

# The impact of the COVID-19 pandemic on presentation of surgical disease in paediatric patients at a tertiary centre in Cape Town, South Africa

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**Background:** Children are less susceptible to infection with SARS-CoV-2 and subsequent severe disease, yet especially vulnerable to the indirect effects of the pandemic. A constrained healthcare service, combined with the societal and behavioural changes observed during the pandemic, is likely to have altered the presentation of paediatric surgical disease. The objective was to investigate the impact of the COVID-19 pandemic on the volume of paediatric surgical admissions, the severity of disease and the type of surgical pathology treated at our centre.

**Methods:** A retrospective cohort study compared paediatric surgical admissions in an eleven-month period before COVID-19 to the same period during the pandemic. Comparisons in volume and diagnoses were based on the number of admissions. Predetermined criteria for severity of disease using triage scores, intraoperative findings and intensive care admissions were compared.

**Results:** A total of 1 810 admissions were recorded, 1061 in the pre-COVID group and 749 during COVID. Emergency admissions reduced by 9.2%, most notably due to a reduction in trauma, caustic ingestions and constipation. There was an increase in incarcerated inguinal hernias and helminth-related pathologies. Significantly more intussusceptions failed pneumatic reduction requiring surgical intervention with bowel resection. There was a two-fold increase in patients requiring emergency intensive care.

**Conclusion:** Paediatric surgical volumes at our centre decreased during the COVID-19 pandemic. There was evidence of more advanced disease on presentation of inguinal hernias and intussusception and a generalised increased demand for emergency ICU admission.

**Keywords:** COVID-19, paediatric surgery, inguinal hernia, intussusception

## Introduction

The emergence of the novel coronavirus SARS-CoV-2 towards the end of 2019 in Wuhan, China, and the subsequent expansion towards a global pandemic has had far-reaching consequences on healthcare provision. Compared to the adult population, children have proven to be less susceptible to infection and severe disease, possibly due to a lower expression of angiotensin-converting enzyme-2 (ACE-2) receptors within the nasal passages and, therefore, fewer viral binding sites.<sup>1,2</sup> However, the “hidden” burden due to the indirect effects of the pandemic may be disproportionately large in this vulnerable population, particularly in developing countries.<sup>3</sup>

In South Africa, on 15 March 2020, the government announced a national state of disaster in response to the early identification of the first COVID-19 cases in the country.<sup>4</sup> The enforcement of a series of strict societal limitations followed, including the banning of public gatherings, shutting of schools, restrictions of movement, banning of alcohol and tobacco, and mandatory mask-wearing in public. The country saw various iterations of these lockdown measures according to the ebb and flow of positive cases nationally for

2 years ending with the cessation of the state of disaster on 5 April 2022.<sup>5</sup> Hospital activity underwent drastic changes too, with the closing of outpatient clinics, cessation of elective surgeries, and the redirecting of resources to COVID-testing facilities, field hospitals, medical wards, and intensive care units.

The impact of the COVID-19 pandemic and its associated restrictions on the most common paediatric surgical diseases in South Africa is largely unknown. Although some studies have noted a possible role in the pathophysiology of appendicitis, intussusception, and testicular torsion,<sup>6-11</sup> direct interaction of the virus in surgical pathophysiology is limited. Instead, it is expected that indirect factors would greatly impact on the presentation of surgical disease. Fearful avoidance of healthcare facilities, restrictions on movement and limited transport services may have led to delays in health seeking behaviour.<sup>3,12-14</sup> Other considerable factors include the disruption to the economic or social stability of homes, the closing of schools, the interruption of vaccination services and disease prevention strategies such as routine deworming, and the pausing of food programmes.<sup>3,14,15</sup>

The primary aim of this study was to compare all paediatric surgery admissions at our facility during the

height of the COVID-19 pandemic to a similar period before the pandemic in terms of age and gender, surgical volume, type of pathology, severity of disease and length of stay. The secondary aim was to perform a sub-analysis of our centre's most common surgical emergencies to determine if these were more severe on presentation during the pandemic.

## Methods

### Study Design

A retrospective cohort study was undertaken. The control group included all admissions to the paediatric surgical department at Tygerberg Hospital over an eleven-month period between 15 March 2019 to 15 February 2020 prior to the COVID-19 outbreak in South Africa. The study group included all admissions for the period 15 March 2020–15 February 2021 during the height of the COVID-19 pandemic and the national state of disaster.

### Setting

Tygerberg Hospital is a tertiary hospital in Cape Town, South Africa, serving an area of the Western Cape with a population of 3.4 million people.<sup>16</sup> Within this structure, the department of paediatric surgery serves as a referral centre for paediatric surgical care providing treatment for children from birth to 12 years of age across a broad range of pathologies.

### Participants and variables

Each data entry reflects an admission of a patient treated by our department divided into pre-COVID-19 and COVID-19 groups based on the admission date. Children with a surgical disease treated by other departments were omitted, but those who were co-managed with the paediatric surgery team were included. Admissions included day case surgery and overnight hospital stays, but emergency room and ward consults were only included if surgical treatment followed. In cases where patients required multiple admissions, each was entered as a separate data entry, but readmissions for the same patient were indicated as such.

Variables captured included age, gender, diagnosis, urgency of admission (emergency vs elective), surgical procedures performed, average length of stay and features of severe or advanced disease. The diagnosis was defined by the admission's discharge summary. Elective admissions were defined as pre-scheduled hospital stays, and emergency admissions were unscheduled presentations through our emergency department or via referral. Elective procedures had been pre-booked and placed on an outpatient elective waiting list prior to the completion of surgery. Severe or advanced disease was graded using the following criteria: a TEWS (triage early warning score)<sup>17</sup> on presentation of 5 or more or a PEWS (paediatric early warning score)<sup>18</sup> on presentation of 3 or more, the requirement of a non-elective ICU bed and/or inotropic support.

A sub-analysis of the five most common surgical emergencies namely intussusception, appendicitis, inguinal hernia, soft tissue sepsis and trauma was performed. Disease-specific features of severe or advanced disease were defined as follows: intussusception – the failure of pneumatic reduction and/or the need for surgical resection; inguinal hernias – the presence of incarceration requiring sedation or surgery to reduce; appendicitis – an intraoperative grading

score described by Gomes et al.<sup>19</sup> of 3 or more; trauma and soft tissue sepsis – TEWS/PEWS scores of > 5 or 3 respectively or the need for inotropes or ICU admission.

### Data analysis

All data were collected retrospectively by a single researcher using electronic hospital records. The RedCap™ online database system was used for data capture, and statistical analysis was performed using IBM SPSS™ software. Demographic and clinical categorical variables were cross-tabulated and compared pre- and post-COVID-19 using Pearson's chi-square tests. For variables with data groups smaller than 5, Fisher exact tests were used. Non-parametric data were compared using Mann-Whitney U tests. Significant differences between the groups were based on a probability (*p*-value) of < 0.05.

## Results

A total number of 1 810 admissions were recorded. These included 1061 in the pre-COVID-19 group and 749 in the COVID-19 group; 239 (22.5%) of these admissions in the pre-COVID-19 group were re-admissions compared to 164 (21.9%) in the COVID-19 group (*p* = 0.751). The number of emergency admissions were 573 (54%) in the pre-COVID-19 group and 520 (69%) in the study group (*p* < 0.001).

The ratio of male to female patients was 2:1 in the pre-COVID-19 group and 1.8:1 in the COVID-19 group (*p* = 0.480). The mean age at presentation was 3 years and the median length of stay was 3 days in both cohorts.

### Surgical volume

Figure 1 shows a breakdown of admissions requiring surgery. There was no significant difference in the proportion of total admissions requiring surgery between the groups (pre-COVID-19 71% vs COVID-19 72%, *p* = 0.466). There was a small difference in the proportion of emergency admissions requiring surgery (pre-COVID-19 54% vs COVID-19 61%, *p* = 0.026) and the number of patients who had their surgeries postponed, (pre-COVID-19 43 vs COVID-19 8, *p* = 0.003).

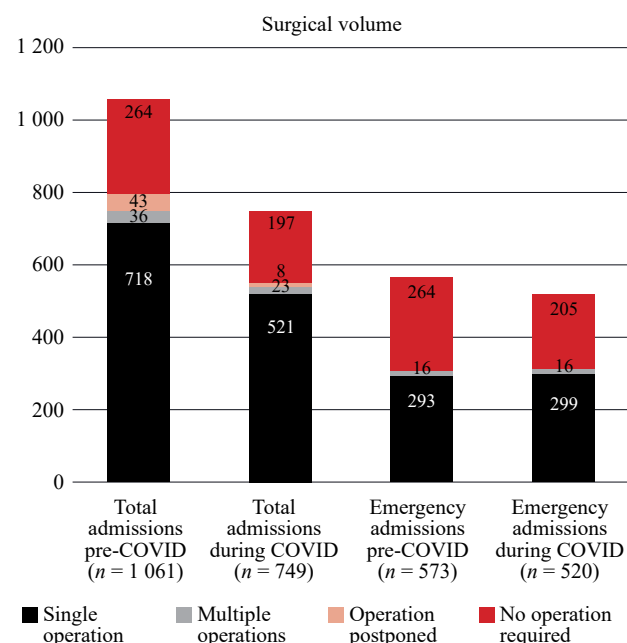


Figure 1: Breakdown of surgical procedure volumes per admission

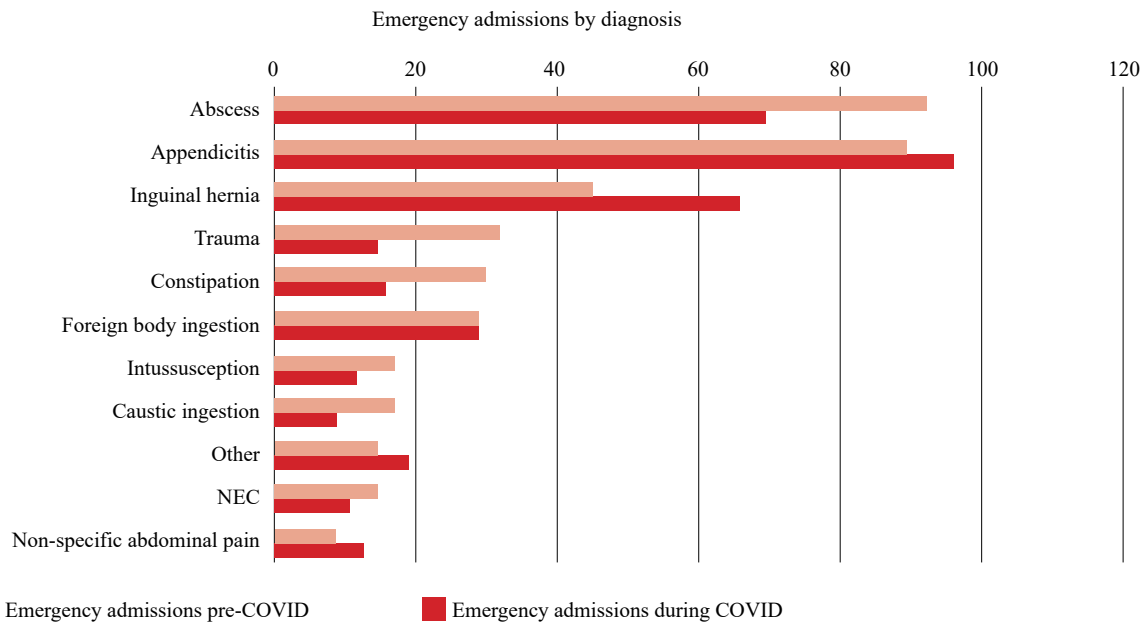


Figure 2: Most common surgical emergency admissions by diagnosis

### Common diagnoses

Figure 2 reflects the most common emergency admissions per diagnosis. There was a noticeable decrease in cases of abscesses (-23%), constipation (-47%), caustic ingestions (-47%) and trauma (-53%) cases, and a marked increase in inguinal hernias presenting as emergencies (+47%) during COVID-19 ( $p < 0.001$ ). Notably, there were 7 cases of complicated helminth infestation during COVID-19 compared to none pre-COVID-19 ( $p = 0.016$ ).

### Severity of disease

162 (33.2%) emergency admissions in the pre-COVID-19 group had PEWS or TEWS scores  $\geq 3$  or 5 respectively, compared to 153 (32.7%) in the COVID-19 group

Table I: Analysis of inguinal hernia admissions

Inguinal hernia admissions			
	Pre-COVID	COVID	p-value
Total admissions	147	140	0.005
Readmissions	13	16	0.468
Emergency admissions	45	66	0.004
Reducible	118	91	0.012
Incarcerated <sup>a</sup> (with or without bowel obstruction)	29	49	0.012
Median length of stay (in days)	3	3	
Severe TEWS/PEWS score <sup>b</sup>	21	22	0.734
Non-elective ICU bed	1	4	0.205
Inotropic support	0	0	
Surgery cancelled/postponed	14	4	0.026
Operative findings:			
Simple PPV	128	124	0.129
Incarcerated omentum or bowel	1	9	0.01
Requiring bowel resection	0	1	0.304
Incidental bowel/omentum in sac, not incarcerated	4	2	0.393

<sup>a</sup> – Defined as either requiring surgery or sedation to reduce

<sup>b</sup> – TEWS score of 5 or more/PEWS score of 3 or more

( $p = 0.862$ ). In the pre-COVID-19 group, 63 (5.9%) admissions required non-elective ICU beds compared to 76 (10.1%) ( $p = 0.001$ ) in the study group; 8 (0.8%) required inotropes on presentation against 14 (1.9%) ( $p = 0.081$ ).

Sub-analyses of the most common surgical emergencies are depicted in Tables I-V.

Table II: Analysis of acute appendicitis admissions

Appendicitis admissions			
	Pre-COVID	COVID	p-value
Total admissions	89	96	0.27
Readmissions	5	2	0.208
Median length of stay (in days)	5	5	0.83
Non-operative management	16	19	0.752
Severe TEWS/PEWS score*	34	35	0.878
Non-elective ICU bed	6	12	0.221
Inotropic support	2	5	0.722
Intraoperative Gomes score $\geq 3$	57	59	0.716

\* – TEWS score of 5 or more/PEWS score of 3 or more

Table III: Analysis of intussusception admissions

Intussusception admissions			
	Pre-COVID	COVID	p-value
Total admissions	17	12	0.498
Median length of stay (in days)	1	8	0.01
Severe TEWS/PEWS score*	6	5	0.8
Non-elective ICU bed	0	4	0.01
Inotropic support	0	0	
Successful pneumatic reduction	13	3	0.012
Surgery required	4	9	0.012
Intraoperative findings:			
Successful manual reduction	3	3	0.63
Necrotic bowel requiring resection	1	6	0.006

\* – TEWS score of 5 or more/PEWS score of 3 or more

**Table IV: Analysis of soft tissue sepsis admissions**

Soft tissue sepsis admissions	Pre-COVID	COVID	p-value
Total admissions	102	79	0.246
Median length of stay (in days)	2	2	
Severe PEWS/TEWS score*	34	33	0.285
Required surgery	92	66	0.65
Non-elective ICU bed	2	1	1.0
Inotropic support	1	0	1.0

\* – TEWS score of 5 or more/PEWS score of 3 or more

**Table V: Analysis of trauma admissions**

Trauma admissions	Pre-COVID	COVID	p-value
Total Admissions	32	15	0.035
Blunt (MVA/PVA)	12	4	0.745
Blunt (Other)	12	6	0.754
Non-accidental injury	0	2	0.085
Penetrating	8	4	1
Median length of stay	3	4	0.141
Severe PEWS/TEWS score*	7	3	0.582
Required surgery	8	3	0.556
Non-elective ICU bed	1	0	0.682
Inotropic support	0	0	

\* – TEWS score of 5 or more/PEWS score of 3 or more

## Discussion

The overall reductions in admissions during COVID-19 was disproportionately due to fewer elective admissions. However, there was still a modest decrease in some emergencies. Children were more likely to be at home with adult supervision due to lockdown measures, which may explain the reduction in trauma and caustic ingestions. The reduction in abscesses may have been due hospital avoidance leading to spontaneous rupture and resolution at home, or that these were being drained at local hospitals and clinics rather than being referred. A halving in the number of constipation cases requiring admission likely reflects the chronic, indolent nature of symptoms that parents deemed appropriate to tolerate in a time of crisis. There were fewer inpatient operations cancelled or postponed during COVID-19. This excluded outpatients whose operations were delayed extensively due to the broad cancellation of elective lists. There are likely two explanations for this. Firstly, there were numerically fewer elective procedures being performed during COVID-19 with a greater proportion of emergency surgeries. Secondly, a lighter overall surgical load on our emergency surgical services during the pandemic, possibly due to a reduced trauma volume, may have allowed for more inpatient procedures to be done expeditiously. The equivalence in triage scores and length of stay between the two cohorts suggests overall parity of disease severity on presentation between the two groups. However, the two-fold increase in non-elective ICU admissions during a period where there were significant constraints on ICU bed availability is significant.

## Inguinal hernias

Inguinal hernia is one of the most common problems encountered by the paediatric surgeon and this reflects accurately in our data. International studies indicate that incarceration risk of an untreated inguinal hernia in a child is between 7–12%.<sup>20,21</sup> A local study revealed a much lower incarceration rate of 4.9% in patients waiting for herniotomy.<sup>22</sup> Most surgeons, however, would advocate for prompt surgical treatment to mitigate the risk of incarceration and strangulation.<sup>21,22</sup> The increase in cases of incarcerated inguinal hernias reflected in our data contradicts an American study reporting no increase in incarcerations due to surgical cancellations during the pandemic.<sup>23</sup> The delay in the median interval to surgery in that study was a matter of days.<sup>23</sup> Unfortunately, our study does not quantify the period between diagnosis and surgery, however, the significant increase in the number of incarcerated hernias seen during this period would suggest this to be significantly prolonged.

## Intussusception

Intussusception is the most common cause of acute bowel obstruction in the age group between 3 months to 6 years and is a time-sensitive emergency. Delays in presentation or management lead to more significant morbidity and mortality.<sup>24</sup> A South African study published before COVID-19, reflects a nationwide non-operative successful reduction rate far lower than international standards, with a wide variance between centres (from 67% to 9.1%), despite all employing similar technique protocols.<sup>24</sup> In our data, the increase in failed reductions, requirement of bowel resections and ICU admissions undoubtedly reflects more advanced disease in the study group. Despite some reports suggesting that COVID-19 infection can cause severe intussusception in infants,<sup>11</sup> none of our patients in this cohort tested positive for the virus, making a direct role of the virus in the advanced pathology unlikely.

## Appendicitis

Appendicitis is the single most common paediatric surgical emergency worldwide and one of the first surgical diseases to be examined in COVID-19.<sup>25</sup> The CASCADE study in the UK analysed the management and outcomes of paediatric appendicitis during the pandemic and found that the use of diagnostic imaging and non-operative management increased, but outcomes remained relatively unaffected.<sup>25</sup> These results were replicated in a similar study from Lithuania.<sup>26</sup> A local study, albeit in the adult population, found no difference between severity of presentation or intraoperative findings during the pandemic.<sup>13</sup>

Our data suggest similar findings in children: – no difference in length of stay, severity of presentation or intraoperative findings during the pandemic. It should be noted that the rate of complicated appendicitis (Gomes score of 3 or more) in our pre-pandemic group was much higher (78%) than the cohort included in the UK CASCADE trial (35%) and the Lithuanian trial (35%), indicating that even prior to the pandemic, our patient population presented later and with more advanced disease than our international counterparts.<sup>25</sup> This low-base effect may explain why there was no difference in severity of disease between pre- and COVID-19 groups in our local context.

## Helminth infestation

Deworming programmes have been adopted in the Western Cape by government schools since 2009.<sup>27</sup> With schools being closed during periods of the pandemic and local clinics also affected, the increase in complications due to worm infestation can be explained. Of the 7 cases recorded, 5 presented with partial or complete bowel obstruction, 1 presented with bile duct obstruction complicated by bile duct perforation, and 1 presented as an incidental finding in a patient with appendicitis.

## Limitations of the study

Our data comes from a single centre and compares to a single period before the pandemic. All data were collected retrospectively and subject to recall bias. Some cases of paediatric surgical disease within our drainage area, especially significant polytrauma and burns, may bypass our centre and be admitted at a specialised referral unit nearby. This may lead to under-reporting of these conditions in our data. The same is true for instances where older children (> 5 years) with appendicitis or soft tissue sepsis receive surgical treatment by adult surgeons at secondary hospitals. The data compared separate admissions rather than individual patients and therefore does not reflect the true disease incidence in the population group. The study was not designed to investigate in detail the specific factors affecting the change in the pattern of surgical disease proven during COVID-19, and although reasonable explanations have been offered, these would need to be tested with further detailed study.

## Conclusion

During the COVID-19 pandemic, our institution saw a significant decrease in the number of paediatric surgical admissions and paediatric surgical procedures performed. However, the number of emergency admissions and surgery performed remained relatively unchanged. There was a decrease in emergency admissions for trauma, functional constipation, abscesses and caustic ingestions. There was a significant increase in the number of helminthic complications, incarcerated inguinal hernias, and cases of intussusception requiring surgery and bowel resection during the pandemic. Similarly, there was a two-fold increase in admissions requiring an ICU bed during COVID. These findings reflect the impact on paediatric surgical disease due to disruption to the primary healthcare service and delays in presentation and/or treatment due to numerous indirect factors relating to the pandemic.

## Conflict of interest


The authors declare no conflict of interest.

## Ethical approval

Ethical approval was obtained from the University of Stellenbosch Health Research Ethics Committee of the academic institution associated with the tertiary hospital at which the study was done. Reference Number [S21/03/003\_COVID-19].

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