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Research Article

Withstanding the COVID19 pandemic - A tertiary children's hospital's commitment to equitable care

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Abstract

Introduction: The COVID-19 pandemic led to perceived increases in the rates of complicated appendicitis. Multiple studies have shown, both in adults and children, higher rates of complicated appendicitis among patients with Medicaid insurance. At our institution, we previously found that, contrary to statewide and nationwide findings, no differences in complicated appendicitis rates existed based on age, sex, race, insurance status, socioeconomic status, and income level. The purpose of this study was to determine if the COVID-19 pandemic altered our previous findings.

Methods: The electronic medical record of a large tertiary children's hospital was queried for all patients with ICD 10 appendicitis codes from 1/1/2017-12/31/2020. Patient records were reviewed to determine complicated (defined as having either a hole in the appendix, extraluminal fecalith, well-formed abscess, or frank stool in the abdomen) vs. uncomplicated appendicitis. Demographic information including age, sex, race, ethnicity, and insurance type were collected. Rates of complicated appendicitis were compared across years. Correlation between rates of complicated appendicitis and demographic variables was determined both within and across years.

Results: The rate of complicated appendicitis was not significantly different across years from 2017-2020. There was no significant difference in the rate of complicated appendicitis based on age, sex, race, ethnicity, or insurance type.

Conclusion: While some U.S. centers and those abroad found a significantly higher rate of complicated appendicitis in 2020 compared to prior years, the rate of complicated appendicitis at a large tertiary children's hospital did not change during the pandemic. No disparities exist based on age, sex, race, ethnicity, or insurance type.

Keywords: Appendicitis, Pediatric, Pandemic, COVID-19, Disparities, Equity

Introduction

Acute appendicitis is one of the most common surgical procedures performed among pediatric patients in the United States [1]. The pathophysiology of the disease begins with luminal obstruction of the appendix, leading to venous congestion, with eventual arterial inflow obstruction, and finally luminal rupture, resulting in spillage of enteric contents into the abdominal cavity. The progression is quite predictable, with the passage of time from symptom onset correlating with increasing severity of disease. Prior to appendiceal rupture, the disease is termed "uncomplicated," and localized to the appendix only. Once the appendix has ruptured, the disease is termed "complicated," with involvement of the abdominal cavity. Timely treatment is thus essential to prevent complicated appendicitis and the morbidity associated with intra-abdominal contamination such as abscesses, ileus, and need for further intervention.

Given the positive correlation between the duration of disease and severity, timely access to a healthcare setting is essential. It has previously been reported that barriers to timely access, including age, race, insurance type/duration, in particular Medicaid insurance, can be strongly associated with higher rates of complicated appendicitis, specifically among pediatric patients [2-7]. While certain studies have reported these findings, including some from nation- and state-wide registries, we have previously shown that at our large tertiary children's hospital, access to timely surgical care appears to be equitable, with no increased risk of complicated appendicitis based on age, sex, race, insurance status, parental education status, and income level [8].

The arrival of the COVID-19 pandemic in 2020 however, was thought to represent yet another barrier to timely access to care, driven by patient/family fear of entering a hospital and contracting the virus. Multiple studies within the pediatric population, both in the U.S. and abroad, have demonstrated increased rates of complicated appendicitis compared to prior years [9-13]. We therefore sought to build upon our prior study in which we demonstrated equitable access to surgical care and determine if the COVID-19 pandemic modified our earlier findings. Specifically, we sought to determine if the pandemic was a universal barrier to timely care, or if it introduced particular disparities in access with regard to age, sex, race, ethnicity, or insurance type/status. We hypothesized that the COVID-19 pandemic was a universal barrier to access to surgical care of appendicitis, demonstrated by higher rates of complicated appendicitis during 2020 compared to the preceding three years. We also predicted that no disparity would be demonstrated with regard to age, sex, race, ethnicity, or insurance status.

Methods

This study (STUDY00001577) received Institutional Review Board approval as well as an approval for a waiver of informed consent. Following approval, a retrospective review of a large tertiary children's hospital was conducted between January 2017 and December 2020 for all patients with a diagnosis of acute appendicitis. The electronic medical record (EMR) was queried for patients with ICD 10 appendicitis diagnosis codes. A manual chart review was then performed for each patient to verify the diagnosis of acute appendicitis. The type of appendicitis was then determined (uncomplicated or complicated) as well as the treatment rendered (operative or non-operative). For patients that underwent operative intervention, the operative note was reviewed for key findings indicative of complicated appendicitis: a hole visualized in the appendix intra-operatively, an extraluminal fecalith, well-formed abscess, or frank stool in the abdomen. If the patient underwent non-operative therapy, the radiographic imaging was reviewed for signs of perforation, indicative of complicated appendicitis: abscess or phlegmon with radiologist confirmed suspicion for perforation. If the patient was found to have multiple hospitalizations related to acute appendicitis, or returned at a later date for interval appendectomy, only the first hospitalization during the four years was included in an effort to only generate a list of unique patients seen over the 4 years and document the type of appendicitis present at the initial encounter. Demographic information was also obtained on each patient including age at appendicitis diagnosis, sex, race, ethnicity, and type of insurance.

Statistical analysis

Descriptive statistics were utilized to describe cohort demographics. Student's t-test, chi-square, and Fisher's exact test were used for comparisons based on variable type and distribution. The Mann–Whitney U test was used for nonnormally distributed data. Results are presented as the median value and interquartile range or mean and standard deviation. A p-value of <0.05 and 95% CI were considered significant. All statistical analysis was performed using IBM Statistical Package for Social Sciences (IBM SPSS version 26, NY, USA).

Results

During the four-year study period, a total of 2,494 unique patients were diagnosed with acute appendicitis at our institution (n = 622; 2017, n = 653; 2018, n = 628; 2019; n = 591; 2020), (**Table 1**). The majority of patients were male (61.1%, n = 1525), White (77%, n = 1921), non-Hispanic or Latino (90.9%, n = 2267), and had private or commercial insurance (51.3%, n = 1279). The mean age at diagnosis was 11.42 ± 3.72 years. The majority of patients had uncomplicated appendicitis (73.5%, n = 1832), and underwent operative intervention during the index admission (90.3%, n = 2252).

Table 1: Total Cohort Demographics.

Characteristics	**Total n = 2494**
SEX	
Female	38.9% (n = 969)
Male	61.1% (n = 1525)
RACE	
White	77% (n = 1921)
Black or African American	10.1% (n = 251)
Asian	2.6% (n = 65)
Multiple Race	4.8% (n = 119)
Unknown	5.5% (n = 136)
ETHNICITY	
Not Hispanic or Latino	90.9% (n = 2267)
Hispanic or Latino	8.6% (n = 215)
Other/Unknown	0.5% (n = 12)
INSURANCE TYPE	
Medicaid/State Child Health Insurance Plan (sCHIP)	44.1% (n = 1100)
Private/Commercial	51.3% (n = 1279)
Self-Pay	4.5% (n = 113)
Other/unknown	0.1% (n = 2)
MEAN AGE AT APPENDICITIS DIAGNOSIS (Years)	
Mean Age	11.42 ± 3.72
APPENDICITIS CASES BY YEAR	
2017	n = 622
2018	n = 653
2019	n = 628
2020	n = 591

APPENDICITIS TYPE (Proportion)	
Complicated	26.5% (n = 662)
Uncomplicated	73.5% (n = 1832)
MANAGEMENT AT INDEX HOSPITALIZATION	
Operative	90.3% (n = 2252)
Non-operative	9.7% (n = 242)

Looking at the four years individually, the proportion of patients with complicated appendicitis was as follows: 28.1% (2017), 23.1% (2018), 25.3% (2019), and 29.9% (2020). Comparing the proportion of complicated appendicitis in each year revealed no significant differences (**Figure 1**). Stratification of complicated and uncomplicated appendicitis rates by insurance type over the 4 years did not show any significant differences between the different insurance types (Medicaid, Private, self-pay, unknown) within a given year, nor were there significant differences within insurance types across years (**Table 2**). Finally, with regard to complicated appendicitis only, there were no significant linear association between rates of complicated appendicitis by age, sex, race, or ethnicity, either within years, or between years during the four-year study period (**Table 3**). Comparing the average age between patients with complicated vs. uncomplicated appendicitis over the course of the 4 years, we found that the average age of patients with complicated appendicitis was significantly younger at 10.2 ± 3.80 years compared to 11.9 ± 3.6 years (p<0.001).

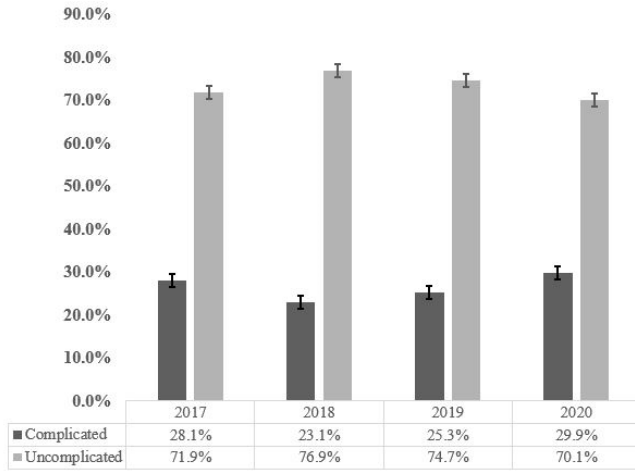

Figure 1. Trend in Appendicitis Types (complicated vs. uncomplicated). During the 4-year study period, the rate of complicated and uncomplicated appendicitis was relatively stable, with approximately three quarters of children having uncomplicated appendicitis, and one quarter having complicated appendicitis in each year. There were no statistically significant differences in the proportion of complicated or uncomplicated appendicitis between years (p > 0.05).

Table 2. Yearly Proportion of Complicated and Uncomplicated Appendicitis Cases Stratified by Insurance Type.

Complicated Appendicitis				
Insurance Type	**2017**	**2018**	**2019**	**2020**
Medicaid/sCHIP	46.9% (n = 82)	49% (n = 74)	42.8% (n = 68)	49.2 (n = 87)
Private/Commercial	49.1% (n = 86)	46.4% (n = 70)	51.6% (n = 82)	44.6% (n = 79)
Self-pay	4.0% (n = 7)	4.0% (n = 6)	5.7% (n = 9)	6.2% (n = 11)
Other/unknown	0% (n = 0)	0.7% (n = 1)	0% (n = 0)	0% (n = 0)
p-value across (0.678) **p-value within (0.779)**				
Uncomplicated Appendicitis				
Insurance Type	**2017**	**2018**	**2019**	**2020**
Medicaid/sCHIP	44.7% (n = 200)	42.2% (n = 212)	43.1% (n = 202)	42.3% (n = 175)
Private/Commercial	50.6% (n = 226)	53.6% (n = 269)	51.8% (n = 243)	54.1% (n = 224)
Self-pay	4.5% (n = 20)	4.2% (n = 21)	5.7% (n = 9)	3.6% (n = 15)
Other/unknown	0.2% (n = 1)	0% (n = 0)	0% (n = 0)_	0% (n = 0)
p-value (across): 0.415 **p-value (within): 0.191**				

Table 3. Comparison of Complicated Appendicitis Rates Across Years and Linear Association Determination Between Complicated Appendicitis Rates and Sex, Race, Ethnicity, and Age at Diagnosis.

	2017 (n = 175)	2018 (n = 151)	2019 (n = 159)	2020 (n = 177)	P-value	P-value (linear association)
SEX						
Female	37.1% (n = 65)	37.7% (n = 57)	42.8% (n = 68)	35.6% (n = 63)	0.570	0.990
Male	62.9% (n = 110)	62.3% (n = 94)	57.2% (n = 91)	64.4% (n = 114)		
RACE						
White	76.6% (n = 134)	82.1% (n = 124)	73.6% (n = 117)	73.4% (n = 130)	0.489	0.162
Black	9.7% (n = 17)	9.3% (n = 14)	11.9% (n = 19)	7.9% (n = 14)		
Asian	2.3% (n = 4)	0% (n = 0)	2.5% (n = 4)	4.0% (n = 7)		
Multiple Race	5.7% (n = 10)	4.6% (n = 7)	7.5% (n = 12)	7.9% (n = 14)		
ETHNICITY						
Hispanic or Latino	6.5% (n = 29)	8.6% (n = 43)	10.2% (n = 48)	6.0% (n = 25)	0.077	0.755
Not Hispanic or Latino	93.1% (n = 416)	90.2% (n = 453)	89.3% (n = 419)	93.7% (n = 388)		
AGE (YEARS)						
Age at Appendicitis	10.2 ± 4	10.2 ± 3.8	10.1 ± 3.7	10.3 ± 3.7	0.957	0.885

Discussion

Acute appendicitis has a very predictable disease course, with a direct correlation between disease severity and duration. A delay in care, manifested by disease progression to perforated appendicitis at the time of presentation, has long been considered an indicator for access to emergent surgical care. Multiple studies, especially in the pediatric population, have demonstrated that barriers to surgical access including age, race, insurance type/duration, in particular Medicaid insurance, are strongly associated with higher rates of complicated appendicitis [2-7]. Therefore, it is plausible that a public health crisis such as the COVID-19 pandemic, that caused universal disruption in access to health services, might exacerbate disparities in access to emergency surgical care, as measured by rates of perforated appendicitis. Indeed, multiple studies have reported such findings both in the Unites States and abroad [9-13]. Accountable care organizations, however, have been shown to mitigate barriers to access to care, and in our previous work we found that at our large tertiary children's hospital with ACO affiliation, access to emergent surgical services was equitable, with no increased risk of complicated appendicitis based on age, sex, race, insurance status, parental education status, and income level [8].

In this follow-up study we found that our previous findings were un-altered, and the COVID-19 pandemic was not a universal barrier to surgical care for the treatment of acute appendicitis. In fact, it does not appear to have been a barrier to timely intervention at all, having found no statistically significant differences in the proportion of complicated appendicitis cases, which are indicative of a delay in treatment, during the pandemic compared to years prior. Furthermore, our results indicate that this finding was universal, with no disparity in access based on age, sex, race, ethnicity, or insurance type.

As discussed in our prior study [8], and still largely applicable to the current study, the utility of a broad referral system is likely at the center of the observed trends, and the ability of our institution to maintain access to surgical services despite the challenges presented by the pandemic. Our institution is the largest children's hospital in the state and serves as a large referral center both for the surrounding region, and neighboring states as well. Moreover, our institution has made a conscious and concerted effort to place primary care facilities in underserved regions of the state, giving them ready access to high acuity services such as emergency surgery, with around the clock access to our on-call surgeons. This system has been in place since well before our previous study in 2006, and as we previously discussed, has been largely successful in bridging the gap in healthcare access, such that, trends in disparities to access based on race, ethnicity, and insurance status seen in other large multi-center cohorts have been mitigated in our local community.

Additionally, the findings of this study may be explained, at least in part, by the influence of our hospital's accountable care organization, Partners for Kids (PFK), that was created in 1994. The organization services Medicaid children in the central and southern regions of Ohio and functions to provide a safety net for the coordination of care of children that might not otherwise receive medical care outside of the emergency room setting. In our cohort, 44% of children had Medicaid insurance, and approximately 92% were serviced by PFK which may have been a major factor in preventing disparities with regard to insurance status, but possibly race, ethnicity, sex, and age as well. During the same time period of this current study, 2017-2020, we recently found that PFK patients did not see a significant rise in the proportion of covered children with perforated acute appendicitis in 2020 compared to prior years [14], demonstrating its ability to maintain timely access even in the setting of an unexpected crisis.

While the utility of ACOs has been an area of great debate over the years, studies have shown they are capable of improving both the quality of care delivered and reducing the cost of delivery [15], and specifically at PFK this has been shown [16]. Additionally, reduction in access disparities associated with ACO participation have been demonstrated. For example, in an adult study looking at diabetes related hospitalization rates among Latino compared to Caucasian patients, participation in an ACO clinic was associated with a

significant decline in the disparity of hospitalization rates [17]. Still others have demonstrated an association of decreased disparity in access to surgical intervention among patients with spinal fractures with ACO participation [18]. Taken together, it's possible that participation in PFK, a pediatric Medicaid ACO, like prior studies, was associated with improved access and quality of care, contributing in part to the ultimate endpoints of this study–rates of appendicitis and rates of complicated appendicitis.

For all patients, regardless of ACO influence, with regard to the pandemic not impacting patient/family behavior in seeking timely care, this may be due to established community relationships. At our institution, quality of care and, in particular, safety in care, is an emphasized value of our healthcare system. The slogan "Zero Hero" is posted throughout the institution and stands for the goal of zero iatrogenic mistakes and our commitment to safety. The culture of quality and safety is something that every patient experiences and likely has played a large part in the establishment of trust between members of our community and providers.

While not as many published studies exist, there are some single institution studies conducted abroad that also demonstrate the lack of the pandemic to influence patient/family behavior, with no alteration in the timing in which patients sought medical care for acute appendicitis in the pediatric population [19]. In the paper by Tristan *et al.* [19], they attributed their findings to the safety and trust families felt in coming to a strictly pediatric hospital as opposed to one in which they could be waiting in the ER with both adults and children. Additionally, they felt that their fast-track treatment of appendicitis (surgery within 24 hours) was attributed to timely management. Overall, both the studies by Tristan and our current study may be highlighting something unique to the pediatric population, and that is a firmly established connection to a trusted healthcare facility. That trust may have facilitated an unwillingness among parents to risk delaying treatment for their children, whereas for themselves, delays were observed in the adult appendicitis literature during the pandemic [20,21].

This study has several limitations including those inherent to a retrospective review. In addition, this study was purely observational and as such, root causes for the observed findings were unable to be determined with complete certainty. Further investigation into the factors that are playing a role in preventing barriers to healthcare access may be of value for other institutions seeking to replicate our results. It is possible however, that intangible and unmeasurable factors are at play, including company culture and community trust as described above, as well as the tangible factors of a large referral network that is leveraging both strategic locations in underserved areas as well as the benefits of an accountable care organization.

Conclusion

The COVID-19 pandemic was believed to have created a barrier to healthcare access for urgent/emergent disease process, likely motivated by fear of contracting the virus from entering a healthcare facility. While other studies in the pediatric population have demonstrated this finding, we found that the COVID-19 pandemic was not a barrier to timely treatment of acute appendicitis. Furthermore, our track record of providing equal access to surgical care for all patients, regardless of age, sex, race, ethnicity, or insurance status remains firmly established, such that, even a global pandemic did not create a disparity in access. A strong referral network and the establishment of primary care facilities in underserved areas, as well as the coordination of care for at risk populations through an accountable care organization, likely contributed to these observations.

Declarations

Authors contribution

Drs. Menchaca, Style, and Olutoye made substantial contributions to the conceptualization/design, methodology, investigation, supervision/oversight, data curation, data analysis, interpretation of results, and drafting/critical revision of the final manuscript. Ms. Chawla, Ms. Kouche, Ms. Burdjalov, and Mr. Kyhl made substantial contributions to the investigation, data curation, data analysis, and drafting/critical revision of the final manuscript.

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Declarations of Interest

None.

Disclosures

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Data Statement

Data available upon request.

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