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## Impact of the first COVID-19 surge on the outcomes of diverticulitis

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### ABSTRACT

**Introduction:** During the first surge of the COVID-19 pandemic, healthcare utilization changed. We sought to examine the impact of the first COVID-19 surge on the outcomes of patients whose elective surgeries for diverticulitis were postponed and those who underwent urgent surgery during the surge.

**Materials and methods:** This was a retrospective study from a single tertiary center in the Northeast of the US. Patients whose elective surgeries were delayed, or who underwent urgent surgery for diverticulitis during the first COVID-19 surge (3/16/2020 to 8/1/2020) were included. A cohort from 2019 was used for comparison. Variables were compared between groups including: procedure, death, length of stay, disposition, stoma rate, technique for surgery, and leak rate.

**Results:** Forty-five patients were included in the COVID-19 group and 44 patients in the 2019 group. Twenty-seven patients had elective surgeries delayed during the COVID-19 surge. Ten (37%) required more urgent surgery, 80% with complicated disease. Six (22%) were admitted to the hospital and 13 (48%) required additional antibiotics. Eight (30%) patients postponed their surgeries indefinitely and 7 (26%) had surgery once permitted. There were no observed differences between the two groups in the rate of complicated disease, leaks, technique for surgery or stoma rate.

**Conclusions:** During the first COVID-19 surge, over 1/3 of patients whose elective diverticulitis surgeries were postponed required urgent surgery, a majority of whom had complicated disease. There were no apparent differences in outcomes when compared to a pre-pandemic cohort, highlighting the importance of a triage system with the ability to escalate surgery in a timely manner.

### Introduction

On March 11, 2020, the World Health Organization (WHO) declared the Coronavirus (COVID-19) a global pandemic in response to rising cases numbers [1]. During the early surge of the pandemic in the United States, Massachusetts was one of the hardest hit states. By early May, Massachusetts had the 3rd highest number of COVID-19 cases, behind only New York and New Jersey [2]. Peak rates of COVID-19 hospitalizations in the state occurred in late April, putting a significant strain on all hospitals in the region [3]. Our hospital was faced with a drastically changing landscape as elective surgeries were put on hold, staff were redeployed and stay at home orders were put in place.

A concern among healthcare professionals was that patients would delay or avoid care during the pandemic, which could result in more advanced stages of disease at the time of presentation. A study from the Veterans Affairs Hospital system demonstrated a significant reduction in

admissions for several emergency conditions from mid-March to mid-April 2020 during the early COVID-19 pandemic [4]. Early literature during the COVID-19 pandemic demonstrated a decline in admissions for other acute illnesses, including diverticulitis [4–9]. A single center in the UK found a 51% decrease in the presentations for acute diverticulitis diagnosed on CT during the acute pandemic period compared to the same time in 2019. Additionally, they found significantly higher rates of Hinchey II, III and IV diverticulitis and need for emergent operations, without differences in mortality [5].

In our institution, elective surgeries were put on hold during the early surge of COVID-19. Urgent and emergent surgeries continued, but there were questions surrounding COVID-19 and its impact on the surgical patient. The early experience in Wuhan, China showed that patients with asymptomatic COVID-19 infections (presumably during the “incubation period”) who underwent elective major abdominal surgery had a mortality of nearly 25% [10]. In a US population, peri-operative

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mortality during the early pandemic for urgent or emergent surgery in the setting of COVID-19 infection was 16.7% [11]. The COVIDSurg Collaborative looked at an international cohort of patients and found that half of patients with peri-operative COVID-19 infections developed postoperative pulmonary complications. They concluded that thresholds for surgery should be higher especially in more vulnerable populations and consideration for postponing non-urgent surgery should be attempted [12,13]. This information raised many questions as to the safety of performing elective surgeries during the first surge, which patients could be safely rescheduled and for how long. Delays in elective surgery have been shown to have a significant economic, emotional, and patient related outcome impact [14]. The long-term outcomes of these delays are yet to be fully realized.

Our objective was to examine the impact that the first COVID-19 surge had on perioperative outcomes of patients with diverticulitis. We hypothesized that patients in the COVID-19 group would have more complicated disease and worse outcomes. Specifically, we examined patients who were scheduled for elective resection for diverticular disease and were delayed by the first surge of COVID-19 as well as those who required urgent surgery during the pandemic and compared these to a time-matched cohort.

**Materials and methods**

This was a retrospective cohort study at a single tertiary referral institution in Massachusetts. The exposure of interest was the first COVID-19 surge among a population of patients with diverticular disease requiring surgical intervention (elective or urgent). The early COVID-19 surge was defined as March 16, 2020 to August 1, 2020. This time frame represents the period of greatest disease burden in our region and contains both the peak hospitalizations and deaths in the state for COVID-19 [3]. This also represented the period when elective surgeries were halted by state mandate. We wanted to see if the COVID-19 cohort of patients had any significant differences from patients before COVID. In order to do this, a comparison cohort was selected from the same time of year one year prior to the pandemic (March 16, 2019 to August 1, 2019).

Patients were included if they were scheduled for elective surgery for

diverticulitis during the early COVID-19 surge or presented acutely to either the hospital or clinic with severely symptomatic disease requiring surgery during this time period. While decision for surgery in patients with diverticulitis can be very nuanced, Fig. 1. displays our general approach to management decisions in our practice for patients with diverticulitis. For this study, the urgent group included both non-elective same-day admission surgeries for symptomatic disease as well as “emergency” inpatient surgeries (i.e., Hartmann procedures for feculent peritonitis). Patients seen for diverticulitis who opted for non-operative management were not included in the study. The patients in the COVID-19 cohort whose elective surgeries were delayed were identified through a departmental database that was prospectively created to track COVID-19 related operating room delays. Urgent surgeries were identified with an existing database maintained by our division that tracks all cases performed by our colorectal surgeons. This divisional database was also used to identify all patients who underwent surgery for diverticular disease during a time-matched period from one year prior to the pandemic (March 16, 2019 through August 1, 2019).

Chart review utilizing our electronic medical record system was performed to capture demographics, operative details, and disease course. Records were reviewed from time of presentation through post-operative visits to capture clinical course at the time of data collection. Patients were classified as complicated or uncomplicated [15]. Surgeries were categorized as either elective or urgent. During the COVID-19 surge, our institution maintained an “OR Escalation” policy that allowed the surgeon to request surgery be performed despite the COVID-19 restrictions if they considered it to be urgent or emergent. If a patient whose elective surgery was delayed ultimately required urgent surgery through the OR escalation system during the surge, they crossed over into the urgent category. Additionally, new patients who presented acutely during the pandemic period that required surgery were categorized as urgent such as patients who presented as transfers, direct admissions, or through the ED who required surgery. Any discrepancies regarding the categorization of type of procedure were resolved through discussion with the primary surgeon and senior author. Patients from the 2019 comparison cohort were categorized as elective if they presented from home on the day of surgery or urgent if they went to surgery from the ED or inpatient status.

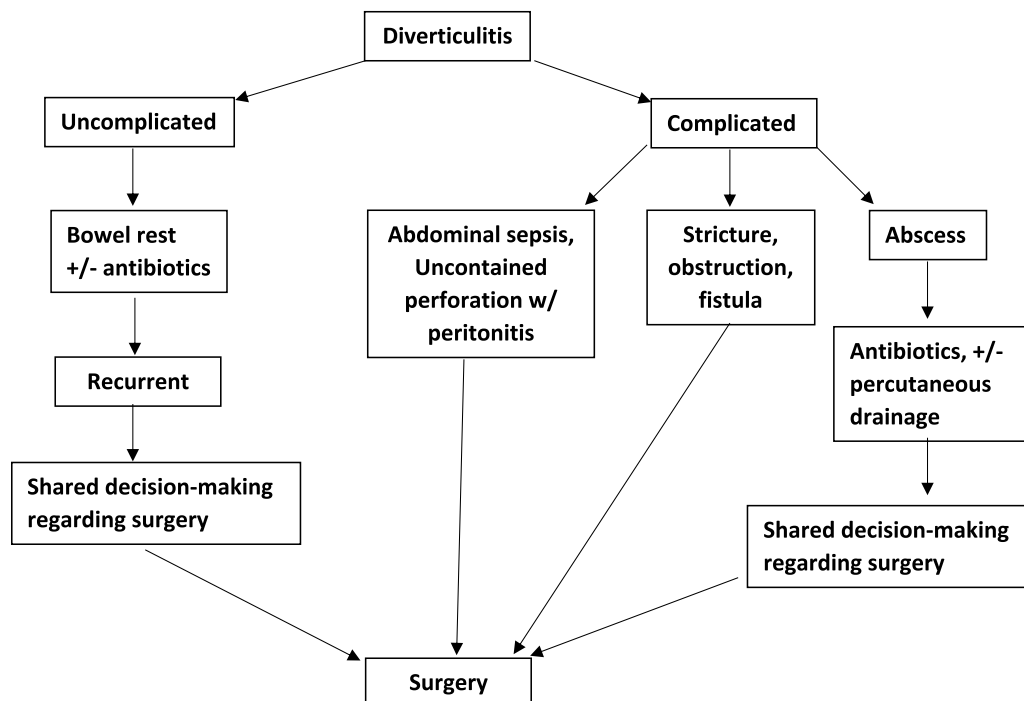


Fig. 1. Flowchart demonstrating management decisions for patients presenting with diverticulitis.

All patients who met our inclusion criteria during our study period of interest and the time-matched cohort were included. Patient characteristics and perioperative outcomes were compared between patients in the COVID-19 and pre-COVID-19 time-matched cohort. Characteristics included for analysis were age, gender, body mass index, American Society of Anesthesiology (ASA) score, diabetes, steroid use, complicated or uncomplicated disease. Perioperative outcomes included stoma rate, length of stay (LOS), disposition, technique for surgery, estimated blood loss (EBL), operative time and death. Subset analyses were performed among patients in each group who underwent elective surgery and urgent surgery.

Categorical variables were compared with Pearson’s Chi-squared test. Parametric continuous variables were compared using Student’s t-test, while non-parametric continuous variables were compared with Mann-Whitney U test. Analyses were performed with Stata 13.1 (College Station, TX). There were rare missing data points, but any missing data were left out of the analysis. P values of <0.05 were considered statistically significant.

This research was approved by our Institutional Review Board (IRB).

**Results**

In the COVID-19 group, 45 patients were identified (Fig. 2). Twenty-seven patients were booked for elective surgery and were delayed due to COVID-19. Of the 27 patients whose elective surgeries were delayed, 15 (56%) had complicated disease, of which 8/15 (53%) required urgent surgery, whereas only 2/12 (17%) with uncomplicated disease required urgent surgery. In contrast, of the elective delayed patients, 5/15 (33%) with complicated diverticulitis safely postponed their surgery until after the surge window compared to (10/12) 83% of patients with uncomplicated diverticulitis.

Two (7%) elective delayed patients with complicated diverticulitis died while awaiting surgery: one from shock (not related to diverticulitis) and one from COVID-19. Ten (37%) elective delayed patients had progression of symptoms leading to urgent surgery during the surge (8/10 with complicated disease). Seven elective delayed patients had surgery once elective surgeries were permitted after August 1st, 2020, 3 of which (43%) had complicated disease. Eight elective delayed patients (30%) postponed their surgeries indefinitely only two of which (25%) had complicated disease.

Eighteen additional patients presented acutely during the pandemic surge and required urgent surgery. In total, 28 patients in the COVID-19 group had urgent surgery. Of the 28 patients who underwent urgent surgery during the surge (10 from the elective group), 26 (93%) had

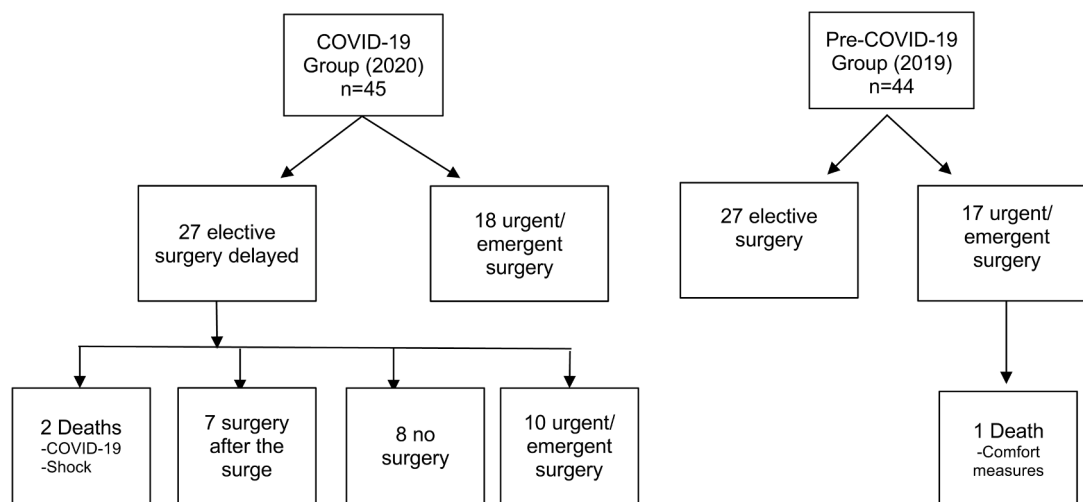
complicated disease.

Of the 27 elective delayed patients during the first COVID-19 surge, six (22%) required admission to the hospital and 13 (48%) required additional courses of antibiotics. Ten patients (37%) required more urgent surgery due to ongoing or escalating symptoms. Of these 10 patients, 50% required admission prior to surgery and 90% needed additional antibiotics.

Patients from the COVID-19 group who underwent surgery urgently during the surge or electively after the first surge was over were compared to all patients who underwent surgery for diverticulitis in the pre-COVID-19 group (Table 1). Between the two groups, there were no differences in baseline characteristics, except for a higher female predominance in 2020 (76% vs. 50%, p = 0.01). In the comparison group from 2019, 44 patients were identified who underwent surgery for diverticulitis, of these 27 were elective and 17 were urgent, respectively. There were no differences identified in the rate of complicated disease, anastomotic leak rate, technique for surgery, estimated blood loss or

**Table 1**  
Characteristics of patients who underwent surgical intervention for diverticulitis during the early COVID-19 surge (3/16/2020-8/1/2020) compared to the pre-COVID-19 group (3/1/2019- 8/1/2019).

	COVID (2020) n=45	Pre-COVID (2019) n=44	P Value
Patients undergoing surgery	35 (78%)	44 (100%)	0.001
Age, mean ± SD	65.2 ± 11.0	61.8 ± 13.0	0.18
Gender, n (%)			
Female	34 (76%)	22 (50%)	0.01
Male	11 (24%)	22 (50%)	
BMI (mean ± SD)	28.7 ± 5.6	30.5 ± 7.0	0.18
Diabetes	5 (11%)	6 (14%)	0.72
Steroids	7 (16%)	4 (9%)	0.35
ASA			
I	0 (0%)	0 (0%)	0.29
II	21 (51%)	18 (41%)	
III	20 (49%)	24 (55%)	
IV	0 (0%)	2 (4%)	
Type of Diverticulitis			
Uncomplicated	12 (27%)	13 (30%)	0.59
Complicated	33 (73%)	31 (70%)	
Leak	1 (3%)	2 (5%)	0.68
EBL (mL), median (IQR)	100 (50-250)	100 (50-200)	0.67
Operative time (min)	254 ± 93.2	201 ± 76.1	0.007
Laparoscopic	23 (69%)	29 (66%)	0.97
Stoma	14 (38%)	19 (43%)	0.63



**Fig. 2.** CONSORT diagram. Patients included in our study for diverticulitis during the early COVID-19 surge (3/16/2020-8/1/2020) compared to time period matched, pre-COVID-19 surge (3/16/2019-8/1/2019).

stoma rate. However, the operative time was significantly longer in the COVID-19 group compared to the pre-COVID-19 group (254 min vs. 201 min,  $p = 0.007$ ).

The types of surgeries performed are listed in Table 2. There were no apparent differences in the type of procedure between the two groups. A similar percentage of patients in both groups underwent a primary anastomosis without a stoma (60% COVID-19 vs. 57% pre-COVID,  $p = NS$ ).

We then analyzed only patients who were scheduled for elective surgeries in both groups (Table 3). Mean length of stay (LOS) was 6.1 and 4.9 days for the COVID-19 and control group, respectively ( $p = 0.16$ ). There were no observed differences in ASA, stoma rate, technique, disposition or death.

There were no apparent differences between patients undergoing urgent surgery for diverticulitis during the first surge compared to the time matched cohort in 2019 with respect to ASA, LOS, disposition, technique, or death (Table 4). There was a higher rate of stomas in patients who underwent urgent surgery for diverticulitis in the 2019 group when compared with the COVID-19 cohort (94% vs. 61%,  $p = 0.02$ ).

### Discussion

Early literature on surgery in COVID-19 patients, demonstrated that operating on elective patients who then developed COVID-19 carries significant morbidity and mortality [10]. Our understanding of the natural history of the disease is still evolving, but we have seen continued surges and strains on the healthcare system two years into the pandemic. Given the large volume of elective surgeries being cancelled during the pandemic worldwide, these disruptions in patient care require a thoughtful approach to reinstatement of elective surgery to mitigate the effects of delays [16,17].

In our institution, there was a significant burden of hospitalized COVID-19 patients during the spring of 2020, elective surgeries were put on hold and systems were rapidly developed to track these patients. A database was created to track all elective cases that were cancelled and categorize them by benign, symptomatic benign, and malignant disease to triage patients who were postponed. Patients were typically called directly by the surgeon to check in and discuss the cancellation. In instances where patients were having ongoing or escalating symptoms, an OR escalation process was created to expedite booking. The OR escalation process allowed direct communication between attending surgeons and OR team to expediate and triage of cases. There was also frequent communication among our division to discuss triage of cases.

During the first COVID-19 surge, 27 patients had elective surgery delayed and 10 patients (37%) required more urgent surgery due to persistent or ongoing symptoms. The majority (8/10, 80%) of these patients had complicated disease. The majority of patients with uncomplicated disease (83%) were able to wait until after the surge to have their elective surgery or postponed their procedure. We believe that the effective tracking system and OR escalation process instituted at our center during the surge resulted in early recognition and intervention for patients with worsening disease and is likely the reason that adverse

**Table 2**

Comparison of type of procedure performed for diverticulitis during COVID-19 surge (2020) and pre-COVID 19 (2019). \*Patient with significant radiation proctitis and incontinence.

Type of Procedure	COVID (2020) n = 35	Pre-COVID (2019) n = 44	P Value
Diversion alone	0 (0%)	5 (11%)	0.24
Hartmann's	7 (20%)	8 (18%)	
Resection, anastomosis, and diversion	6 (17%)	6 (14%)	
Resection and anastomosis	21 (60%)	25 (57%)	
*APR	1 (3%)	0 (0%)	

**Table 3**

27 patients with diverticulitis during the early COVID-19 surge were initially considered "elective" and surgery was delayed, ultimately 17 of these went on to have surgery and were compared with the 27 patients who had elective surgery for diverticulitis. During 2019 (3/16/2019-8/1/2019).

Elective delayed patients	COVID (2020) n=27	Pre-COVID (2019) n=27	P Value
ASA			
I	0 (0%)	0 (0%)	0.52
II	14 (61%)	14 (52%)	
III	9 (39%)	13 (48%)	
IV	0 (0%)	0 (0%)	
LOS (mean days)	6.1 ± 2.7	4.9 ± 2.6	0.16
Stoma	3 (16%)	3 (11%)	0.64
Disposition (rehab)	0 (0%)	2 (7%)	0.12
Laparoscopic	13 (76%)	21 (78%)	0.92
Death	2 (7%)	0 (0%)	0.15

**Table 4**

18 patients presented acutely and underwent urgent surgery during the early COVID-19 surge (3/1/2020-8/1/2020) compared to 17 patients undergoing urgent surgery during the similar time period in 2019.

Patients initially considered "urgent"	COVID (2020) n = 18	Pre-COVID (2019) n = 17	P value
ASA			
I	0 (0%)	0 (0%)	0.25
II	7 (39%)	4 (24%)	
III	11 (61%)	11 (65%)	
IV	0 (0%)	2 (12%)	
LOS (median, IQR)	16 (8-16)	13 (9-16)	0.96
Stoma	11 (61%)	16 (94%)	0.020
Disposition (rehab)	2 (11%)	5 (29%)	0.39
Laparoscopic	11 (61%)	8 (47%)	0.40
Death	1 (6%)	1 (6%)	0.97

outcomes were mitigated. In future surges in which elective surgery are postponed, patients with complicated disease should be managed with caution and efforts should be made to minimize OR delays for those patients that are at highest risk of developing further complications.

Because of the different landscape during the early pandemic, there were slightly different guidelines for what was considered "elective" vs. "urgent" between 2019 and 2020. The urgent patients in the COVID-19 group represents patients who acutely presented through the ED or to clinic and were operated on within the same admission or who required OR escalation in the outpatient setting due to ongoing or worsening symptoms. In 2019, there was a more "traditional" definition of urgent surgery (Hinchey II, III, or IV perforated diverticulitis or other emergent complication of diverticulitis such as large bowel obstruction, symptomatic fistula, etc.). We believe that these differences of the definition of "urgent" during these time periods explains the stark difference in stoma rates between the two groups (61% in the COVID-19 group vs. 94% in the time-matched group), as some of the patients labeled as "urgent" during COVID-19 had smoldering uncomplicated disease that did not require fecal diversion.

Despite these delays, we did not observe worse outcomes. Patients with uncomplicated disease made up a majority of the postponed and non-operative cases. This is not unexpected as we know patients with complicated disease are more likely to have recurrences and require surgery compared to patients with uncomplicated disease [15]. Although there were no differences in the rate of stoma creation in all patients who underwent surgery, in subgroup analysis there were more stomas created in the urgent surgery group from 2019 (Table 4). This difference could be due to the nature of variability in presentation of diverticulitis, or possibly that surgeons in the COVID-19 era were less likely to do a staged approach.

Of those patients who had surgery for diverticulitis during the COVID surge, there was a longer average operative time, compared to the time-



matched cohort. This may be a surrogate for more complexity compared to patients who needed surgery the prior year. Additionally, this can also be explained by reduced operating room volumes and a pervasive concern for the impact of the pandemic on resident and fellow education, leading to a more concerted effort to maximize learning opportunities and trainee involvement in those cases.

We matched our cohorts by time to understand how or if the population had changed. Prior literature examining the early surge and diverticulitis has suggested that admission rates decreased, and severity of disease increased [5,7]. This may be explained by the initial fear of seeking care or delays that may have occurred in receiving care. Most of the literature has focused on disease burden and admissions, rather than patient outcomes. A single institution study found patients during the pandemic were more likely to require surgery and had more severe disease (Hinchey II, III and IV), but did not find any difference in length of stay or mortality [5]. We did not observe differences in perioperative outcomes between the two groups, which highlights the importance of creating a system to triage and track patients whose surgery is delayed. Our findings are in line with a study by Soriano *et al.*, which examined the burden of diverticular disease and noted an overall decrease in uncomplicated diverticulitis episodes, but no impact on rate of complicated disease [9].

This study has several limitations. This was a retrospective study, utilizing chart review and may have failed to capture all the dynamic aspects of OR escalation patterns during the pandemic. The relatively small sample size in this study limits our ability to draw strong conclusions between our two cohorts and limits our ability to detect differences that may actually exist (type II error). Overall, our groups were evenly distributed with a similar number of patients undergoing elective surgery and presenting acutely needing urgent surgery in the COVID-19 group and the pre-COVID group. It is possible however, that some of the elective delayed patients may not have all been included in the tracking database. Additionally, we had no way to identify patients in the 2019 cohort who may have postponed surgery for any reason. If there were patients who delayed in the 2019 cohort, not being able to track their outcomes may have further limited our ability to detect differences between the two cohorts due to the pandemic.

This was a single institution study and given the regional variability during the first COVID-19 surge in early 2020, may not be generalizable to every practice setting. Our data and cohort represent a time where our hospital was greatly affected, elective surgeries were put on hold and the normal flow to patient care was interrupted. Throughout the pandemic, we have seen regional variability in surges where various regions of the country have experienced hospital system overload at different times. With recent variant strains, we have continued to see periods of significant strain on the healthcare system where elective cases have needed to be postponed and thus our experience may be generalizable to these surges.

## Conclusion

We have continued to experience surges in COVID-19 and will likely continue to experience seasonal and variant surges that postpone elective surgery. When elective cases are postponed, patients with complicated diverticulitis should be monitored closely with strong consideration for operative escalation. During the first COVID-19 surge, over one third of patients whose elective surgery for diverticulitis were postponed required more urgent surgery, a majority of whom had complicated disease. Despite this finding, there were no apparent differences in perioperative outcomes when compared to a pre-pandemic time-matched cohort. This highlights the importance of creating a robust triage and tracking system for patients whose surgeries are delayed with the ability to escalate to more urgent surgery in a timely

manner.

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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