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Collateral Damage: The Impact of the COVID-19 Pandemic on Acute Abdominal Emergency Presentations

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Abstract

Introduction: In March 2020, the World Health Organization declared a pandemic caused by a novel coronavirus. Public information created awareness as well as concern in the general population. There has been a reported decrease in the number of patients attending emergency departments (ED) during the pandemic. This is the first study to determine differences in the types of presenting illnesses, severity, and rate of resultant surgical intervention during the pandemic.

Methods and Materials: We carried out a retrospective, observational cohort study comparing two groups of patients attending the ED at our tertiary-care academic hospital. A historical comparison cohort was obtained by reviewing the number of patients referred by the ED for abdominal CT between March 15 and April 15, 2020, compared with March 15 and April 15, 2019. CT reports were reviewed; primary pathologies, complications, and subsequent surgical intervention were documented and compared between the two groups.

Results: In all, 733 patients were included in the 2019 cohort, and 422 patients were included in the 2020 cohort. In 2019, 32.7% had positive CT findings, increasing to 50.5% in 2020. The number of complications increased from 7.9% to 19.7%. The rate requiring surgical intervention increased from 26.3% to 47.6% in 2020.

Conclusion: To date, there is little published data regarding the presentation and severity of illnesses during the coronavirus disease 2019 pandemic. This information has important public health implications, highlighting the need to educate patients to continue to present to hospital services during such crises, including if a purported second wave of COVID-19 arises.

Key Words: Abdominal, COVID-19, CT, emergency department, pandemic

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INTRODUCTION

On March 11, 2020, the World Health Organization declared a pandemic caused by a novel coronavirus previously not identified in humans [1]. The novel coronavirus originated in Wuhan, China and has led to a global

pandemic with significant economic, social, and health implications worldwide [1,2]. Coronavirus disease 2019 (COVID-19) is primarily spread through the respiratory tract via droplets, although multiple routes of transmission have recently been reported as the virus has been isolated from blood and fecal swabs [3]. The public information and various forms of media coverage of COVID-19 created awareness as well as concern in the general population. On March 17, 2020, the Government of Ontario declared a provincial state of emergency and issued a public statement saying “stay home, stay informed, stay healthy and stay calm” [4]. During the COVID-19 pandemic, a decrease in the number of acute non-COVID-19-related emergency hospital presentations was noted in various publications and news outlets [5,6]. Søreide et al hypothesized that a decrease in trauma admissions to the emergency departments (EDs) was a result of social

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distancing and overall reduced activity during the pandemic. They also discuss that patients may prefer to defer nonessential elective surgery owing to fear of contracting COVID-19 while in hospital; this fear is also likely to prevent patients from seeking timely care for conditions that would otherwise be correctable or curable by presenting at an earlier stage [5]. Dreifuss et al also described delays in patient consultation during the pandemic that resulted in worse postoperative outcomes in cases of appendicitis [6]. They hypothesize that the “stay home” policy and the population's fear of the hospital environment contributed to the severity of the presenting disease [6].

In this observational study, we first wished to quantify changes in the overall volume of CT scans performed for all causes of acute abdominal presentations from the ED after the pandemic announcement. To date, there has been a relative paucity of literature regarding the impact of the pandemic on morbidity and mortality, with some data looking at appendicitis outcomes alone [6,7]. We wished to provide a broader view, looking at not just appendicitis but all acute abdominal presentations to our center. We sought to determine differences in the types of presenting illnesses, the severity of illness, and the rate of resultant surgical intervention during the pandemic to better understand patterns of care seeking under COVID-19.

MATERIALS AND METHODS

We carried out a retrospective, observational cohort study comparing two groups of patients attending the ED at our tertiary-care academic hospital, during two equivalent time intervals, 1 year apart (Table 1). The research and ethics committee approved this retrospective study. A historical comparison cohort was obtained by reviewing the number of patients referred by the ED for abdominal CT between March 15 and April 15, 2020 (representing the first 4 weeks of the COVID-19 pandemic in our geographical area), compared with March 15 and April 15, 2019.

Patients were identified by use of a free-text search of our RIS/PACS system using a natural language processing search engine (mPower Clinical Analytics, Nuance Medical, Burlington, Massachusetts). All consecutive abdominal and pelvic CT study reports referred from the ED for both the 2019 and the 2020 cohorts were re-reviewed by a fellowship-trained abdominal radiologist. All patients referred by emergency staff for an abdominal CT to investigate acute abdominal symptoms between March 15 and April 15, 2020, and March 15 and April 15, 2019, were included. To provide broader context of the changes in ED presentations, we also compared the overall number of ED visits during the two study periods.

The reports were initially categorized as either “no abnormality found” or as having a cause identified for their presenting symptoms. The abdominal abnormalities identified on CT were categorized into 10 groups, which included gastrointestinal (GI), genitourinary (GU), hepatobiliary and pancreas, peritoneal, malignancy (categorized as GI and GU encompassing all intra-abdominal pathologies including hepatobiliary and other; Table 2). The GI group was further subdivided according to common pathologies including inflammation (eg, colitis, enteritis, esophagitis), ischemia, bowel obstruction, diverticulitis, and appendicitis. The category “other” included a broad range of less common pathologies such as pelvic inflammatory disease, epiploic appendagitis, hernias, and pneumonia (Table 2).

The CT reports were then evaluated for complications arising from the primary pathology. Two abdominal radiologists agreed in consensus what constituted a complication as a result of the primary pathologies outlined in Table 3. The complications included perforation (eg, in the case of bowel obstruction, diverticulitis, or ischemic bowel), abscess formation (eg, in case of appendicitis, diverticulitis), ischemia (eg, in case of bowel obstruction), reactive inflammation of adjacent structures

Table 1. Patient demographic from both cohorts (2019 and 2020)

Patient Profile	2019		2020		P Value
	n	%	n	%	
Total number of patients in the ED	11,119		5,924		<.005
Total patients undergoing CT abdomen	733		422		<.001
% of all ED patients undergoing CT abdomen		6.6		7.1	.2321
Female patients	369	50.3	200	47.4	.3594
Male patients	364	49.7	222	52.6	
Average age (y)	59.4	-	57.9	-	.2057

Table 2. Number assigned to each pathology documented and the number of patients in 2019 and 2020 that presented with each

Pathology	2019		2020	
	n	%	n	%
GI pathology	103	42.92	101	47.42
1. GI obstruction	36	15.00	41	19.25
2. GI inflammation	29	12.08	25	11.74
3. GI ischemia or perforation	3	1.25	2	0.94
4. GI diverticulitis	20	8.33	15	7.04
5. GI appendicitis	15	6.25	18	8.45
6. GU pathology	38	15.83	46	21.60
7. HPB	20	8.33	17	7.98
8. Peritoneal	9	3.75	12	5.63
9. GI or GU malignancy	28	11.67	12	5.63
10. Other	42	17.50	25	11.74
Total patients with pathology	240	100.00	213	100.00

GI and GU malignancy categories include hepatobiliary and gynecology malignancies. GI = gastrointestinal; GU = genitourinary; HPB = hepatobiliary.

(eg, pelvic inflammatory disease causing inflammation of adjacent bowel, appendicitis causing small bowel inflammation), aspiration, cardiac arrest, and first-time diagnosis of invasive cancer with extension or growth into adjacent organs (Table 3). These complications were assigned a numerical identity from 1 to 8 for the purpose of data collection.

The electronic patient record was reviewed to investigate if patients had subsequent surgical intervention. COVID-19 status was documented when available for the 2020 cohort.

Table 3. Number assigned to each complication documented and the number of patients in 2019 and 2020 that presented with each

Complication	2019		2020		P Value
	n	%	n	%	
1. Perforation	7	36.84	13	30.95	
2. Abscess	7	36.84	9	21.43	
3. Ischemia	3	15.79	12	28.57	
4. Inflammation	1	5.26	5	11.90	
5. Aspiration	0	0.00	1	2.38	
6. Hydronephrosis	0	0.00	1	2.38	
7. Cardiac arrest	0	0.00	1	2.38	
8. Invasive cancer progression	1	5.26	0	0.00	
Total complications	19	100.00	42	100.00	.499

Statistical analysis was performed with SPSS (Version 25.0. IBM Corp, Armonk, New York). A Fisher exact test was performed for analysis of the unpaired groups, investigating complication rates and surgical intervention, particularly when the number of cases was small. A χ^2 test was used for analysis of the primary pathologies and Student *t* test for continuous variables. A Fisher exact test was performed to investigate the differences in sex makeup, complication rates, and surgical intervention frequency between 2019 and 2020. A single χ^2 test was used to analyze the distribution of the types of pathologies and the types of complications. Average age was analyzed using Student *t* test for continuous variables.

P < .05 was considered statistically significant.

RESULTS

A total of 1,155 patients were identified for this study. The mean age was 58.9 years, and 49.3% were female patients. There were 733 patients included in the 2019 cohort (mean age 59.4 years, 50.3% female) and 422 patients in the 2020 cohort (mean age 57.9 years, 47.4% female). Overall findings are summarized in Table 1. There were no statistically significant differences in the recorded patient demographics (age and sex).

In terms of total emergency room visits for the two cohorts, there were 5,942 visits recorded in 2020 during the study period and 11,119 in the 2019 time frame. There was a 46.7% decrease in net number of ED visits in that time (*P* < .005). In 2019, approximately 6.6% of all patients in the ED underwent a CT scan of the abdomen; in 2020, 7.1% of patients visiting the ED underwent CT, which was not statistically different.

In 2019, 240 patients (32.7%) had positive findings on CT abdomen compared with 213 patients (50.5%) in 2020, a statistically significant increase in the percentages of pathological cases (*P* < .0001). However, the distribution of the pathologies did not significantly differ between 2019 and 2020 (*P* = .192; Table 2). The percent of scans with complications also increased significantly from 7.9% in 2019 to 19.7% in 2020 (*P* = .0003; Table 4). Nevertheless, the distribution of the types of complications outlined in Table 3 did not significantly differ between the 2 years (*P* = .4999).

Of the 2020 patient cohort 10 (2.4%) were confirmed COVID-19 positive. One patient had a known diagnosis of COVID-19. In 70%, abdominal pain was the cause of the visit, and 20% had associated respiratory symptoms. However, only one had an abdominal abnormality identified on CT—a new diagnosis of pancreatic malignancy and liver metastases. None of the COVID-19-positive

Table 4. The total number of positive CT abdomens in 2019 and 2020 detailing the number of complications and surgeries in both cohorts

CT Abdomen	2019		2020		P Value
	n	%	n	%	
Total patients undergoing CT abdomen	733		422		
Pathology	240	32.7	213	50.5	<.0001
No pathology	493	67.3	209	49.5	
Complications	19	7.9	42	19.7	.0003
Surgeries	5	26.3	20	47.6	.1623
COVID-19+	0	0.0	10	2.4	<.0001

COVID-19 = coronavirus disease 2019.

patients had bowel or biliary pathology at the time of imaging. Four patients (40%) had features of COVID-19 at the lung bases; five patients had no positive abdominal CT findings.

The number of abdominal CT scans requested between the two epochs also significantly decreased by 42% in 2020 ($P < .001$). There was a statistically significant increase in the number of patients who had complications arising from the primary pathology identified on CT in the 2020 cohort compared with the 2019 cohort ($P = .0003$). The rate at which patients with complications required surgical intervention also increased in 2020 from 26.3% to 47.6% but because of the small overall numbers of patients undergoing

surgical management, the differences were not statistically different ($P = .1623$). There was also a decrease in the number of GI and GU malignancies reported in 2020 compared with 2019 (5.6% of cases in 2020 compared with 11.7% of cases in 2019; $P < .036$).

DISCUSSION

The economic, social, and travel and immigration ramifications of the COVID-19 pandemic are myriad and have a significant collateral impact on all health outcomes. In this study, we investigated the specific impact of the COVID-19 pandemic on ED visits for acute abdominal CT imaging. Naidich et al reported a 46% decrease in the number of CTs

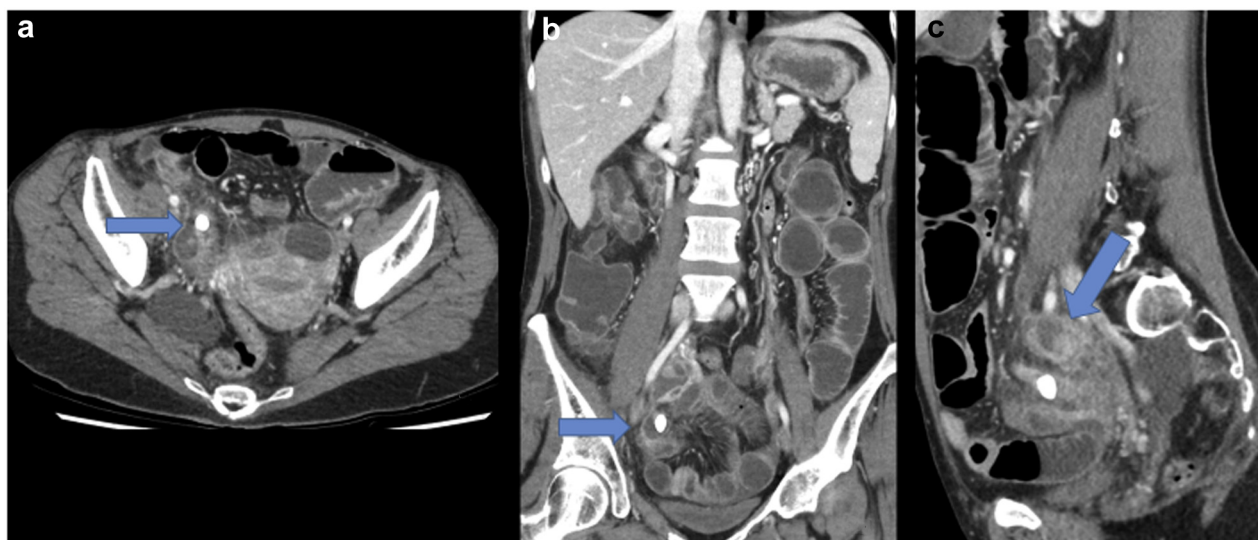


Fig 1. (a-c) Axial, coronal, and sagittal contrast-enhanced abdominal CT images from a 43-year-old woman who presented to the emergency department with a 5-day history of lower abdominal pain. The images show a perforated appendicitis with a >1 cm appendicolith in the right lower pelvis. The abscess involves the right adnexa and fallopian tube. The blue arrows show an abscess secondary to a perforated appendicitis with a >1cm appendicolith in the right lower pelvis.

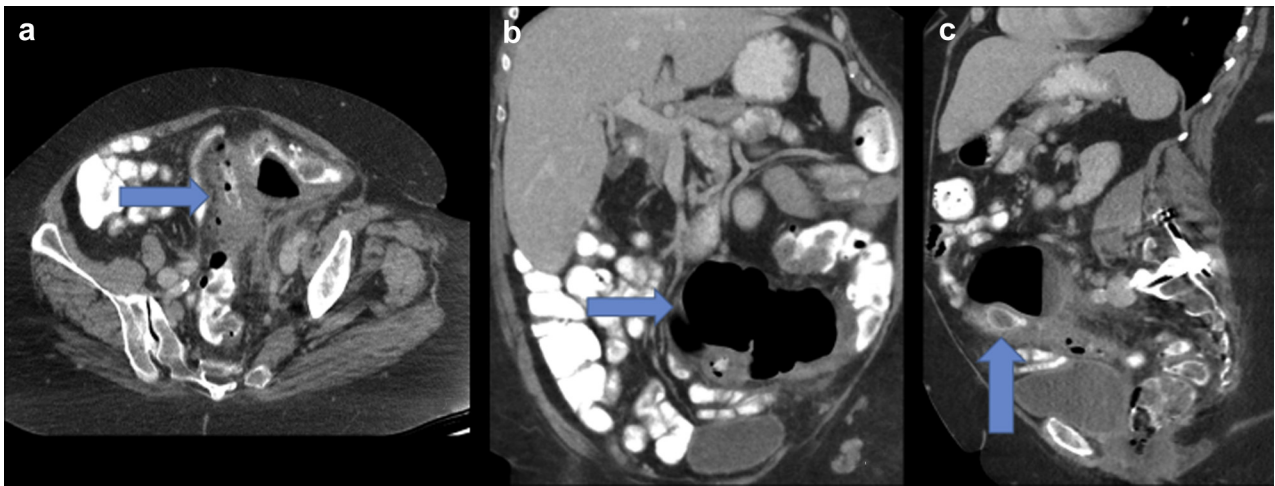


Fig 2. (a-c) Axial, coronal, and sagittal contrast-enhanced abdominal CT images from a 73-year-old woman presenting to emergency department with a 5-day history of lower abdominal pain and constipation. The images demonstrate severe sigmoid diverticulitis with a perforation and large air and fluid collection in the left lower quadrant. The blue arrows demonstrate severe sigmoid diverticulitis with a perforation and large air and fluid collection in the left lower quadrant.

performed in the EDs at a tertiary referral center in New York City at week number 16 of the COVID-19 pandemic compared with the same time in 2019 [8]. Madhuripan et al also reported a steady decrease in imaging volume at Stanford Healthcare, noting a 37% decrease in emergency CT volume on April 3, 2020 [9]. We noted a 46.7% decrease in net number of ED visits and a 42% decrease in abdominal CTs performed for the ED at our tertiary care academic hospital over a 4-week period in 2020 compared with the same period in 2019, similar to the prior studies. Our study is

significant in that we specifically highlight the collateral effects of COVID-19 on non-COVID-19-related outcomes and the aftermath of potential delayed presentations to the ED with abdominal symptoms.

Although our two patient populations were similar in terms of age and sex, we demonstrated a significant increase in the number of positive abdominal CT studies in 2020 compared with the same period in 2019. The increase in the positivity as well as severity of cases is likely multifactorial. This could possibly be because of patient concerns related to

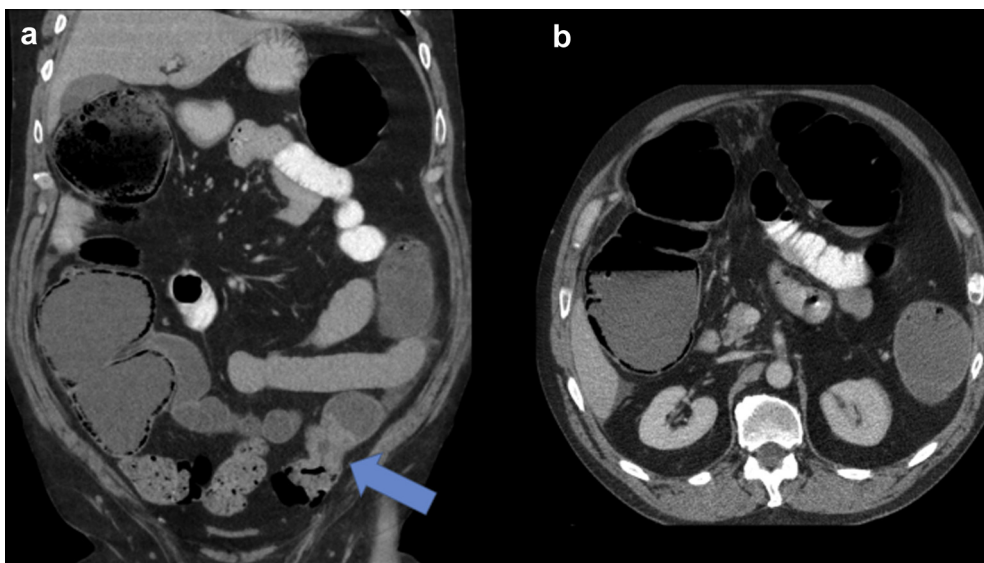


Fig 3. (a, b) Axial and coronal contrast-enhanced abdominal CT images from a 56-year-old man presenting with a 6-day history of increasing abdominal girth, no bowel motion or flatus. The images show an obstructing apple core mass in the sigmoid colon with an associated large bowel obstruction and free fluid. The gas pattern of the caecum is suspicious for ischemia. The blue arrow shows an obstructing apple core mass in the sigmoid colon with an associated large bowel obstruction and free fluid.

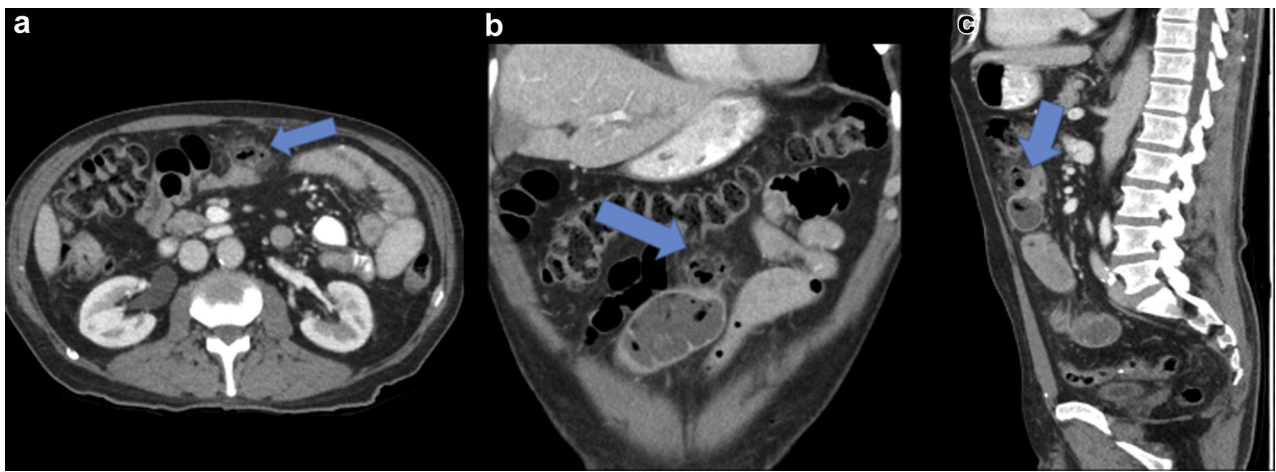


Fig 4. (a-c) Axial, coronal, and sagittal contrast-enhanced abdominal CT images from a 73-year-old man presenting with a 3-day history of vomiting and no bowel motions. The images demonstrate a proximal small bowel obstruction and associated perforation. There is an organizing air and fluid collection in the anterior upper abdomen. The blue arrows demonstrate a proximal small bowel obstruction and associated perforation.

COVID-19 exposure at the hospital, leading to a delay in presenting to the ED. A higher percentage of patients in 2020 had complicated abdominal pathologies (Figs. 1-4); for example, we found increased numbers of complicated appendicitis in 2020 (39%) compared with 2019 (20%; Fig. 1) and increased numbers of complicated bowel obstruction (30% in 2020 compared with 6% in 2019; Fig. 2). Although we cannot confirm the reasons behind this, it is hypothesized that patients stayed at home for longer with abdominal symptoms in the 2020 cohort, leading to increased morbidity from pathologies such as appendicitis, diverticulitis, and so on. Although the literature does report a decline in the volume of imaging studies performed during the pandemic [8], to date, little has been published regarding the severity of illness or morbidity when patients do present to the ED. We have demonstrated that the rate of positive cases in abdominal imaging increased as did the severity of the findings and the need for surgical intervention (Figs. 3 and 4).

Interestingly, we found a 6% reduction in the number of malignancies reported in 2020 compared with 2019 in the two cohorts. It has been reported that the delay in cancer diagnosis and treatment secondary to COVID-19 will have future implications on patient survival. Sud et al reports that short delays (3 months) will have a significant impact on patient survival for aggressive cancers, and, comparatively, cancers with a favorable prognosis may result in tumor progression and upstaging, leading to poorer survival outcomes [10]. This delay in diagnosis and treatment may lead to medical and surgical emergencies proving more costly in terms of surgery or chemotherapy [10]. Our 6% reduction in GI and GU malignancy cases over a 4-week period is limited to patients in the ED and is a small number overall.

However, it raises concerns for the short-term future of cancer diagnosis and treatment as restrictions related to COVID-19 are relaxed and eventually removed. This is an area in which further research is warranted to fully investigate the impact of COVID-19 on cancer diagnosis and outcomes.

COVID-19 is associated with abdominal manifestations involving the bowel and liver. COVID-19-positive patients frequently have elevated liver enzymes of uncertain etiology; a recent study reported that more than 50% of these patients had cholestasis on ultrasound [11]. Bowel manifestations include bowel wall thickening, pneumatosis, and portal venous gas possibly related to direct viral infection, small vessel thrombosis, or nonocclusive mesenteric ischemia [11]. In our 2020 patient cohort, 10 patients tested positive for COVID-19. Of these patients, only one had abdominal pathology, which was a new diagnosis of pancreatic malignancy and liver metastasis. None of the 10 COVID-positive patients in our study had bowel or biliary pathology reported at the time of their abdominal imaging.

Our study has limitations, mainly pertaining to its retrospective single-center nature. Although we have data to show a reduction in net number of patient visits and increased rates of positive findings, complications, and need for surgery, we can only hypothesize that patients chose to avoid the ED and acknowledge that other factors may have come into play during this pandemic. We also acknowledge that it is possible that the emergency physicians requested fewer CT studies to reduce patient time in the hospital and COVID-19 exposure. Finally, we acknowledge that the drop in the number of hospital visits and CT scans performed is also partly because people who did not really need

an ED visit were less likely to come. However, the number of complications outlined in our results does suggest that there is still a need for people to be encouraged to come when they are ill.

In conclusion, we have documented a significant reduction in the overall number of ED visits as well as the number of abdominal CT scans performed during the first month after the COVID pandemic was announced in our area. There was a concomitant increase in “positive” findings as well as an increase in complications related to the findings and need for surgical intervention during the COVID-19 pandemic. To date, little has been published regarding the severity of illness or morbidity when patients do present to the ED. This information has important public health implications and highlights the need to educate patients to continue to present to hospital services during such crises or indeed if a purported second wave arises.

TAKE-HOME POINTS

- COVID-19 has resulted in a global decrease in medical imaging studies, some postponed by government bodies, some appropriately delayed by physicians, and others canceled or not initiated by the patients, potentially as a result of their own anxiety and fear.
- Although there has been a decline in the number of CT studies performed from the ED (7.1% to 6.6%), the proportion of acute abdominal pathologies has increased (from 32.7% to 50.5%). We demonstrated an increase in the severity of these pathologies (7.9% to 19.7%) and an associated trend for increased need for surgical intervention (26.3% to 47.6%).
- In the event of a second wave of COVID-19, patients need to be educated on when to present to the ED for assessment. They should be informed of the measures in place throughout health care institutions to keep them safe from the spread of the virus.

- The onus is on the government, media, and health care institutions to publicize the measures undertaken to ensure patient safety during the pandemic and reduce anxiety associated with presenting to hospital when in need of any type of medical attention.

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