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Severe acute respiratory syndrome coronavirus 2 pandemic related morbidity and mortality in patients with pediatric surgical diseases: A concerning challenge

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Abstract

The global spread of the novel severe acute respiratory syndrome coronavirus 2 has had serious consequences in terms of patient morbidity and mortality and overburdened health care systems as well as the socioeconomic implications. In the absence of effective therapies and vaccinations during the viral outbreak, the major and most concise means to control viral spread is spread prevention. Although information concerning the impact of severe acute respiratory syndrome coronavirus 2 on pediatric surgical patients has greatly expanded, relevant comprehensive studies are scarce. However, pandemic related morbidity has increased, while under normal circumstances mortality could have been minimized.

Key Words: SARS-CoV-2; COVID-19; Pandemic, Pediatric surgery; Children; Morbidity; Mortality

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Core Tip: Severe acute respiratory syndrome coronavirus 2 pandemic related morbidity and mortality have been increased in children. Moreover, pandemic may manifest additional clinical problems. Pediatric surgeons must be aware of the different forms and symptoms in children affected by coronavirus disease 2019 infection.

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INTRODUCTION

It has been approximately 1 year since the outbreak of novel pneumonia caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first reported in the city of Wuhan in China. The disease was subsequently named coronavirus disease 2019 (COVID-19)[1]. The global spread of this new virus forced the World Health Organization to declare it a pandemic on March 11, 2020[2]. It is estimated that up to June 23, 2021, about 180079074 people worldwide have already been infected, and the number of confirmed deaths had reached 3900967[3].

In an attempt to restrict the accelerated transmission of the disease, governments and health organizations across the world adopted various measures[4]. The pediatric surgical community responded accordingly, both globally and locally. The American College of Surgeons and the American Pediatric Surgical Association proposed certain criteria for the management and prioritization of pediatric surgical procedures, taking into account elective procedures that could be postponed and balancing the risk between disease progression and viral vulnerability[5,6]. Similarly, the European Association of Urology issued a statement of recommendations for pediatric urological cases during the SARS-CoV-2 era[7]. In the same spirit, the Spanish Association of Pediatric Surgery published and announced elective surgery restrictions, with the exception of emergencies and oncological cases[8]. Several organizations in the United Kingdom also provided evidence-based guidelines for elective pediatric surgical services[9]. In addition to these measures, many hospitals at the local level established extensive protocols for the security, protection, and proper management of sick children and their parents[10].

Apart from the resultant drop in elective surgeries amid SARS-CoV-2 cases[11,12], many pediatric surgical centers also noted a decline in emergency cases[11]. Moreover, the pandemic has seen the emergence of a new clinical entity, defined as multisystem inflammatory syndrome in children (MIS-C), which is considered by many to be a complication of SARS-CoV-2[13].

This study aims to identify the influence of the SARS-CoV-2 pandemic on morbidity and mortality among children with surgical diseases.

METHODS

We selected all related articles regarding the morbidity and mortality of surgical pediatric patients during the SARS-CoV-2 pandemic by searching PubMed, Google Scholar, and Mendeley search network (www.mendeley.com) from January 1, 2020 to June 23, 2021. The search terms "COVID-19 and pediatric surgery" or "SARS-CoV-2 and pediatric surgery" or "COVID-19 and pediatric surgery and morbidity" or "SARS-CoV-2 and pediatric surgery and morbidity" or "COVID-19 and pediatric surgery and mortality" or "SARS-CoV-2 and pediatric surgery and mortality" were used. Articles in full texts including reviews, original articles, case reports, case series, and letters to the Editor were screened without language restrictions. Abstracts, recommendations, strategies, and opinions were excluded.

RESULTS

A data-based search retrieved 939 articles from the period January 1, 2020 to June 23, 2021. After subtracting duplicates, out of the 809 articles that emerged, we assessed 118 manuscripts in full text and finally reviewed 46 studies (Figure 1). The details of these studies are described below and summarized in Table 1.

The literature search revealed 24 articles[14-35] concerning the influence of SARS-CoV-2 in children with acute appendicitis (AA). More specifically, we found 14 retrospective studies[14-27], one letter to the editor[28], two case series[29,30], one brief communication[31], and four case reports[32-35]. In many series[17,20,24], the diagnosis of AA was delayed for various reasons, such as fear of contact with SARS-

Table 1 Morbidity and mortality in pediatric surgical patients in the pandemic era

Ref.	Journal	Patient number	SARS-CoV-2 test	Disease	Treatment	Outcome	Study details
Place R <i>et al</i> [14]	JAMA Network Open 2020; 3: e2027948	90	N/A	CAA: 35CAA + abscess: 8	OT: 35; Abscess drainage with IA: 8	Successful	<i>Retrospective study.</i> The authors noted increased number of CAA compared with the same period in 2019
Kvasnovsky CL <i>et al</i> [15]	J Pediatr Surg 2020(Epub head of print)	55	Positive: 3 (without symptoms)	NOT: 25 (2 with CAA); OT: 30 (CAA: 13, Simple AA:17)	NOT: 25 pts (3 CAA); OT: 30 (13 CAA); 1 patient SARS-CoV-2+; OT; 2 patients SARS-CoV-2+: NOT	Successful	<i>Retrospective study.</i> 45.5% of all patients: NOT protocol to minimize operative resources; The majority of children (78.2%) did not meet previous criteria for non-admissions comparable to pre- SARS-CoV-2 era
Gerall CD <i>et al</i> [16]	J Pediatr Surg 2020 (Epub head of print)	89 (41: pre SARS-CoV-2 era, 48: SARS-CoV-2)	Positive: 4 (excluded from the study)	UAA and CAA	NOT: Antibiotics 3 in the pre- SARS-CoV-2 era vs 7 during pandemic; OT: 33 in the pre- SARS-CoV-2 era vs 23 during pandemic	Successful	<i>Retrospective study.</i> It compares children's' symptoms and complications in pro- vs SARS-CoV-2 era. Patients in SARS-CoV-2 era: -Duration of symptoms: longer; -Increased number of imaging findings for perforation, increased LOS, increased time until resolution of symptoms.
Snapiro O <i>et al</i> [17]	Acta Pediatr 2020; 109: 1672-1676	7	N/A	CAA (perforated, abscess)	OT: 4; NOT: 4 (abscess drainage)	Successful	<i>Retrospective study.</i> Delayed diagnosis: Insufficient initial evaluation, telemedicine: 3, parental concerns)
Fisher JC <i>et al</i> [18]	Ann Surg 2020 (Epub head of print)	57 patients SARS-CoV-2 era vs control: 1292	Positive: 11/28	CAA in the SARS-CoV-2 era: 45% vs 27% in the control group	OT: UAA: 30; CAA: 20; NOT: 7	Successful	<i>Retrospective study.</i> Comparison of clinical characteristics of children vs pre- SARS-CoV-2 era. Main findings: Higher duration of symptoms and perforation rates in the SARS-CoV-2 era. No differences between perforation rates and LOS among positive or negative SARS-CoV-2 children.
La Pergola F <i>et al</i> [19]	Front Pediatr 2020; 8: 600320	86 vs 309 in the pre-SARS-CoV-2 era	Positive: 3	UAA: 59; CAA: 27	N/A	Successful	<i>Retrospective study.</i> COVID-19 era vs previously (2017-2019); - No differences: in the prevalence of the AA, duration of symptoms and CAA
Raffaele A <i>et al</i> [20]	Br J Surg 2020; 107: e529-e530	14	Positive: None	UCC: 7; CAA: 7	OT: 13/14; NOT: 1 (abscess drainage)	Successful	<i>Retrospective study.</i> -Delayed presentation in the ED vs previous years, delayed admission to OT due to COVID-19 test preoperatively
Montalva L <i>et al</i> [21]	Pediatr Surg Int 2020; 36: 1397-1406	108 (69 during lockdown)	Positive: 3	UAA: 24; CAA: 84	OT: UAA and CAA with peritonitis:94; CAA with abscess: 14 (drainage or medical treated)	Successful	<i>Retrospective cohort study.</i> The authors found increased cases of AA during the period of lockdown compared to pre-lockdown era. LOS, complication rates, re-admissions and peritoneal abscesses similar
Bellini T <i>et al</i> [22]	Acta Pediatr 2021 (Epub head of print)	27 in the SARS-CoV-2-era vs 75 control group	Positive: None	UAA: 14; CAA: 13 vs UAA: 50; CAA: 25	N/A	Successful	<i>Retrospective study.</i> CAA cases significantly more when compared with previous 3 yr due to delayed admissions ($P = 0.004$)
Zampieri N <i>et al</i> [23]	Minerva Pediatr 2020;	N/A	N/A	N/A	N/A	N/A	<i>Retrospective study.</i> The authors found decreased number cases of AA during lockdown vs post-lockdown period ($P < 0.05$) possibly due to the less exposure to co-factors
Velayos M <i>et al</i> [24]	Ann Pediatr (Barc) 2020; 93:	Pre- SARS-CoV-2-era: 41; Post- SARS-CoV-2:	Positive: 1	CAA: -pre- SARS-CoV-2: 3; - post- SARS-CoV-2: 8	OT: All patients	Successful	<i>Retrospective study.</i> Increased number of CAA in SARS-CoV-2 era compared to pre- SARS-CoV-2 era due to delayed

	118-122	25						diagnosis ($P = 0.019$), LOS increased in the CAA SARS-CoV-2 group
Malhotra A <i>et al</i> [25]	Pediatr Inf Dis J 2021; 40: e49-e55	10	Positive: 10	CAA+MIS-C: 5; UAA: 5	OT: 8; NOT: 2	Successful		Retrospective study. CAA associated with MIS-C
Cai <i>et al</i> [26]	Front Pediatr 2020;8: 1-9	5	Positive: 5	1 patient: CAA + MIS-C	OT	Successful		Retrospective study. CAA associated with MIS-C
Schäfer FM <i>et al</i> [27]	Front Pediatr 2021; 9: 683607	514	N/A	CAA				
Zvizdic Z <i>et al</i> [28]	J Pediatr Surg 2021; 56: 196-200	6	Positive: None	AA	OT	Successful		Letter to the Editor. Decreased admissions of AA compared to pre- SARS-CoV-2 era. Hypothesis: Correlation with decreased exposure to microbes due to lockdown
Lishman J <i>et al</i> [29]	J Pediatr Infect Dis 2020; 39: e472-e473	4	Positive: 4	UAA: 4; CAA: 2; MIS-C: 3	OT: 3	Successful		Case series. AA with MIS-C
Meyer JS <i>et al</i> [30]	J Pediatr Surg Case Rep 2021; 64: 101734	4	Positive: All	UAA: 2; CAA: 2	OT: 4	Successful		Case series. Possible association of SARS-CoV-2 with AA
Lee-Archer P <i>et al</i> [31]	J Pediatr Child Health 2020; 56: 1313-1314	48	N/A	UAA: 25; CAA: 23	OT	Successful		Brief communication. Increased number of CAA compared to previous years (2014-2019), parental concerns
Wang H <i>et al</i> [32]	Chin J Pediatr Surg 2020; 41: 299-302	1	Positive	UAA +; pneumonia	OT			Case report. UUA associated with pneumonia of the right lung
Harwood R[33]	J Surg Case Rep 2020; 9: 1-3	2	Positive: 1	CAA + MIS-C	OT	Successful		Case report. CAA associated with MIS-C
Shahbaznejad L [34]	BMC Pediatrics 2020; 513	10	Positive: 10	1 patient: UAA with MIS-C	OT	Successful		Case report. UAA associated with MIS-C
Alsuwallem AB <i>et al</i> [35]	Cureus 2020; 12: e8677	1	Positive	CAA	OT	Successful		Case report. CAA associated with COVID-19 Infection
Mehl SC <i>et al</i> [36]	Pediatr Infect Dis J 2021	1	Positive	NEC	NOT	Successful		Case report. Full term neonate with NEC secondary to SARS-CoV-2 infection
Rohani P <i>et al</i> [37]	J Pediatr Surg Case Rep 2021; 61: 101667	1	Positive	NEC	NOT	Successful		Case report. Gastrointestinal SARS-CoV-2 manifestation
Moazzam Z <i>et al</i> [38]	J Pediatr Surg Case Reports 2020; 59:101533	1	Positive	Intussusception	Pneumatic reduction	Successful		Case report. Gastrointestinal manifestation of SARS-CoV-2
Rajalakshmi L <i>et</i>	Indian J Pract	1	Positive	Intussusception	Pneumatic reduction	Successful		Case report. Gastrointestinal manifestation of SARS-CoV-2

al[39]	Pediatr 2020; 22:236							
Martinez-Castañoi[40]	Pediatr Emerg Care 2020;36: e368	1	Positive	Intussusception	Hydrostatic reduction	Successful	Case report. Gastrointestinal manifestation of COVID-19	
Makrinioti H <i>et al</i> [41]	J Pediatric Infect Dis Soc 2020; 9: 504-506	2	Positive: 2	Intussusception; Intussusception + malrotation	Pneumatic reduction; Surgical reduction + ladd procedure	Death; Successful	Case reports. Fatal gastrointestinal manifestation of SARS-CoV-2; Gastrointestinal manifestation of SARS-CoV-2	
Bazuaye-Ekhuyasi EA <i>et al</i> [42]	Emerg Radiol 2020; 27: 761-764	1	Positive	Intussusception	Hydrostatic reduction	Successful	Case report. Gastrointestinal manifestation of SARS-CoV-2	
Guerrón N <i>et al</i> [43]	Global Pediatr Health 2021; 8: 1-3	1	Positive	Intussusception	Hydrostatic reduction	Successful	Case report. Gastrointestinal manifestation of COVID-19	
Osorno JF <i>et al</i> [44]	Global Pediatr Health 2021; 8: 1-3	1	Positive	Intussusception (delayed presentation)	Laparotomy	Successful	Case report. Gastrointestinal manifestation of COVID-19	
Kawalec AM[45]	Burns 2020; 46: 1713-1714	Increased admissions in ED compared to previous year	N/A	Increased TBSA burns, house fire burns and PICU admissions <i>vs</i> previous year	Outpatient care, hospitalization, PICU	N/A	Retrospective study. Need for a family plan during pandemic	
Demircan M[46]	Burns 2020 (Epub ahead of print)	Increased admissions and hospitalizations compared to previous year	N/A	Increased TBSA burns, increased all kinds of burns	Outpatient care, hospitalization	N/A	Retrospective study. Burn care material must be ready	
Sethuraman U [47]	Burns 2020 (Epub head of print)	Increased admissions in ED <i>vs</i> all visits	N/A	Increased TBSA	Outpatient care, hospitalization, PICU	1 death	Retrospective study. Parents should keep children away from hot liquids and surfaces	
Pelizzo G <i>et al</i> [48]	Healthcare 2021; 9: 551	84 (pandemic era: 52; previous pre-pandemic period: 32)	Positive: 1	TBSA < 10%: 32; 10%-15%: 11; > 15% >: 9	34/52: Discharge; 18/52: Burn Service Area; (10/18: Ward; 8/18: PICU)	Successful	Retrospective study. A higher number of admissions during pandemic was noticed compared to the same period in the previous year. An appropriate planned service and care ensure a safe and feasible hospitalization without risks of infections and major complications	
Marino-Mateo L <i>et al</i> [49]	Actas UrolEsp 2020; 44: 659-654	45	Positive: 0	Pelviureteric junction obstruction, spina bifida, lithiasis, hypospadias	49 interventions	Successful	Retrospective study. A stratification of the urological based on the different phases of pandemic and EAU was conducted	
Cesaro S <i>et al</i> [50]	Pediatr Blood Cancer 2020; 67: e8466	247	Positives: 10	Solid tumors, leukemia	Ceased chemotherapy and radiation for 12-26 d	Successful	Retrospective study. Mild or asymptomatic patients with positive tests may continue therapy	
Hrusak O <i>et al</i> [51]	Eur J Cancer 2020;132: 11-16	200	Positives: 9	Hepatoblastoma: 2; Wilms tumor: 1; Ewing's sarcoma: 1; osteosarcoma: 1; cervical rhabdoid: 1; ALL: 1	Antibiotics and/or hydroxychoquine, lopinavir, ritonavir	Successful	Retrospective study. Children on anticancer therapy may have mild or asymptomatic course of infection with SARS-CoV-2. In this case anticancer treatment should not be delayed or postponed	

Madhusiidhan PP <i>et al</i> [52]	Pediatr Blood Cancer 2020; e28843	578	Positive: 98; No symptoms: 73	Neuroblastoma: 5;Solid tumor: 16; Others: 77	Mechanical; ventilation: 7; Supplemental oxygen: 25; SARS-CoV- 2 direct treatment: 98	Successful: 94; Death: 4	<i>Multi-institutional cohort study.</i> Low morbidity and mortality among oncologic patients but higher than in general pediatrics. Significant impact of pandemic: Delay in therapy in 67% of positive patients; Overall delays: Chemotherapy 54%, surgery 46%, transplant 30%
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CAA: Complicated acute appendicitis; OT: Operative treatment; IA: Interval appendectomy; NOT: Non-operative treatment; AA: Acute appendicitis; UAA: Uncomplicated acute appendicitis; LOS: Length of hospital stay; MIS-C: Multisystem inflammatory syndrome in children; ED: Emergency department; NEC: Necrotizing enterocolitis; TBSA: Total body surface area; ALL: Acute lymphoblastic leukemia; SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2; COVID-19: Coronavirus disease 2019; PICU: Pediatric intensive care unit.

CoV-2 patients, telemedicine, fear of traveling, and disruption of the local health system; this led to an increase in the number of cases with complicated AA (CAA). While an association between AA and SARS-CoV-2 has been speculated[26], other studies have also reported 13 children with CAA diagnosed in the context of MIS-C [29,33,34]. It is worth noting that one case reported the coexistence of AA and pneumonia[32].

Two children aged 7 wk and 6 years respectively, both positive for SARS-CoV-2 infection, presented with clinical signs of acute abdomen. The clinical and diagnostic investigation showed necrotizing enterocolitis (NEC), which was successfully treated with antibiotics. The authors considered infection to be responsible for this emergency clinical manifestation[36,37].

Seven articles[38-44] referred to cases of ileocolic intussusception. Eight infants, aged 4-10 mo, presented with clinical symptoms related to intussusception (abdominal cramps, bilious vomiting, currant jelly stools) and were confirmed by ultrasound. On admission, seven infants were found to be positive for SARS-CoV-2, and one was found to be positive on the third postoperative day; four[38,40-42] had relatives with suspected or confirmed SARS-CoV-2 infection. Reduction (pneumatic or hydrostatic) was attempted in seven patients, six of whom had a successful outcome. Only two cases were treated surgically. Notably, in one case, at laparotomy, malrotation was found in addition to intussusception, and a Ladd’s procedure was performed[41]. In the other case, intestinal resection with consequent ileostomy and mucous fistula was performed due to intestinal ischemia and peritonitis[44]. Moreover, following successful pneumatic reduction of intussusception, one female infant with documented SARS-CoV-2 infection went on to develop acute respiratory infection and multiorgan complications during hospitalization, including abdominal ascites and intestinal failure, which subsequently led to her death[41].

A total of four articles was extracted for SARS-CoV-2 in children with burns[45-48]. All of them disclosed useful information. Specifically, they recorded an increase in admissions of children with moderate and severe fire-related burns in comparison to earlier years, while the greater difference in burned total body surface area was statistically significant[46-48].

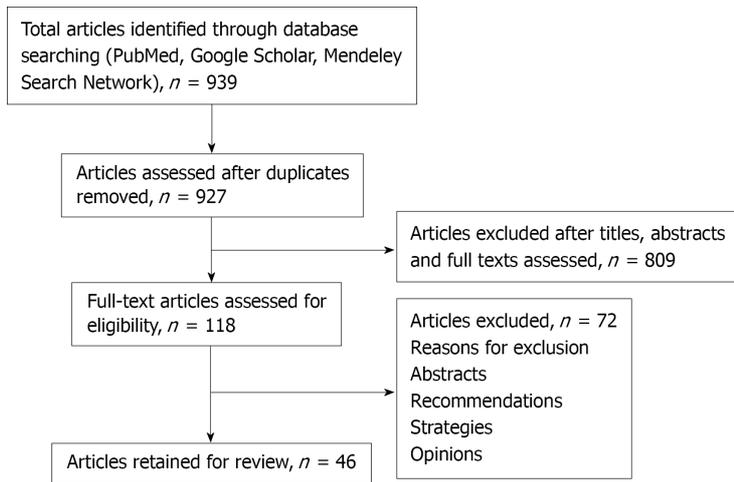


Figure 1 Flow chart of articles selection.

One article from Spain was included[49] that reported clinical and surgical data, complications, and readmissions of all children who underwent procedures for various urological conditions. The authors developed an escalation program based on the different phases of the pandemic and the European Association of Urology recommendations. They concluded that this strategy allowed them to manage successfully urological diseases.

Three studies[50-52] that screened pediatric oncology/hematology patients for SARS-CoV-2 infection were evaluated. In the first study, 334 nasopharyngeal swabs were taken from 247 patients, only 10 (4%) of whom tested positive for SARS-CoV-2 infection (eight patients were asymptomatic and two had a mild fever). In nine patients, chemotherapy was postponed until they had tested negative (time period ranges from 12-26 d), while only one patient on chemotherapy and radiation was positive after 30 d[50]. In a multicenter survey performed in 25 countries involving 200 suspected patients, only nine tested positive for SARS-CoV-2 infection[51]. Notably, none required admission to pediatric intensive care or mechanical ventilation. Finally, a retrospective, multicenter study among 13 institutions including 578 patients examined test-positive SARS-CoV-2 patients aged ≤ 21 years receiving active anticancer treatment[52]. Among those 578 patients, 98 (16.95%) were positive, 78 (79.6%) of whom were symptomatic, and four died (4%). Delay of anticancer therapy occurred in 67% of these patients. Overall, these studies raised the question concerning the benefits of discontinuing or delaying chemotherapy in mild or asymptomatic SARS-CoV-2 positive patients.

DISCUSSION

This study provides descriptive data on pediatric surgical patients infected with the novel coronavirus SARS-CoV-2. The data show that the impact of SARS-CoV-2 seems to be multifactorial as it interferes directly with human health due to the vulnerability of the virus and indirectly with the resources to access care, thereby increasing morbidity and mortality[12].

SARS-CoV-2 infection can affect all ages of children with median age of infection of 6.7 years (1 d to 15 years)[53], with no gender predominance[54]. The angiotensin-converting enzyme 2 is the main host receptor of SARS-CoV-2 and is frequently expressed in ciliated epithelial cells in human lungs. The second most common site of angiotensin-converting enzyme 2 receptors is the gastrointestinal cells[53]. Notwithstanding, gastrointestinal symptoms attributed to SARS-CoV-2 infection are more prevalent in children, while respiratory involvement is more common in adults[55,56]. In line with this finding, Meyer *et al*[30] speculated a conceivable association of SARS-CoV-2 and AA based on the assumption of the predominant association of gastrointestinal infection and SARS-CoV-2. However, in the era of SARS-CoV-2, other factors such as the fear of contact with persons positive for SARS-CoV-2, difficulty in visiting health centers, and insufficient evaluation *via* telemedicine may constitute strong reasons for delayed diagnosis of CAA[17,20,24].

The predominant association of gastrointestinal infection and SARS-CoV-2 might also explain the cases of intussusception[38-44] and the two cases of NEC[36,37]. Intussusception is the most common cause of intestinal obstruction in infancy[57]. Although in most cases it is thought to be idiopathic, a preceding viral infection due to adenovirus and rotavirus has been reported in approximately 30% of cases[58]. Notably, all cases described here were positive for SARS-CoV-2 infection, while a previous history of upper respiratory tract infection was diagnosed in three cases[38-40]. In the two cases of NEC, the association of SARS-CoV-2 test positivity with coexistence of pneumatosis intestinalis and bloody stools suggests ischemic necrosis in both cases and hence NEC[36,37].

The increase in the number of children presenting with burns during the outbreak could be ascribed to the fact that the lockdown obliged children to stay home where they may have had less surveillance, since parents were constrained to work from home and were thus unable to keep a close watch on children. Educational programs are needed to increase parents' knowledge concerning safety behaviors during a prolonged stay at home[45-48].

The impact of SARS-CoV-2 outbreak on children with urological problems is not known. An escalation program based on different phases of the pandemic has been proposed by Merino-Mateo *et al*[49] for the management of urological problems. However, the lengthy postponement of certain crucial surgical procedures, such as cryptorchidism, or obstructive uropathies including ureteropelvic junction obstruction, ureterovesical junction obstruction, or neurogenic bladder may lead to loss of a testicle function or loss of renal function. Three articles referred to testicular torsion[59-61]. The conclusions were contradictory, as increased rate of orchidectomies was noticed in the two articles due to delayed presentation[59,60], while in the remaining one article the authors found early presentation in testicular torsion and no differences in rates of orchidectomies between SARS-CoV-2 period and preceding era[61].

Children with cancer face significant health problems in view of the rapid changes in the health system and restrictions in accessing medical support. Compromised immunity due to malignancy and the unknown behavior of SARS-CoV-2 lead to further insecurity. Although the studies mentioned above[54-56] did not show significant consequences from the virus itself, it was clear that postponement of therapies owing to the heavily burdened health system could result in insufficient medical support.

In May 2020, the Centers for Disease Control in the United States expressed concern for a new entity termed MIS-C associated with SARS-CoV-2[34,62]. MIS-C is defined by clinically severe illness requiring hospitalization that presents with fever, elevated inflammatory markers, and multisystem organ dysfunction in the setting of recent proven or probable SARS-CoV-2 infection and the absence of a plausible alternative explanation[34]. However, there are no data available as to whether the mechanism that can lead to severe respiratory failure resembles that of MIS-C. Current data raise the suspicion for a distinct entity related to severe SARS-CoV-2 infection[62]. MIS-C-related AA was suspected in three studies[25,33,34] in which the coexistence of CAA and positive was tested.

This study is not without its limitations inasmuch as it is based on all types of articles, most of which included retrospective studies, letters to the Editor, case reports, and case series, all of which were written during the pandemic within a short period of time in an effort to share experiences and divulge information that could help the scientific community. Furthermore, in order to achieve a better understanding, a substantial number of studies compared their results with those to pre- SARS-CoV-2 era, which can lead to a significant bias. Another limitation is that most data were collected within 204 mo. Consequently, there is a lack of acceptable follow-up that would have helped us gain precise knowledge as concerns post-operative outcomes and readmissions of patients treated during the pandemic.

CONCLUSION

Pediatric surgical practice during the SARS-CoV-2 pandemic is challenging. Summarizing the information and results of studies, we conclude that SARS-CoV-2 infection could have a negative influence on virtually the entire pediatric surgical spectrum. Morbidity has increased for various reasons in children with burns, urological problems, and cancer including fear of contracting the virus in health centers, lockdown, telemedicine, postponement of medical consultation and elective surgeries, or unknown manifestations of SARS-CoV-2. Under normal circumstances,

mortality could have been minimized. The delay in presentation and consequent management of AA has resulted in an increased number of CAA. The impact of SARS-CoV-2 on the gastrointestinal system has further exacerbated the manifestation of common pediatric surgical conditions such as AA, intussusception, and NEC. Further studies and research are needed to overcome the demands of this period.

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