is more challenging with telemedicine, as our comfort with virtual patient care continues to evolve, we will be able to better integrate telemedicine into our triage of patients. Fear of contracting COVID-19 and decreased access to outpatient clinics secondary to reallocation of resources experienced during the pandemic must be balanced with parent education of non-specific symptoms and the importance of seeking early medical care. Additionally, practitioners need to continue integrating a heightened awareness of this delay in presentation in their evaluation of children presenting with common symptoms that may be the forbearer of serious illness.

It is likely that COVID-19 will remain with us for some time and become a long-term presence that pervades all aspects of our patient care. We need to start thinking of strategies to quell patients' fear of healthcare institutions. This starts in the doctor's office or on the office's answering service, with evidence-based messages outlining the risks of contracting COVID in different hospital and non-hospital settings. As our understanding of the virus and its mode of transmission has improved, hospitals have instituted infection control measures and rapid testing that have shown to prevent nosocomial transmission of SARS-CoV-2 [25]. Systems-based strategies, with broad testing programs have already been implemented and need continued support from hospital administration. Local, state and federal government involvement will continue to be crucial, through the use of informative public service

announcements, efforts to improve access to care and funding for widespread testing and contact tracing.

Limitations of our study include those inherent to a retrospective review. In addition, although we do not believe that COVID-19 testing led to significant delays in time to OR, we cannot verifiably confirm that it did not impact timeliness. Initial COVID-19 testing took up to 8–12 h to result, however our institution quickly acquired rapid tests that would result within 1–2 h, which we do not believe contributed to any delays in treatment or time to operation. Furthermore, even during the time of early testing, the inherent delay associated with waiting for OR availability was likely more significant than the delay caused by testing. Another limitation of the study is that the follow up time for patients treated in 2020 is notably shorter than that of patients treated in 2019. Post-operative complications and non-operative failure rates in patients treated in 2019 have been collected over several months. However, data collected on patients treated between March and May of 2020 was collected in June, resulting in limited follow up time to obtain data on post-treatment outcomes with known readmission of patients treated during the pandemic since data collection ended. As previously mentioned, the NYP hospital system redirected the care of all of its pediatric patients to our institution during the pandemic. Although similar studies noted decreased total ED visits and diagnosis of common conditions during the pandemic, we are unable to compare the total number of patients diagnosed with appendicitis during the pandemic to those diagnosed during a similar time period in 2019 before the pandemic as we were unable to obtain patient data from each pediatric hospital during 2019. As a result, the total number of patients diagnosed in 2019 primarily represents those patients who would otherwise present directly to our institution, whereas the patient population in 2020 represents patients from all children's hospitals in the NYP system, contributing to the increased number of patients diagnosed with appendicitis in the designated timeframe in 2020. Finally, in order to compare two patient populations with similar baseline characteristics and similar type of treatment, we excluded COVID positive patients from the study. Although including COVID positive patients may reflect a more real world experience, we considered that their inclusion would introduce confounding variables into the statistical analysis and make it less rigorous. For this reason, we excluded these patients who received different treatment and may also have GI side effects from COVID itself.

Unfortunately, the number of patients included in our study was too small to examine the impact of socioeconomic background on time to presentation and outcomes. We suspect that patients with poorer access to healthcare, including virtual healthcare, were disproportionally impacted by the findings described in this study, as evidenced by prior studies. O'Toole et al. looked at socioeconomic and insurance-related differences in the presentation of acute appendicitis in pediatric patients and noted significantly higher duration of symptoms prior to presentation, increased rate of perforation, and longer hospital stay in both uninsured and Medicaid-covered patients as compared to patients with HMO or private insurance [20]. Similarly, in a study by Smink et al. involving 33,184 pediatric patients with appendicitis, perforated appendicitis disproportionately affected both children of minority race and those insured by Medicaid [21].

4. Conclusion

Pediatric patients who presented to the ED at our institution with appendicitis during the peak of the COVID-19 pandemic had higher rates of delayed presentation, more severe illness and worse outcomes when compared to patients presenting during the same months in 2019. We hypothesize that the fear of contracting COVID-19 in the hospital setting primarily led to our observed outcomes. Additionally, decreased access to outpatient care and increased need for transfer between healthcare centers likely also contributed to delayed presentation and treatment. The continued COVID-19 outbreak poses many challenges with trying to mitigate viral transmission while continuing to provide care for patients with other illnesses. Integrating telemedicine as an avenue for outpatient screening of patients for conditions requiring timely treatment may help decrease delay in presentation during a pandemic. Additionally, creating public service announcements guiding parents on the symptoms of appendicitis as well as the importance of contacting an established medical hotline or virtual provider for triage provides another resource for preventing delays. We must continue to advocate for our patients and create an environment in which they feel safe seeking medical care.

Declarations of competing interest

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