

Characteristics and Outcomes of Endoscopies before and during the COVID-19 Pandemic in New York

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Keywords

Coronavirus disease 2019 · Endoscopy · Procedure yield · Racial disparities

Abstract

Introduction: The COVID-19 pandemic drastically changed hospital workflows. This study aimed to characterize differences in gastrointestinal endoscopies in the New York metropolitan region before, during, and after the first wave of the pandemic. **Methods:** Across 3 hospitals, we compared demographics, indications, and yield of endoscopies before and after March 16, 2020, the date on which elective procedures were canceled, as well as a recovery period for 5 months after they were resumed. **Results:** A total of 9,401 procedures before and 332 procedures during the first wave were performed. Females comprised 57 and 44% of patients ($p < 0.01$), respectively. There was a decline in the proportion of Black (15 vs. 7%, $p < 0.02$) and Hispanic patients (29 vs. 16%, $p < 0.02$) undergoing outpatient procedures. There was a significant rise in urgent indications such as bleeding and jaundice. There was an increase in the diagnostic yield of all esophagogastroduodenoscopies for bleeding ($p < 0.01$) and of outpatient endoscopic ultrasounds for malignancy ($p =$

0.01), but no increase in yield of inpatient colonoscopy for bleeding. A review of 7,475 procedures during the recovery period showed a return to many nonurgent indications, but still showed decreased proportions of Hispanic and male patients compared to the prepandemic period. **Discussion/Conclusion:** Lower proportions of Black and Hispanic patients underwent outpatient endoscopies during and after the first wave. The proportion of procedures done for emergent indications and their diagnostic yield increased during the pandemic, suggesting a higher threshold to perform endoscopy. In resource-sparing conditions, clinicians should pay attention to thresholds to perform colonoscopy for bleeding and to racial disparities in outpatient healthcare access.

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Introduction

The coronavirus disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus 2, caused drastic shifts in hospital capacities and workflows in affected areas internationally. Due to limited supply of personal protective equipment and risk of viral

spread through respiratory droplets, hospitals encouraged personnel to limit the extent and frequency of in-person patient contact. Some invasive procedures are thought to cause aerosolization of viral particles, including intubation and the manipulation of instruments through the endoscope channel in gastrointestinal procedures [1]. For these reasons and to preserve staffing and resource availability, many hospitals limited inpatient and outpatient procedures to the most urgent types of cases. This included the cancellation of elective procedures, including commonly performed gastrointestinal procedures.

The aim of this study was to characterize the effect of the pandemic on gastrointestinal procedures across 3 hospitals in the New York metropolitan area, the initial epicenter of the COVID-19 pandemic in the USA in spring 2020. We examined changes in the numbers, indications, and diagnostic yield of the 4 most common procedures: upper endoscopy or esophagogastroduodenoscopy (EGD), endoscopic ultrasound (EUS), endoscopic retrograde cholangiopancreatography (ERCP), and colonoscopy. We hypothesized that there would be increased diagnostic yield of these procedures for their most common indications in the pandemic period due to restrictions on nonurgent cases.

Materials and Methods

Study Design and Setting

We performed a multicenter retrospective comparative series of endoscopies on adults ≥ 18 years of age, with the primary predictor variable being the date, classified as either before, during, or after the first wave of the pandemic. The date of cancellation of all elective procedures (March 16, 2020) was used as a demarcation for the onset of the first wave, which we studied for 9 weeks (until May 17, 2020). Data from the equivalent time frame from the 3 years prior (March 16–May 17 for the years 2017, 2018, and 2019) were used to compare demographics, procedure counts, and procedure indications. To study procedure yield, we compared the data from the first wave to the prior 6 months (September 15, 2019, to March 15, 2020). Finally, we compared the demographic and procedure indication data from both the prepandemic and first wave periods to the recovery period following the first wave (defined as June 16, the date when outpatient elective procedures were resumed, to November 30, when counts began to rise again in New York). The study reviewed data from 3 settings in the New York metropolitan area: 1 academic medical center and 2 community hospitals with academic affiliations. Both inpatient and outpatient procedures were included.

Primary outcomes were the most common indications of the 4 major gastrointestinal procedures (EGD, EUS, ERCP, and colonoscopy) and the diagnostic or therapeutic yield for each indication. We also analyzed the distribution of procedure indications between the time periods.

Indications

We identified all inpatient and outpatient procedures at the 3 hospitals during the time span specified above. For each procedure, we determined the most common indications separated by time period (before or during pandemic) and inpatient or outpatient location. Certain indications were grouped together. For example, a grouped indication of bleeding included indications of “melena,” “hematochezia,” “active GI bleeding,” etc. A grouped indication of suspected malignancy included indications such as “suspected mass in pancreas on magnetic resonance cholangiopancreatography” but also included some procedures with the indication of “abnormal magnetic resonance cholangiopancreatography” which required individual chart review to identify the abnormality in question. The indication of jaundice was reviewed without grouping with other indications (see online suppl. Table 1; see www.karger.com/doi/10.1159/000515431 for all online suppl. material for components of each grouped indication).

Procedure Yield

The most common indication for each procedure during the pandemic period was examined more closely for diagnostic or therapeutic yield, in comparison with prepandemic yield for the same indication. For each procedure category, if >100 procedures were performed in each time period, a random sample of 100 procedures (using procedures from all sites) was chosen for review of diagnostic or therapeutic yield. Inpatient EGDs performed for bleeding in the prepandemic time period were studied in further detail, with a random selection of 350 total EGDs reviewed. Aborted procedures were excluded from yield analysis. Inpatient EGDs and colonoscopies for an indication of bleeding were excluded if they were a repeat procedure on the same patient during a single admission, to limit any skewing of yield due to rebleeding of previously found lesions. For suspected malignancy, EUSs (alone or with ERCP) were only included if endoscopy was to diagnose a new mass or metastasis. We included review of all ERCPs for jaundice, including repeat procedures on a single admission, as separate interventions may differentially affect therapeutic yield.

A procedure performed for an indication of bleeding was determined to have positive diagnostic yield if a suspected bleeding source was found. Suspected sources found on EGD were defined as ulcers, varices, severe esophagitis (Los Angeles classification D), arteriovenous malformation, Cameron’s ulcer, Dieulafoy’s lesion, Mallory-Weiss tear, treated angioectasia, gastric antral vascular ectasia, or large polyp >20 mm. Bleeding sources found on colonoscopy were tumors, bleeding diverticula, ulcers, and treated angioectasia. Nonbleeding diverticulosis and internal hemorrhoids were included as positive findings but subclassified as “source possibly identified.” When available, follow-up gastrointestinal consult notes, discharge summaries, outpatient clinic notes, or physician letters were reviewed to corroborate yield based on the writing physician’s suspicion that a source was found. For example, if a postprocedure note stated “hematochezia due to diverticular bleed” or “anemia due to severe gastritis,” such findings were classified as the suspected source.

For the indication “suspected malignancy,” yield was accomplished if samples retrieved during the procedure were positive or deemed suspicious for malignancy on the pathology or cytology reports. For combined EUS with ERCP procedures, pathology samples could have been taken from either the EUS or ERCP portions of the procedure to qualify as positive yield. For the indica-

Table 1. Baseline characteristics of patients undergoing procedures in the prepandemic and pandemic periods

Demographics	Prepandemic 16 Mar–17 May (2017–2019)	Pandemic period 16 Mar 2020– 17 May 2020	<i>p</i> value
Inpatient			
Patients, <i>N</i>	1,181	146	
Procedures, <i>N</i>	1,662	192	
Mean age, years	63.4	63.7	0.80
% female	45.8	41.7	0.22
Race, <i>n</i> (%)			
American Indian or Alaskan Native	5 (0.3)	0	
Asian or Pacific Islander	70 (4.2)	7 (3.6)	
Black or African American	395 (23.8)	46 (24.0)	0.67
White	67 (40.7)	71 (37.0)	
Other, unknown, or declined	515 (31.0)	68 (35.4)	
Ethnicity, <i>n</i> (%)			
Hispanic or Latin American	527 (31.7)	68 (35.4)	0.30
Outpatient			
Patients, <i>N</i>	6,346	117	
Procedures, <i>N</i>	7,739	140	
Mean age, years	59.2	60.1	0.46
% female	57.3	47.1	0.05
Race, <i>n</i> (%)			
American Indian or Alaskan Native	11 (0.1)	0	
Asian	303 (3.9)	5 (3.6)	
Black or African American	1,081 (14.0)	10 (7.1)	<0.001
White	4,307 (55.7)	79 (56.4)	
Other, unknown, or declined	2,026 (26.2)	46 (32.9)	
Ethnicity, <i>n</i> (%)			
Hispanic or Latin American	2,335 (30.2)	23 (16.4)	<0.001

tion “jaundice,” therapeutic yield of ERCP was determined by improvement in bilirubin levels, either within 72 h for inpatient studies or within 8 weeks for outpatient studies. Findings were subclassified as “possible improvement” if liver function tests were already declining prior to the procedure and continued to decline after.

A single investigator reviewed all procedures. Univariate analyses were conducted using the Student’s *t* test, χ^2 test, and Fisher’s exact test using a cutoff for significance of a 2-sided *p* value of <0.05. This study was approved by the Institutional Review Board of the Columbia University Irving Medical Center. All authors had access to the study data and reviewed and approved the final manuscript.

Results

Demographics

We reviewed a total of 9,401 inpatient and outpatient procedures before the pandemic (between March 16 and May 17 of 2017, 2018, and 2019) and 332 procedures in the pandemic period (between March 16, 2020, and May

17, 2020). There was a mean of 333 procedures per week before pandemic (range 112–439) and 37 per week in the pandemic period (range 10–68), representing an 89% decline in weekly procedures. Thirty-one EGDs for bleeding were excluded due to being repeat procedures during the same admission (*n* = 28) or being aborted (*n* = 3).

Patient characteristics separated by inpatient and outpatient settings are listed in Table 1. Combining both practice settings, the mean age of patients was 59.9 years in the prepandemic period and 62.2 years in the pandemic period (median 62 vs. 65 years). Women comprised 56 and 44% of patients undergoing procedures before and during the pandemic, respectively (*p* < 0.01). There were no significant differences in baseline demographics in the inpatient group. In the outpatient group, there were significantly fewer women during the pandemic period (prepandemic 57% vs. pandemic 47%, *p* = 0.05), as well as fewer Black and Hispanic patients (Black 14 vs. 7%, *p* < 0.001 for all race distributions; Hispanic 30 vs. 16%, *p* < 0.001).

Table 2. Distribution of common procedures in the prepanemic and pandemic periods

Procedure type	Prepanemic 16 Mar–17 May (2017–2019) n (%)	Pandemic period 16 Mar 2020– 17 May 2020 n (%)	p value
Inpatient			
All exams	1,662	192	
EGD	841 (51)	95 (49)	0.77
EUS	123 (7)	22 (11)	0.05
Alone	83 (5)	13 (7)	0.29
Together with ERCP	40 (2)	9 (5)	0.06
ERCP	174 (10)	30 (16)	0.03
Colonoscopy	350 (21)	28 (14)	0.04
Outpatient			
All exams	7,739	140	
EGD	2,843 (37)	32 (23)	<0.001
EUS	476 (6)	26 (19)	<0.001
Alone	412 (5)	16 (11)	<0.01
Together with ERCP	64 (1)	10 (7)	<0.001
ERCP	291 (4)	40 (29)	<0.001
Colonoscopy	3,765 (49)	25 (18)	<0.001

EGD, esophagogastroduodenoscopy; EUS, endoscopic ultrasound; ERCP, endoscopic retrograde cholangiopancreatography.

Distribution of Procedures and Indications

Table 2 shows the distributions of the most common procedures in both inpatient and outpatient settings, and Table 3 shows their most common indications in both time periods. In the inpatient setting, there were statistically significant increases in the proportions of EUSs (7 vs. 11%, $p < 0.05$) and ERCPs (10 vs. 16%, $p = 0.03$) and decrease in the proportion of colonoscopies (21 vs. 14%, $p = 0.04$). There were slight increases in the proportion of inpatient EUS and ERCPs performed during the pandemic. Significant differences included a greater proportion of inpatient EGDs performed to evaluate for bleeding (57 vs. 72%, $p = 0.01$) and of ERCPs performed to evaluate jaundice (23 vs. 50%, $p < 0.01$). There were also increases in the proportion of colonoscopies performed to evaluate for bleeding, ERCPs performed for cholangitis, and combined EUS with ERCPs performed for suspected malignancy, though these differences were not statistically significant (Table 3).

In the outpatient setting, there were statistically significant differences in the proportions of each of the major procedures (Table 2). In the pandemic period, there were fewer outpatient EGDs (37 vs. 23%, $p < 0.001$) and

colonoscopies (49 vs. 18%, $p < 0.001$), while the proportion of EUS increased 3-fold (6 vs. 19%, $p < 0.001$), and the proportion of ERCPs increased nearly 10-fold (4 vs. 29%, $p < 0.001$). There were also significant differences in the distribution of outpatient procedure indications that reflected an increased urgency of studies being performed. The EGDs and colonoscopies that were performed were more likely to be for bleeding (EGD 8 vs. 44%, $p < 0.001$; colonoscopy 12 vs. 36%, $p < 0.001$), and EUSs were more likely to be for suspected malignancy (34 vs. 87%, $p < 0.0001$).

Procedure Yield

A total of 919 prepanemic and 168 pandemic period procedures were reviewed for evaluation of diagnostic yield, totaling 690 inpatient and 397 outpatient procedures (Table 4). The prepanemic comparison period for procedure yield was September 15, 2019, to March 15, 2020. Combined inpatient and outpatient EGDs for bleeding had significantly greater diagnostic yield during the pandemic period (47 vs. 65%, $p < 0.01$). Outpatient EGDs for bleeding had a steeper increase in yield during the pandemic (19 vs. 57%, $p < 0.01$) than inpatient EGDs, which had an increased yield that did not reach statistical significance (56 vs. 66%, $p = 0.20$). Of inpatient EGDs for bleeding that found a causative lesion, the most common findings in both time periods were ulcers (57 vs. 56%, $p = 0.82$), varices (12 vs. 13%, $p = 0.08$), and severe esophagitis (9 vs. 9%, $p = 0.97$). There was an increase in the proportion of Dieulafoy's lesions found as the causative source for inpatient EGDs during the pandemic period (2 vs. 8%, $p = 0.02$). We also evaluated patients' lowest hemoglobin level between time of admission and time of inpatient EGD and found that patients in the pandemic period had slightly lower hemoglobin nadirs between admission and procedure date (7.01 g/dL, range 2.6–12.6) than in the prepanemic period (7.50 g/dL, range 3.1–15.1; $p = 0.06$).

While suspected malignancy was the most common indication for EUS (alone or with ERCP) during the pandemic, only 32 procedures for this indication were performed during the pandemic period. In the outpatient setting, when comparing all EUSs performed for malignancy (both alone and with ERCP), there was a significant increase in diagnostic yield during the pandemic period (43 vs. 74%, $p = 0.01$). EUS alone performed for suspected malignancy had slightly greater diagnostic yield both in the inpatient (68 vs. 80%, $p = 0.99$) and outpatient (41 vs. 69%, $p = 0.08$) settings, as did combined EUS with ERCP (inpatient 59 vs. 63%, $p = 0.99$; outpatient 50 vs.

Table 3. Distribution of the most common procedure indications in the prepandemic and pandemic periods

Procedure indications	Prepandemic 16 Mar–17 May (2017–2019) <i>n</i> (%)	Pandemic period 16 Mar 2020– 17 May 2020 <i>n</i> (%)	<i>p</i> value
Inpatient			
EGD	841	95	
Bleeding	483 (57)	68 (72)	<0.01
Dysphagia	87 (10)	12 (13)	0.32
Abdominal pain (any location)	47 (6)	3 (3)	0.47
EUS alone	83	13	
Suspected mass or lymphadenopathy	24 (29)	5 (38)	0.52
Cyst or pseudocyst	15 (18)	0 (0)	0.21
EUS with ERCP	40	9	
Suspected mass or lymphadenopathy	22 (55)	8 (89)	0.13
ERCP	174	30	
Bile duct stone	61 (35)	8 (27)	0.37
Jaundice	40 (23)	15 (50)	<0.01
Cholangitis	17 (10)	5 (17)	0.33
Colonoscopy	350	28	
Bleeding	253 (72)	22 (79)	0.47
Abnormal CT of the GI tract	35 (10)	5 (18)	0.20
Screening for colorectal neoplasm	18 (5)	0 (0)	0.38
Outpatient			
EGD	2,843	32	
Heartburn	524 (18)	3 (9)	0.25
Epigastric abdominal pain	421 (15)	7 (22)	0.26
GI bleeding	240 (8)	14 (44)	<0.001
EUS alone	412	15	
Suspected mass or lymphadenopathy	141 (34)	13 (87)	<0.0001
Pancreatic cyst or pseudocyst	70 (17)	2 (13)	1
Screening for neoplasm	37 (9)	0 (0)	0.63
EUS with ERCP	64	10	
Suspected mass or lymphadenopathy	17 (27)	6 (60)	0.06
ERCP	291	40	
Stent change or removal	88 (30)	4 (10)	<0.01
Bile duct stone	47 (16)	3 (8)	0.24
Jaundice	38 (13)	15 (38)	<0.001
Colonoscopy	3,765	25	
Screening for neoplasm	1,629 (43)	1 (4)	<0.001
History of polyps (nonmalignant)	864 (23)	2 (8)	0.09
Bleeding	441 (12)	9 (36)	<0.001

EGD, esophagogastroduodenoscopy; EUS, endoscopic ultrasound; ERCP, endoscopic retrograde cholangiopancreatography; CT, computerized tomography; GI, gastrointestinal.

83%, $p = 0.20$), though these individual findings were not statistically significant.

Of 122 ERCPs performed for the indication of jaundice, 6 were excluded because they were aborted due to failed biliary cannulation. Of the remaining, 78% included stent placement before the pandemic compared to 83% during the pandemic ($p = 0.61$). An additional 15 ERCPs were excluded from therapeutic yield analysis due to lack

of either preprocedure or postprocedure hepatic function tests. The therapeutic yield of ERCP for jaundice was similar across both time periods (Table 4). On average, inpatients undergoing ERCP for evaluation of jaundice during the pandemic had higher levels of total bilirubin before the procedure than did their prepandemic counterparts (mean 17 mg/dL during the pandemic vs. 11 before pandemic, $p = 0.02$).

Table 4. Diagnostic or therapeutic yield of the most common procedure indications in the prepandemic and pandemic periods

Procedure and indication	Procedure yield*		<i>p</i> value
	prepandemic 15 Sep 2019–15 Mar 2020, <i>n</i> reviewed*	pandemic period 16 Mar 2020–17 May 2020, <i>n</i> reviewed	
<i>Inpatient</i>			
EGD for bleeding	350	68	
Positive findings, <i>n</i> (%)	195 (56)	45 (66)	
Source not identified, <i>n</i> (%)	155 (44)	23 (34)	0.11
EUS alone for suspected malignancy	31	5	
Positive findings, <i>n</i> (%)	21 (68)	4 (80)	1
Pathology positive for malignancy	21	4	
Negative findings, <i>n</i> (%)	10 (32)	1 (20)	
Pathology “atypical”	2	0	
No mass or pathology negative	8	1	
EUS with ERCP for suspected malignancy	32	8	
Positive findings, <i>n</i> (%)	19 (59)	5 (63)	1
Pathology positive for malignancy	17	4	
Findings “suspicious” for malignancy	2	1	
Negative findings, <i>n</i> (%)	13 (41)	3 (38)	
Pathology “atypical”	1	2	
No mass or pathology negative	12	1	
ERCP for jaundice	61	13	
Postprocedure improvement in LFTs, <i>n</i> (%)	39 (64)	7 (54)	0.54
No postprocedure improvement in LFTs, <i>n</i> (%)	22 (36)	6 (46)	
Colonoscopy for bleeding	100	22	
Positive findings, <i>n</i> (%)	54 (54)	12 (55)	0.96
Source identified	53	12	
Source likely identified	1	0	
Negative findings, <i>n</i> (%)	46 (46)	10 (45)	
Source not identified	46	10	
<i>Outpatient</i>			
EGD for GI bleeding	100	14	
Positive findings, <i>n</i> (%)	19 (19)	8 (57)	<0.02
Source identified	19	7	
Source likely identified	0	1	
Negative findings, <i>n</i> (%)	81 (81)	6 (43)	
Source not identified	81	6	
EUS alone for suspected malignancy	100	13	
Positive findings, <i>n</i> (%)	41 (41)	9 (69)	0.07
Pathology positive for malignancy	40	8	
Findings “suspicious” for malignancy	1	1	
Negative findings, <i>n</i> (%)	59 (59)	4 (31)	
Pathology “atypical”	5	2	
No mass or pathology negative	54	2	
EUS with ERCP for suspected malignancy	28	6	
Positive findings, <i>n</i> (%)	14 (50)	5 (83)	0.20
Pathology positive for malignancy	13	3	
Findings “suspicious” for malignancy	1	2	
Negative findings, <i>n</i> (%)	14 (50)	1 (17)	
Pathology “atypical”	4	1	
No mass or pathology negative	10	0	

Table 4 (continued)

Procedure and indication	Procedure yield*		p value
	prepandemic 15 Sep 2019–15 Mar 2020, n reviewed*	pandemic period 16 Mar 2020–17 May 2020, n reviewed	
ERCP for jaundice	17	10	1
Positive findings, n (%)	13 (76)	7 (70)	
Improvement in LFTs	9	7	
Possible improvement in LFTs	4	0	
Negative findings, n (%)	4 (24)	3 (30)	
No improvement in LFTs	4	3	
Colonoscopy for bleeding	100	9	0.11
Positive findings, n (%)	71 (71)	9 (100)	
Source identified	12	5	
Source possibly identified	59	4	
Negative findings, n (%)	29 (29)	0 (0)	
Source not identified	29	0	

EGD, esophagogastroduodenoscopy; EUS, endoscopic ultrasound; ERCP, endoscopic retrograde cholangiopancreatography; LFT, liver function test. * Procedure yield is defined as the following: for upper GI endoscopies for bleeding: whether a source of bleed was identified. For EUS alone for suspected malignancy: whether pathology or cytology from a biopsy during EUS resulted positive or was classified as “suspicious” for malignancy. For EUS with ERCP for suspected malignancy: whether pathology or cytology from a biopsy either during EUS or during ERCP resulted positive or was classified as “suspicious” for malignancy. For ERCP for jaundice: whether LFTs improved within 72 h of procedure for inpatient procedures, or in the next set of bloodwork drawn within 2 months for outpatient procedures. Some cases were classified as “possible improvement” if LFTs were already declining prior to the procedure and continued to decline after. For colonoscopy for bleeding: whether a source of bleed was identified. *For each procedure indication, if >100 completed procedures existed, a random sample of 100 procedures were chosen for review. Inpatient EGDs were reviewed in further detail, with a random sample of 350 procedures chosen for review. Some ERCPs were not applicable for review due to a lack of follow-up bloodwork.

Finally, inpatient colonoscopies for bleeding had similar diagnostic yield before and during the pandemic (54 vs. 55%, $p = 0.99$). Despite bleeding being the most common indication for outpatient colonoscopy, there were only 9 performed for bleeding in the pandemic period. All 9 (100%) found a suspected or possible source, compared to 71% of colonoscopies performed for bleeding before pandemic ($p = 0.11$).

Recovery from First Wave

We studied 7,475 inpatient and outpatient procedures in the recovery period after the first wave, June 16–November 30, 2020 (online suppl. Tables 2–4). There were 1,428 inpatient procedures studied, averaging 56 procedures per week (vs. 57 per week in the prepandemic period). The mean age for inpatient patients was 62.9 years, similar to both prior time periods. There was a higher proportion of women undergoing inpatient procedures in the recovery period (49% compared to 46% prepandemic and 42% during the first wave). During the recovery period, the proportion of White patients increased,

but there was a significant decrease in Black and Hispanic patients compared to both the prepandemic and first wave periods. There was an increase in the proportion of inpatient colonoscopies from 14% during the first wave to 23% ($p < 0.01$) and an increase in the proportion of EGDs to above prepandemic levels (51% before pandemic to 55% during the recovery period, $p < 0.01$). There was also an associated decrease in the proportion of ERCPs performed to below prepandemic levels (10% before pandemic to 3% during the recovery period, $p < 0.05$).

The indications for inpatient procedures during the recovery period generally returned to prepandemic distributions. There was a trend away from emergent procedures, including fewer proportions of EGDs for bleeding, combined EUS and ERCPs to evaluate for malignancy, and ERCPs performed for jaundice. The proportion of inpatient colonoscopies performed for bleeding decreased to lower than prepandemic levels, comprising only 65% (compared to 72% before pandemic, $p = 0.04$).

There were 6,047 outpatient procedures studied, averaging 241 per week (about 9% lower than prepandemic

levels of 266 per week). The mean age was 58, slightly lower than the mean age for outpatients before and during the pandemic. The proportion of women undergoing outpatient procedures increased markedly from 47% during the first wave to 59% during the recovery period ($p < 0.01$), even reaching higher than prepandemic levels (57%, $p = 0.03$). Unlike seen on the inpatient side, there was a return to the prepandemic proportion of Black patients. However, the proportion of Hispanic patients increased from 16 to 22% but failed to reach prepandemic levels (30%, $p < 0.001$).

There were statistically significant changes for the distribution of all outpatient procedures when compared to the first wave of the pandemic (all p values < 0.001), all trending towards prepandemic distributions with greater proportions of EGDs and colonoscopies. Notably, the proportion of colonoscopies exceeded prepandemic levels. Many outpatient indications lowered to prepandemic proportions, again showing a trend away from urgent indications such as bleeding and jaundice. Unlike the inpatient setting, there were many indications for outpatient endoscopies that were significantly different from prepandemic distributions. For example, EGDs for heartburn and abdominal pain surpassed prepandemic levels, as did EUSs and colonoscopies performed for cancer screening or diagnosis.

Discussion/Conclusion

In this analysis, we aimed to characterize differences in types of gastrointestinal procedures, indications, and their diagnostic or therapeutic yield between the period preceding the COVID-19 pandemic and during the height of the pandemic among inpatients and outpatients in 3 hospitals in the New York City region. Our data during the pandemic period show a few notable demographic trends. We saw a sharp decline in the proportion of women undergoing outpatient procedures, which was predicted with the cancellation of all elective procedures. Women in the USA are more likely to utilize healthcare services, including preventative care services [2]. Women are also known to be less severely affected by COVID-19 infection, with one study in New York City finding that only 40% of patients admitted with COVID-19 were women [3]. While our study found a decline in the proportion of women undergoing inpatient procedures during the pandemic (to 42%), this difference did not reach statistical significance, perhaps because we included all patients, regardless of CO-

VID-19 status. There were also fewer Black and Hispanic patients undergoing outpatient procedures during the pandemic. The shift may be a result of increased financial barriers and decreased healthcare access during the pandemic by Black and Hispanic patients, who also experienced disproportionately greater rates of age-adjusted COVID-19 fatalities in New York City [4]. There are well-documented racial disparities in access to outpatient care, including access to common gastrointestinal procedures such as screening colonoscopies [5], and these trends seem to have been exacerbated during the pandemic. Our analysis of the recovery period also suggests a long-term impact of these trends. The percentage of men undergoing outpatient procedures performed declined further than prepandemic levels. The percentage of outpatient procedures performed on Hispanic patients remained significantly lower than prepandemic levels at 22%, despite Hispanics and Latinos making up more than two-thirds of the neighborhoods served by 2 of the 3 hospitals studied (including the tertiary academic center which performed most of the procedures in this study) [6].

The significant shift in outpatient procedures towards more EUSs and ERCPs during the first wave was also expected with the cancellation of elective procedures, which normally comprise most outpatient EGD and colonoscopies. Both inpatient and outpatient data on common indications show that procedures performed in the pandemic period were for more urgent causes, namely, to evaluate for bleeding, malignancy, and biliary obstruction. During the recovery period, expectedly, the frequency of urgent inpatient procedures trended back down to prepandemic levels. As elective procedures and routine screenings returned in the outpatient setting during the recovery period, there was also rebound of endoscopies for more routine indications (e.g., heartburn or abdominal pain) which exceeded prepandemic proportions. Outpatient EGDs and colonoscopies for bleeding and outpatient EUS (alone or with ERCP) for malignancy had greater diagnostic yield in the pandemic period, likely reflecting the restriction of endoscopies to patients with a higher level of suspicion for structural pathology that is amenable to intervention. Diagnostic yield of outpatient EGD for bleeding during the pandemic period was similar to the yield of inpatient EGD before the pandemic, again suggesting a higher degree of urgency for cases in the outpatient setting. The lack of significant improvement in yield for corresponding inpatient procedures in the pandemic period, particularly colonoscopy in the evaluation of bleeding, may suggest a

ceiling effect of the therapeutic potential of endoscopic procedures. During the recovery period, inpatient colonoscopies for bleeding dropped to below prepandemic levels, possibly as endoscopists continued to weigh virus exposure risks against the relatively low diagnostic yield. Lower preprocedure hemoglobin levels and higher preprocedure bilirubin levels indicate that patients during the first wave had higher severities of illness that may affect procedure yield. Patients may also have been presenting at later stages in their disease course in an attempt to avoid hospital settings. This is also suggested by our prior finding that patients admitted for gastrointestinal bleeding during the pandemic (with or without undergoing endoscopy) had significantly lower hemoglobin levels on admission [7].

Our study has some findings similar to those reported in the current literature. Other studies showed reduced colorectal cancer detection and reduction in endoscopy activity for months [8]. Other studies have found increased diagnostic yield for urgent EGD but no increase for urgent colonoscopy [9]. However, these studies evaluated shorter time period when evaluating yield (e.g., only 1 month) or did not include a recovery period as ours did.

This study has limitations. As a retrospective study, we can only hypothesize patient and physician motivations and the causal nature between procedure date and yield. The cancellation of most outpatient procedures and limitations on inpatient procedures during a pandemic contributes to low sample sizes in the pandemic period, limiting our statistical power. Our findings regarding racial and ethnic demographic changes among outpatients during the pandemic period should be interpreted with caution, given the substantial proportions of patients classified as “other, unknown, or declined.” This also highlights the lack of systematic collection of race and ethnicity data, despite its requirement as part of the Meaningful Use of Electronic Health Records by the Center for Medicare and Medicaid Services. This is a common problem across hospital systems and limits them from being able to track health outcomes and design programs targeted towards gaps in quality of care for disadvantaged populations [10]. Nevertheless, in our study, it is unlikely that those in the “other, unknown, or declined” category would be differentially classified in the prepandemic or recovery periods compared to the pandemic period. Further studies may aggregate data from other institutions located in heavily affected cities. Another limitation is that our comparison of procedure yield used data from 6 months before the pandemic, a

different time period than the one used in our comparison of demographics, procedures, and indications. This was the scope of our initial study design. However, this directly preceding time period avoids the introduction of other variables that could be present when comparing procedures from up to 3 years prior (e.g., technological and procedural advances, endoscopy faculty changes, and increased training with certain procedures). Future studies may also review other outcomes in analyzing procedure yield. For example, this study did not find an improvement in liver function tests after ERCP in patients with high preprocedure bilirubin levels during the pandemic, but we did not analyze whether the interventions provided symptomatic relief or decreased the likelihood of repeat ERCP.

Finally, while our study warns of decreased healthcare access to underserved populations, it does not evaluate any methods to combat it. Access gaps can be intervened upon by institutions interested in doing so. Many institutions, including one in this study, have created patient navigator programs targeted at supporting underserved patients with education, scheduling assistance, and appointment reminders. Such programs can increase outpatient procedure volume and are cost-effective interventions to improve screening in vulnerable populations [11, 12].

Our study offers a comparative series of gastrointestinal procedures before, during, and after the first wave of the COVID-19 pandemic. As case counts continue to surge now in the second wave of the pandemic [13], it is possible that hospitals in affected regions will see similar trends. Our results suggest that in the face of high exposure risks and staffing strain, endoscopists performed procedures on patients with higher severity of illness, and that they had higher levels of suspicion for active bleeding and malignancy prior to endoscopy. Gastroenterologists in areas heavily affected by COVID-19 should anticipate doing fewer procedures but with a higher likelihood of positive findings for upper gastrointestinal bleeding and malignancy. However, clinicians should be aware that the barriers to care that Black and Hispanic patients routinely face may be worsened during the pandemic and may persist even months after case counts quell. The impact of a delayed cancer diagnoses is undoubtedly more devastating in populations already disproportionately affected by the pandemic as well as future times of economic recession. Clinicians should take measures to prevent the exacerbation of healthcare disparities when maintaining access to outpatient care.

Statement of Ethics

The Institutional Review Board of Columbia University approved the study, under protocol AAAS8635. It was approved under expedited review, with waiver of the need for informed consent, as the risk of harm to subjects was deemed no more than minimal.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Study concept and design: V.A., D.F., and B.L.; data collection: V.A.; data analysis: V.A.; manuscript preparation: V.A. and B.L.; and critical revision of the manuscript: V.A., J.W.B., D.F., C.H., P.G., and B.L.