



Feasibility of cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC) for advanced peritoneal surface tumors during the COVID-19 pandemic: A single-institution experience

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Abstract

Background and objectives: Cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC) is a complex treatment used in selected patients with peritoneal surface malignancies. HIPEC procedures are time and resource intensive. The primary aim of this analysis was to compare the experience of treating advanced abdominal tumors with CRS-HIPEC before and during the coronavirus disease 2019 (COVID-19) pandemic.

Methods: Patients included in this analysis received CRS-HIPEC at a single center during either a prepandemic (March 18, 2019–March 17, 2020) or pandemic (March 18, 2020–February 5, 2021) interval. A retrospective chart review was performed.

Results: Our analysis included 67 patients: 30 (45%) treated prepandemic and 37 (55%) treated during the pandemic. Median age at the time of operation was 58 years (interquartile range: [49–65]); 53% of patients were women. Patients treated during the pandemic presented with higher peritoneal cancer index (PCI) scores with 32% ($n = 12$) having a PCI > 20 at the time of surgery ($p = 0.01$). Five patients had delays in surgery due to the pandemic. Rates of overall postoperative morbidity, reoperation, and readmission were not different between the cohorts.

Conclusions: Despite presenting with more extensive disease, patients treated with CRS-HIPEC during the height of the COVID-19 pandemic had comparable perioperative outcomes to patients treated prepandemic.

KEYWORDS

COVID-19, cytoreduction surgical procedures, hyperthermic intraperitoneal chemotherapy, peritoneal surface malignancies

1 | INTRODUCTION

The allocation of medical resources shifted significantly during the initial phase of the coronavirus disease 2019 (COVID-19) pandemic. When the Centers for Disease Control and Prevention declared a national state of emergency in March 2020, surgeons were encouraged to temporarily suspend elective operations to prioritize urgent and nondeferrable oncologic procedures.¹ Surgical societies such as the Society of Surgical Oncology, the Society of American Gastrointestinal and Endoscopic Surgeons, and the American College of Surgeons also published recommendations on how to safely reschedule and prioritize procedures in an attempt to safeguard hospital beds and resources for COVID-19 patients and minimize viral spread.²⁻⁴

Although temporary, these provisions, as well as fear of spreading COVID-19, had lasting impacts on the delivery of care. To date, more than 93 million cases and over 1 million deaths from COVID-19 have been reported in the United States.⁵ At the height of the COVID-19 pandemic lockdowns in April 2020, health maintenance testing was significantly reduced, with the number of cancer screenings, biopsies, office visits, and operations for breast, colon, prostate, and lung cancer 50%–85% lower than the previous year.⁶ Cancer patients awaiting surgical care were often hesitant to undergo surgical procedures and opted, instead, to receive neoadjuvant chemotherapy, hormonal therapy, or radiotherapy, while awaiting surgery.⁷ Specific questions were raised about how to prioritize patients with peritoneal malignancies that required cytoreductive surgery and hyperthermic intraperitoneal chemotherapy (CRS-HIPEC). For these individuals, receipt of operative care in a timely manner is often critical. However, concerns were raised about resource utilization and allocation, as CRS-HIPEC is a complex and resource intensive procedure, often requiring an intensive care unit (ICU) stay and a prolonged hospital course in many cases.^{8,9}

At present, no studies have reported on the experience of performing CRS-HIPEC in patients with primary gastrointestinal malignancies during the COVID-19 pandemic. The primary aim of this analysis was to compare the experience of treating peritoneal tumors with HIPEC at a single center before and during the height of the COVID-19 pandemic restrictions. The study sought to accomplish the following aims: (1) characterize the impact of the pandemic on the referral and presentation of patients with advanced abdominal tumors, (2) report the short-term outcomes of the patients who received CRS-HIPEC during this period, and (3) identify the number of patients who had disruptions in care due to COVID-19 restrictions. In doing so, we hope to guide future recommendations on both the surveillance of patients treated during the pandemic and the management of patients with complex peritoneal disease during potential future periods of resource scarcity.

2 | MATERIALS AND METHODS

2.1 | Study population

This is a retrospective study at a single quaternary care center in the United States. Patients included in this analysis received CRS-HIPEC

between March 18, 2019 and February 5, 2021. The cohort was subdivided into two intervals: prepandemic (March 18, 2019 to March 17, 2020) and pandemic (March 18, 2020 to February 5, 2021). The start of the pandemic time interval was defined by the date that elective cases were paused at this center and near-complete visitor restrictions were enacted (March 18, 2020). The end of the pandemic time interval was selected as the date that patient visitor restrictions were lifted at this center (February 5, 2021). The comparison prepandemic period was the year before the pandemic (March 18, 2019 to March 17, 2020). Patients <18 years of age, those whose procedure was aborted or did not receive intraperitoneal chemotherapy, and patients receiving CRS-HIPEC for strictly palliative purposes were excluded from this analysis. This study was reviewed and approved by the Institutional Review Board of the Johns Hopkins University School of Medicine.

2.2 | Baseline characteristics

Demographic characteristics included age, sex, and race (White, Black, Asian, or other). Baseline clinical characteristics included American Society of Anesthesiologists (ASA) Classification, health insurance status (private or government), functional status, primary site of tumor (colorectal, appendix, gastric, mesothelioma, ovarian, or small bowel), obesity (body mass index ≥ 30), smoking history, diabetes, hypertension, preoperative chronic steroid use, prior CRS-HIPEC procedure, preoperative albumin (stratified as <4.0 or ≥ 4.0), time from initial clinic visit to surgery (days), time from last chemotherapy session to surgery (days), operative time (minutes), intraoperative estimated blood loss, intraoperative transfusion of red blood cells, peritoneal cancer index (PCI), completeness of cytoreduction score, procedure type, and ostomy creation/revision.¹⁰

2.3 | Outcomes

The primary outcome was postoperative morbidity. Overall morbidity was defined as the occurrence of one or more of the following adverse events within 30 days postoperatively: wound infection (superficial), wound dehiscence, pneumonia, urinary tract infection (UTI), venous thromboembolism (VTE/PE), cardiac complication (composite of myocardial infarction or cardiac arrest), infection requiring antibiotics, unplanned reintubation, bleeding requiring transfusion, renal complication (composite of moderate/severe acute kidney injury or acute renal failure requiring renal replacement therapy), dependence on ventilator >48 h postoperatively, organ space surgical infection, anastomotic leak, or reoperation. Serious morbidity was defined based on Clavien-Dindo Class III–IV (cardiac or renal complication, shock/sepsis, unplanned intubation, on ventilator >48 h, organ space surgical site infection, or reoperation).¹¹

Secondary outcomes included discharge destination, in-hospital mortality, weekend discharge, ileus or nasogastric tube replacement, hospital length of stay (LOS), ICU LOS, postoperative readmission,

and time to readmission (<30 days, 30–60 days, or 60–90 days). LOS was defined as number of days from operation to discharge. Discharge destination was defined as home, home with home health services, or rehabilitation facility (which includes subacute, acute, or ventilator facilities).

2.4 | Statistical analysis

Baseline characteristics and outcomes were compared between the pre-pandemic and pandemic patient cohorts. Fisher's exact test was used to compare categorical variables and Wilcoxon rank-sum (Mann-Whitney) test was used to compare continuous variables. Statistical significance was indicated by $p < 0.05$ (two-tailed). All analyses were performed using Stata software, version 17.0 (Stata Statistical Software: Release 15, StataCorp LLC).

3 | RESULTS

3.1 | Study population

A total of 68 patients who underwent CRS-HIPEC for peritoneal metastases during the study period were identified. After applying our exclusion criteria (one patient was excluded for a strictly palliative operation), 67 patients remained in the study: 30 (45%) of whom received CRS-HIPEC during the pre-pandemic interval and 37 (55%) of whom received CRS-HIPEC during the pandemic interval.

There were no significant differences in age, sex, or race for patients who underwent surgery during the pandemic compared with patients who underwent CRS-HIPEC surgery in the pre-pandemic interval. Overall median age at surgery was 58 years (interquartile range [IQR]^{49–65}) and 34 (53%) patients were women (Table 1). There was no difference in ASA classification, health insurance status, functional status, or rates of obesity, smoking history, diabetes, hypertension, or chronic steroid use for the two patient comparison groups (Table 1). The most common primary site of tumor was the appendix (43% in both groups), followed by colorectal and gastric.

Patients who underwent CRS-HIPEC during the pandemic trended toward higher median PCI scores (12.5 [IQR:7–24.5] vs. 10.5 [IQR:8–12] $p = 0.18$) and the number of patients who underwent CRS-HIPEC with a PCI > 20 was significantly higher in the pandemic group compared with pre-pandemic (12 [32%] vs. 2 [7%], $p = 0.01$). Median operative time was longer for patients receiving CRS-HIPEC during the COVID-19 pandemic time interval than during the pre-pandemic time interval (720 [IQR: 600–960] vs. 660min [IQR: 540–840], $p = 0.04$). There was no significant difference in the types of procedures performed or in the rates of ostomy creation between the comparison groups. All patients, except those with a diagnosis of a primary ovarian cancer, received HIPEC with single agent mitomycin-C at a concentration of 25 mg/m² for 90 min in accordance with hospital protocol. Those with primary ovarian cancer ($n = 4$) received cisplatin at a concentration of 100 mg/m² for 90 min.

3.2 | Outcomes

There was no significant difference in rates of overall or serious morbidity between the pandemic and pre-pandemic CRS-HIPEC groups (Table 2). Overall, the rate of any morbidity was 73% ($n = 49$) and the rate of serious morbidity was 31%. The most common morbidity experienced differed between the groups. In the pre-pandemic group, the most common complications were UTI ($n = 4$ [15%]) and VTE ($n = 4$ [15%]); 48% ($n = 13$) of patients experienced an ileus. For patients treated during the pandemic, the most common complication was infection requiring antibiotics ($n = 10$ [27%]) and bleeding requiring transfusion ($n = 8$ [22%]); 33% ($n = 12$) of these patients experienced an ileus.

Patients treated during the pandemic experienced higher rates of reoperation ($n = 5$ (14%) vs. $n = 1$ (3%)). However, this difference was not statistically significant ($p = 0.21$). Total LOS and ICU days did not differ significantly between the two groups. Although discharge destination was not significantly different between the patients treated during or before the pandemic, patients treated during the pandemic experienced higher rates of discharge to a rehabilitation center ($n = 3$ [8%] vs. 0 [0%]) and one patient treated during the pandemic experienced an in-hospital mortality. During the pandemic, there was a significantly lower rate of weekend discharge than pre-pandemic ($n = 9$ [25%] vs. $n = 16$ [53%], $p = 0.02$). Although readmission rates were lower in the pandemic group ($n = 10$ [27%] vs. $n = 12$ [40%]), this difference was not statistically significant ($p = 0.30$). The reasons for readmission and reoperation in the pandemic group are shown in Table 3.

3.3 | Subanalysis of patients impacted by COVID-19: Delayed surgical intervention

Five patients in the pandemic group (14%) experienced a delay in surgical planning and scheduling due to the COVID-19 pandemic. Delay in scheduling surgery was due to a diagnosis of COVID-19 ($n = 1$), extension of neoadjuvant chemotherapy to avoid care during pandemic ($n = 1$), and delay in being seen in clinic after last dose of chemotherapy due to concern of contracting COVID-19 ($n = 3$). At last follow-up, two patients had no evidence of disease, one patient died due to multifactorial causes with COVID-19 listed as a contributor, one patient was alive with stable disease, and one patient had a recurrence and underwent a repeat CRS/HIPEC procedure (Table 4).

4 | DISCUSSION

The COVID-19 pandemic has posed unprecedented challenges to all aspects of society and its impact on healthcare access and delivery has been profound. The pandemic exerted a lasting impact on the paradigm of healthcare, transitioning many in-person visits to telehealth consults, delaying care for routine health checkups, and

TABLE 1 Demographic, clinical, and operative characteristics stratified by time period

Characteristic, n (%)	Total 67	Prepandemic 30 (44.8%)	Pandemic 37 (55.2%)	p
Age in years, median (IQR)	58 (49–65)	56 (47–63)	62 (50–67)	0.20
Female	34 (53)	17 (57)	18 (49)	0.62
Race				
White	47 (70)	22 (73)	25 (68)	0.69
Black	12 (18)	6 (20)	6 (16)	
Asian	6 (9)	2 (7)	4 (11)	
Other	2 (3)	0 (0)	2 (5)	
ASA classification				0.39
II	16 (24)	9 (30)	7 (19)	
III	50 (75)	21 (70)	29 (78)	
IV	1 (2)	0 (0)	1 (3)	
Health insurance status				
Private	44 (66)	22 (73)	22 (59)	0.30
Government	23 (34)	8 (27)	15 (41)	
Dependent functional status	1 (1)	1 (3)	0 (0)	0.45
Primary site		0.99		
Colorectal	19 (28)		8 (27)	11 (30)
Appendix	29 (43)		13 (43)	16 (43)
Gastric	7 (10)		3 (10)	4 (11)
Mesothelioma	3 (4)		1 (3)	2 (5)
Ovarian	4 (6)		3 (10)	1 (3)
Small bowel	5 (7)		2 (7)	3 (8)
Obese (BMI > 30)	20 (30)	6 (20)	14 (38)	0.18
Smoking history	22 (34)	12 (40)	11 (30)	0.44
Diabetes	9 (13)	2 (7)	7 (19)	0.17
Hypertension	32 (48)	10 (33)	22 (59)	0.05
Chronic steroid use	4 (6)	3 (10)	1 (3)	0.32
Prior CRS or HIPEC	15 (22)	5 (17)	10 (27)	0.38
Albumin < 4.0	14 (21)	9 (30)	5 (14)	0.13
Time from clinic to surgery (days)	48 (29–107)	40 (27–81)	57 (31–109)	0.38
Time from last chemotherapy to surgery (days)	34 (31–46)	40 (34–45)	31 (28–49)	0.05
Operative time, minutes	720 (600–960)	660 (540–840)	720 (600–960)	0.04*
Estimated blood loss (ml)	500 (350–1000)	500 (350–1000)	500 (325–900)	0.54
Intraoperative RBC transfusion	21 (31)	8 (27)	13 (35)	0.60
PCI, median (IQR)	11 (7–17)	10.5 (8–12)	12.5 (7–24.5)	0.18
PCI > 20	14 (21)	2 (7)	12 (32)	0.01*
CC				0.62
CC0	63		29	34
CC1	4		1	3

TABLE 1 (Continued)

Characteristic, n (%)	Total 67	Prepandemic 30 (44.8%)	Pandemic 37 (55.2%)	p
Procedure type				
Gastric resection	14 (21)	4 (13)	10 (27)	0.23
Partial colectomy	32 (48)	13 (43)	19 (51)	0.62
Small bowel resection	27 (40)	12 (40)	15 (41)	1.00
LAR	20 (30)	9 (30)	11 (30)	1.00
Liver resection	13 (19)	5 (17)	8 (22)	0.76
Distal pancreatectomy	7 (10)	3 (10)	4 (11)	1.0
Ostomy creation/revision	16 (24)	5 (17)	11 (30)	0.26

Abbreviations: APR, abdominoperineal resection; ASA, American Society of Anesthesiologists; BMI, body mass index; CC, completeness of cytoreduction; CRS, cytoreductive surgery; HIPEC, hyperthermic intraperitoneal chemotherapy; IBD, inflammatory bowel disease; IQR, interquartile range; LAR, low anterior resection; PCI, peritoneal cancer index; RBC, red blood cell.

*Indicates statistical significance at $p < 0.05$.

postponing elective procedures across a variety of surgical subspecialties to minimize viral spread and preserve resources for COVID-19 patients.¹²⁻¹⁸ Although many studies have explored the experience of surgical treatment for a myriad of malignancies during the early COVID-19 pandemic, this is the first study to report on the experience and surgical outcomes of patients treated with CRS-HIPEC for gynecologic malignancies during the COVID-19 pandemic.¹⁹⁻²¹

We identified 67 patients with advanced abdominal malignancy treated at a single center with CRS-HIPEC between March 18, 2019 and February 15, 2021: 30 (45%) patients received treatment during the prepandemic interval, whereas 37 (55%) received CRS-HIPEC during the pandemic. Despite restrictions limiting the use of elective surgeries at our center, we found that the number of CRS-HIPEC operations performed was maintained in the first year of the pandemic. Moreover, although number of patients treated during the pandemic with PCI scores > 20 was significantly higher and 14% experienced delays in surgical scheduling, rates of postoperative morbidity, reoperation, and readmission were not statistically different between patients treated during the prepandemic and pandemic intervals.

To date, the only study that has explored the implementation and efficacy of CRS-HIPEC during the COVID-19 pandemic was limited to patients with ovarian cancer.²² This project concluded that, with appropriate patient selection, CRS-HIPEC for ovarian malignancy is both safe and feasible during the COVID-19 pandemic. As in this single-center study, we also found no differences in short-term outcomes of patients receiving CRS-HIPEC before and during the pandemic, reflecting the ability to safely provide complex care despite shifts in healthcare prioritization and resource allocation during the pandemic.

Nonetheless, it is important to monitor long-term outcomes of our cohort closely, not only because patients receiving CRS-HIPEC during the pandemic were more likely to have higher volume disease at the time of surgery, but also because five patients (13.5%) experienced delayed care due to the pandemic. There are several

potential reasons that the number of patients with an intraoperative PCI score of >20 underwent surgery during the pandemic. Patients might have avoided health care facilities due to a fear of contracting the virus, leading to delayed diagnosis and more advanced disease at the time of surgery. The increase in PCI might also have reflected a shift in thought by healthcare professional across disciplines of the risks and benefits of a complex operation during the pandemic and the eligibility criteria for patients looking to receive CRS-HIPEC. A proposal was circulated in France at the beginning of the pandemic (April 2020) by the BIG-RENAPE and RENAPE groups, which recommended to prioritize administration of CRS-HIPEC in patients for whom systemic chemotherapy would not be a suitable temporary or permanent alternative to CRS-HIPEC.²³ Young patients with few comorbidities and limited peritoneal spread of disease would also be suitable candidates, as well as patients with the following disease processes: patients with pseudomyxoma peritonei, resectable malignant peritoneal mesotheliomas, peritoneal metastases of colorectal origin if unresponsive after up to 12 cycles of systemic chemotherapy, and for first-line ovarian carcinomatosis, if resectable, coupling HIPEC with CRS would have to be evaluated and approved by an independent center.²³ Although there were no official consensus statements or guidelines about the use of CRS-HIPEC in the United States during this period, it is possible that some institutions adopted these guidelines during the early stages of the pandemic.

Changes in prioritization guidelines for receipt of elective procedures was compounded by modifications in hospital infrastructure that affected patient care during the COVID-19 pandemic. To support the changing needs of the pandemic, our center, like many hospitals at the time, experienced a high rate of turnover of nurses and residents across its many units.²⁴ Before the pandemic at our institution, two surgical ICUs (SICU) were available to care for these patients after surgery (with the number of beds ranging from 34 to 40 based on staffing). During the pandemic, both the medical ICU and one of the SICUs were temporarily renovated to negative

TABLE 2 Outcomes stratified by pandemic and prepandemic periods

Outcome (%)	Total 67	Prepandemic N = 30	Pandemic N = 37	p
Discharge destination				
Home/Home Health Services	63 (94)	30 (100)	33 (89)	0.25
Rehabilitation ^a	3 (4)	0 (0)	3 (8)	
In-hospital mortality	1 (2)	0 (0)	1 (3)	
Weekend discharge	25 (38)	16 (53)	9 (25)	0.023
Overall morbidity ^b	49 (73)	23 (77)	26 (70)	0.59
Serious morbidity ^c				
Superficial SSI	4 (6)	1 (4)	3 (8)	0.63
Pneumonia	4 (6)	1 (4)	3 (8)	0.63
UTI	9 (13)	4 (15)	5 (14)	1.00
VTE	8 (11)	4 (15)	4 (11)	0.72
Infection requiring antibiotics	13 (19)	3 (10)	10 (27)	0.12
Reintubation	4 (6)	1 (3)	3 (8)	0.62
Bleeding requiring transfusion	11 (16)	3 (10)	8 (22)	0.32
On ventilator >48 h	3 (4)	1 (3)	2 (5)	1.00
Organ space infection ^d	6 (9)	1 (3)	5 (14)	0.21
Anastomotic leak	5 (7)	1 (3)	4 (11)	0.37
Ileus/NGT replacement	25 (40)	13 (48)	12 (33)	0.30
Reoperation	6 (9)	1 (3)	5 (14)	0.21
LOS (days), median (IQR)	14 (10–21)	12 (9–17)	14 (11–22)	0.39
Total ICU days	3 (2–4)	2 (1–4)	3 (2–4)	0.09
Readmission	22 (33)	12 (40)	10 (27)	0.30
Time to readmission				
<30 days	18 (82)	10 (83)	8 (80)	0.77
30–60 days	3 (14)	2 (17)	1 (10)	
60–90 days	1 (5)	0 (0)	1 (1)	

Abbreviations: IQR, interquartile range; LOS, length of hospital stay; NGT, nasogastric tube; SSI, surgical site infection; UTI, urinary tract infection; VTE, venous thromboembolism.

^aIncludes acute rehab, subacute rehab, ventilator rehab.

^bOverall morbidity: Wound infection (superficial), wound dehiscence, pneumonia, UTI, venous thromboembolism (DVT/PE) cardiac complication, shock/sepsis, unplanned intubation, bleeding transfusion, renal complication, on ventilator >48 h, organ space surgical site infection, and anastomotic leak, reoperation.

^cSerious morbidity: Clavien-Dindo III–IV (cardiac complication, shock/sepsis, unplanned intubation, renal complication, on ventilator >48 h, organ space SSI, and reoperation).

^dComposite of deep SSI and intrabdominal infection.

pressure units. Residents were placed on a rotating schedule of coverage every 4 days, to allow for more time out of the hospital instead of spending 1–2 months on a particular service. Additionally, SICU nursing staff was often redeployed to COVID units to provide expertise and extra help. This scarcity of beds in the ICUs, coupled with the constant rotation of resident physicians, fellows, and nursing care disrupted the continuity of patient care. Due to these COVID restrictions at our hospital, it was necessary to obtain approval from

hospital administrators for each patient receiving CRS-HIPEC. This could have led to more careful and restrictive patient selection than in previous years. Despite presenting with more extensive disease and receiving fragmented perioperative care, patients with advanced abdominal tumors receiving HIPEC during the COVID-19 pandemic experienced similar perioperative outcomes than those of patients treated before the pandemic and were similar to that of other large volume trials published in national cohorts.^{25,26}

Although short-term outcomes for patients receiving CRS-HIPEC before or during the COVID-19 pandemic were not significantly different, the pandemic did impact rates of weekend discharge. In fact, patients treated during the pandemic were more likely to be discharged during the week, perhaps due to limited resources and staffing of home care agencies. It is possible that the lower rates of weekend discharge seen in patients receiving CRS-HIPEC during the pandemic falsely elevated LOS for these patients. Although not a statistically significant difference, a higher proportion of patients treated during the pandemic were discharged to rehabilitation facilities, rather than to home/home with home health care services. This increase in nonhome discharge disposition may reflect the more severe disease presentation or inability to have family care for patients upon discharge during the pandemic.

TABLE 3 Reasons for reoperation or readmission

	Prepandemic	Pandemic
Reoperation	1	5
Obstruction	1	-
Infection	-	2
Urine leak	-	1
Bleeding	-	1
Further resection of disease ^a	-	1
Readmission	12	10
FFT	5	4
Infection	3	4
Ileus/SBO	3	-
High ostomy output	2	1
Dislodged drain	1	1

Abbreviations: FFT, failure to thrive; SBO, small bowel obstruction during the same hospital stay.

^aPatient underwent further resection of disease after IR localization during the same hospital stay.

Our study is not without limitations. First, our patient cohort is small and limited to a single center, which may not be reflective of practices and outcomes in other hospitals. In fact, hospitals in Maryland never reached absolute capacity like in other states more severely affected by the pandemic and is a state with high rates of vaccine utilization.²⁷ Although our study is reassuring, the global and national landscapes of the COVID-19 pandemic may have been quite different to the experience in our state and the effective implementation of CRS-HIPEC at our institution may not be widely applicable. Additionally, the retrospective nature of our study does not allow for causal inference and our short follow-up intervals do not capture the impact of the COVID-19 pandemic on long-term patient outcomes. It is also possible that patients in our cohort missed follow-up visits on account of being wary of healthcare visits during the pandemic, and that our data may not accurately capture their postoperative course. Finally, our study did not include patients ineligible for surgical intervention on account of excessive disease. The number of patients who would have been surgical candidates but avoided healthcare settings due to fear of the disease and barriers posed by the pandemic is unknown. The long-term ramifications of the fragmentation of oncology care is an area of research that should be studied in detail in the near future, especially in this patient population, as unfortunately the pandemic appears to be here to stay.

5 | CONCLUSION

The COVID-19 pandemic continues to impact the landscape of healthcare in this country and abroad. The unprecedented crisis that the disease caused led to supply, staff, and hospital occupancy issues that are still an issue today. Despite this, we did not observe a decrease in rates of CRS-HIPEC at our institution, and we found that with appropriate patient selection, coordinated patient care, and a collaborative and flexible team of staff, residents, and physicians, it was safe to perform CRS-HIPEC during the COVID-19 pandemic for patients with advanced abdominal tumors.

TABLE 4 Patients impacted by COVID-19: delayed surgery

Primary site	Time from clinic to surgery	Intraoperative PCI score	Follow-up ^a	Status at last follow-up
Appendix	169	7	620	NED
Colon	123	9	303	Dead
Rectal	20 ^b	18	706	Alive with disease
Small bowel	119	7	715	Recurrence at Day 484, underwent repeat CRS/HIPEC
Appendix	55	17	736	NED

Abbreviations: COVID-19, coronavirus disease 2019; CRS/HIPEC, cytoreductive surgery/hyperthermic intraperitoneal chemotherapy; PCI, peritoneal cancer index, NED, no evidence of disease.

^aFollow-up from index surgery until last clinic visit and/or surveillance scan in days.

^bPatient was referred to be seen in clinic in February 2020 but delayed presentation due to concerns about COVID-19.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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