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# Predicting endoscopic activity recovery in England after COVID-19: a national analysis



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## Summary

**Background** The COVID-19 pandemic has led to a substantial reduction in gastrointestinal endoscopies, creating a backlog of procedures. We aimed to quantify this backlog nationally for England and assess how various interventions might mitigate the backlog.

**Methods** We did a national analysis of data for colonoscopies, flexible sigmoidoscopies, and gastroscopies from National Health Service (NHS) trusts in NHS England's Monthly Diagnostic Waiting Times and Activity dataset. Trusts were excluded if monthly data were incomplete. To estimate the potential backlog, we used linear logistic regression to project the cumulative deficit between actual procedures performed and expected procedures, based on historical pre-pandemic trends. We then made further estimations of the change to the backlog under three scenarios: recovery to a set level of capacity, ranging from 90% to 130%; further disruption to activity (eg, second pandemic wave); or introduction of faecal immunochemical testing (FIT) triaging.

**Findings** We included data from Jan 1, 2018, to Oct 31, 2020, from 125 NHS trusts. 10 476 endoscopy procedures were done in April, 2020, representing 9.5% of those done in April, 2019 (n=110 584), before recovering to 105 716 by October, 2020 (84.5% of those done in October, 2019 [n=125 072]). Recovering to 100% capacity on the current trajectory would lead to a projected backlog of 162 735 (95% CI 143 775–181 695) colonoscopies, 119 025 (107 398–130 651) flexible sigmoidoscopies, and 194 087 (172 564–215 611) gastroscopies in January, 2021, attributable to the pandemic. Increasing capacity to 130% would still take up to June, 2022, to eliminate the backlog. A further 2-month interruption would add an extra 15.4%, a 4-month interruption would add an extra 43.8%, and a 6-month interruption would add an extra 82.5% to the potential backlog. FIT triaging of cases that are found to have greater than 10 µg haemoglobin per g would reduce colonoscopy referrals to around 75% of usual levels, with the backlog cleared in early 2022.

**Interpretation** Our work highlights the impact of the pandemic on endoscopy services nationally. Even with mitigation measures, it could take much longer than a year to eliminate the pandemic-related backlog. Urgent action is required by key stakeholders (ie, individual NHS trusts, Clinical Commissioning Groups, British Society of Gastroenterology, and NHS England) to tackle the backlog and prevent delays to patient management.

**Funding** Wellcome/EPSRC Centre for Interventional and Surgical Sciences (WEISS) at University College London, National Institute for Health Research University College London Hospitals Biomedical Research Centre, and DATA-CAN, Health Data Research UK.

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## Introduction

The COVID-19 pandemic has had a profound effect on the National Health Service (NHS), causing a reorganisation from a comprehensive health-care service to one predominantly focused on treating patients with COVID-19.<sup>1</sup> Guidance from the British Society of Gastroenterology issued in March, 2020, recommended a 6-week pause in endoscopic activity, such that all but emergency and absolutely essential endoscopy must stop, including bowel cancer screening, allowing time to refine triage systems.<sup>2</sup> Data from the UK National Endoscopy Database (NED), encompassing 79% of endoscopic units in the UK, showed that activity fell to as low as 5% of normal levels in the period affected by COVID-19 from March 23 to May 31, 2020.<sup>3</sup>

There are substantial concerns for the effect of continued disruption on health-care services, most

notably with a backlog of cases caused by delayed and cancelled procedures at a time of reduced capacity, having adverse effects on timely diagnosis and outcomes, especially of cancer.<sup>4</sup> This issue was recognised by the British Society of Gastroenterology in late April, 2020, as it recommended restarting endoscopy services safely.<sup>5</sup> Early data have shown a reduction in the number of patients on colorectal cancer pathways and significant decreases in the number of cancers detected at endoscopy.<sup>3,6</sup> Moreover, it has been postulated that a 1-year restriction on endoscopic services could lead to 28 800 undiagnosed gastrointestinal cancers and a backlog of 1.46 million endoscopic procedures in the UK.<sup>7</sup> Several strategies, such as use of faecal immunochemical testing (FIT) for triaging, have been suggested, but there is little information as to how use of this procedure might affect the endoscopy backlog nationally.<sup>8</sup>

*Lancet Gastroenterol Hepatol* 2021; 6: 381–90

Published Online

March 10, 2021

[https://doi.org/10.1016/S2468-1253\(21\)00058-3](https://doi.org/10.1016/S2468-1253(21)00058-3)

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### Research in context

#### Evidence before this study

We searched PubMed for relevant literature at the start of the study (Oct 8, 2020) and during manuscript preparation (Dec 4, 2020), with no restrictions on language or date of publication. We used the search terms "(COVID-19 OR SARS-CoV-2) AND endoscopy". We identified 37 articles that presented data for the effect of the COVID-19 pandemic on endoscopy services. 18 studies were surveys of endoscopy units. Of the remaining 19 studies, which all contained procedural data, four were national or territorial (UK [two studies], Netherlands [one study], Hong Kong [one study]). A further study was health-care system based (USA). Only one single-centre study projected a backlog of procedures.

#### Added value of this study

Our study is one of several that describe the effect of the COVID-19 pandemic on endoscopy services nationally and

describe the initial recovery. We believe we are the first study to quantify the theoretical backlog of procedures within England, and to show how mitigation strategies such as going above normal capacity and faecal immunochemical testing triaging might affect the backlog.

#### Implications of all the available evidence

Given the scale of the backlog, urgent action is needed by key stakeholders (ie, individual NHS trusts, Clinical Commissioning Groups, British Society of Gastroenterology, and NHS England) for a coordinated approach to tackle the problem. In the first instance, health policy makers must look to support and protect endoscopy service recovery, and to assess means of either increasing short-term capacity or reducing demand.

Since December, 2020, the rise in COVID-19 infections associated with the second peak of the pandemic has led to reports of a further reduction in endoscopic services, adding additional pressure to already overstretched services.

We aimed to investigate the effect of the COVID-19 pandemic on endoscopy services and calculate an estimate for the backlog of procedures; present strategies to clear the potential endoscopy backlog related to the COVID-19 pandemic, including a temporary increase in capacity and use of FIT triaging; and estimate the effect of a further reduction in endoscopy capacity on the overall backlog.

## Methods

### Study design and population

We analysed data from NHS England's Monthly Diagnostic Waiting Times and Activity Data, which is part of National Statistics and is publicly available.<sup>9</sup> 15 key diagnostic tests, including endoscopic procedures, non-obstetric ultrasound, and CT are included. NHS England collects data from individual NHS trusts on waiting times and number of procedures done, stratified by urgency (ie, planned or surveillance or unplanned, which included inpatient and emergency procedures) and waiting list (either general practice or hospital referral). Notably, this dataset excludes colonoscopies done under the Bowel Cancer Screening Programme and flexible sigmoidoscopies done under the Bowel Scope Screening Programme. Each NHS trust is also allocated an NHS commissioning region based on their location.

We included colonoscopies, flexible sigmoidoscopies, gastroscopies, and total endoscopic procedures done in 125 NHS trusts in England (figure 1). We excluded procedures done in seven NHS trusts due to incomplete monthly data (see appendix p 2). Several NHS trusts and

NHS commissioning regions merged during the study period; pre-merger trusts and regions were aligned with their post-merger counterparts in the final analysis to ensure consistency. Ethical approval was not required as the study uses publicly available non-identifiable data.

### Outcomes

The primary outcomes captured were the change in number of endoscopic procedures compared with the same month in 2019, and an estimate of the backlog of procedures associated with the pandemic. Secondary outcomes were to estimate the effect of increasing capacity, a temporary reduction of capacity, and the effect of FIT triaging on the backlog of procedures.

### Statistical analysis

We analysed data on a per-month basis using the  $\chi^2$  test to compare the same month in 2019 and 2020 and the Kruskal-Wallis test to compare the overall number of procedures done, the case mix for each individual procedure, and also the number of procedures done in each region. A p value of 0.05 or less was considered significant, with Dunn's test performed for multiple comparisons. We also created two linear logistic regression models; the first model used data from January, 2018, to January, 2020, to calculate the number of expected procedures in the absence of the pandemic, based on historical demand. The second model used data from April, 2020, to October, 2020, to estimate the recovery of endoscopic capacity. We calculated the potential backlog of procedures by cumulating the difference between the two models. Subsequently, we altered parameters in the second model to simulate different scenarios, including a sustained recovery to plateau at different levels of capacity (ranging from 90% to 130%), a further reduction in endoscopic activity, or a

See Online for appendix

reduction in colonoscopy referrals through use of FIT triaging. We included 95% CIs in our projections. We assumed these scenarios occurred in December, 2020. Statistical analyses were done using R, version 4.0.2, and GraphPad Prism, version 9.0.0.

### Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

### Results

We included data from Jan 1, 2018, to Oct 31, 2020, for 125 NHS trusts. In 2018, a mean of 112 680 (SD 6090) endoscopy procedures were done per month (figure 2). This amount increased to a mean of 116 538 (SD 5766) in 2019, a 3.5% rise. The pandemic led to a sudden decrease, to a low point of 10 476 procedures in April, 2020, 9.5% of the procedures done in April, 2019 (n=110 584; table 1). There was a partial recovery, with 105 716 procedures in October, 2020, representing 84.5% of the procedures done in October, 2019 (n=125 072). Although individual endoscopic procedures have all followed the same general trend of a sudden decrease followed by a slow recovery, gastroscopies appeared least affected, with 5642 procedures completed in April, 2020 (11.4% compared with April, 2019), whereas only 1599 flexible sigmoidoscopies were completed (7.0% compared with April, 2019). Individual procedures have also recovered at different rates: in October, 2020, flexible sigmoidoscopy was at 62.2% of October, 2019, levels, compared with 89.6% for gastroscopy and 91.3% for colonoscopy. When analysing actual procedure numbers between January and October, 2020, there was an overall significant difference between the three procedures ( $p=0.015$ ).

We also investigated whether there was any regional effect on the total number of procedures (appendix p 3). East of England was the most affected region in April, 2020, performing 4.5% of the number of overall procedures compared with April, 2019. By contrast, the corresponding percentage for the Midlands, the least affected region, was 17.6% ( $p<0.0001$  for East of England vs Midlands). Recovery also differed between regions. By October, 2020, North East and Yorkshire (considered together) had recovered least well (75.3% compared with October, 2019), whereas East of England recovered most effectively, to 106.2% ( $p<0.0001$  for East of England vs North East and Yorkshire). However, when analysing numbers of procedures done in each month from January to October, 2020, no significant difference between regions was seen. This finding suggests that the COVID-19 pandemic led to similar patterns of decrease and recovery across all regions in England.

The pandemic also led to a different case mix of procedures (ie, proportions of planned or surveillance, unscheduled, and waiting list procedures) being done

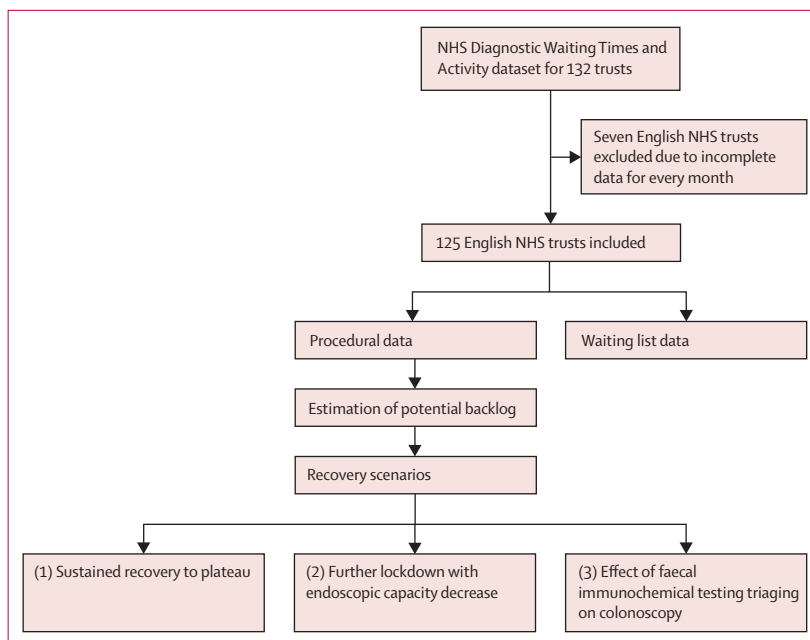


Figure 1: Data analysis

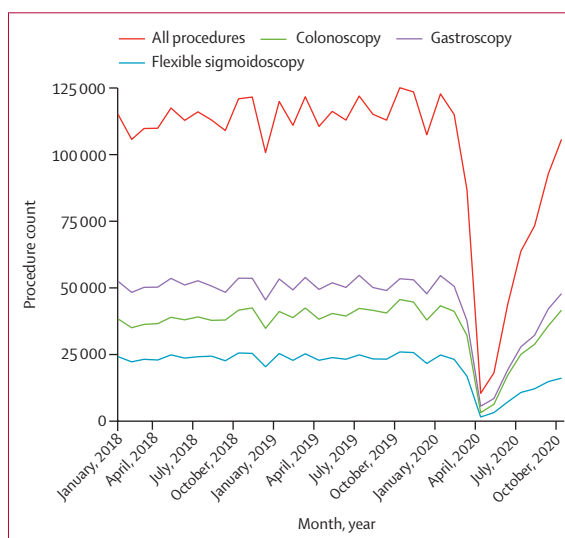


Figure 2: Trends in number of endoscopy procedures from January, 2018, to October, 2020

(table 1). An increase was seen in the proportion of unscheduled procedures, whereas there was a decrease in planned or surveillance and waiting list procedures. This difference was most stark in the month of April, 2020, in which 108 (3.3%) colonoscopies, 361 (22.6%) flexible sigmoidoscopies, and 1501 (26.6%) gastroscopies were unscheduled, compared with 401 (1.0%) of 38 266 colonoscopies, 1187 (5.2%) of 22 877 flexible sigmoidoscopies, and 3532 (7.1%) of 49 441 gastroscopies in April, 2019 ( $p<0.0001$  for all three individual procedures between proportion of unscheduled and scheduled [ie, planned or

	Planned or surveillance procedures		Unscheduled procedures		Waiting list procedures		Total procedures	
	n (%)	As percentage of 2019 procedures	n (%)	As percentage of 2019 procedures	n (%)	As percentage of 2019 procedures	n	As percentage of 2019 procedures
<b>Colonoscopy*</b>								
January	5868 (13.5%)	93.5%	364 (0.8%)	57.6%	37 082 (85.6%)	108.2%	43 314	105.2%
February	5457 (13.2%)	91.4%	389 (0.9%)	74.8%	35 381 (85.8%)	109.3%	41 227	106.1%
March	4030 (12.5%)	62.3%	274 (0.9%)	44.6%	27 852 (86.6%)	78.7%	32 156	75.7%
April	488 (15.1%)	9.2%	108 (3.3%)	26.9%	2639 (81.6%)	8.1%	3235	8.5%
May	393 (6.2%)	6.7%	277 (4.3%)	60.7%	5701 (89.5%)	16.7%	6371	15.8%
June	1190 (6.9%)	20.1%	384 (2.2%)	86.7%	15 644 (90.9%)	47.2%	17 218	43.6%
July	1897 (7.6%)	31.8%	546 (2.2%)	130.0%	22 627 (90.3%)	63.0%	25 070	59.3%
August	2443 (8.5%)	42.7%	493 (1.7%)	70.4%	25 933 (89.8%)	73.7%	28 869	69.4%
September	3603 (10.1%)	61.4%	570 (1.6%)	137.7%	31 590 (88.3%)	92.0%	35 763	88.1%
October	4467 (10.7%)	69.8%	616 (1.5%)	132.2%	36 579 (87.8%)	94.3%	41 662	91.3%
<b>Flexible sigmoidoscopy*</b>								
January	2878 (11.6%)	91.0%	1222 (4.9%)	80.1%	20 747 (83.5%)	100.1%	24 847	97.8%
February	2610 (11.2%)	91.7%	1098 (4.7%)	92.0%	19 501 (84.0%)	103.7%	23 209	101.6%
March	1829 (10.8%)	57.8%	939 (5.6%)	66.8%	14 143 (83.6%)	68.2%	16 911	66.8%
April	140 (8.8%)	5.5%	361 (22.6%)	30.4%	1098 (68.7%)	5.7%	1599	7.0%
May	149 (4.6%)	5.5%	728 (22.4%)	55.3%	2376 (73.0%)	12.0%	3253	13.6%
June	394 (5.4%)	14.1%	965 (13.3%)	84.9%	5875 (81.2%)	30.4%	7234	31.1%
July	732 (6.8%)	26.5%	1204 (11.1%)	96.6%	8866 (82.1%)	42.4%	10 802	43.4%
August	810 (6.7%)	32.4%	1108 (9.1%)	78.4%	10 260 (84.3%)	52.7%	12 178	52.1%
September	1054 (7.1%)	39.8%	1242 (8.4%)	107.5%	12 568 (84.6%)	64.5%	14 864	63.8%
October	1233 (7.6%)	39.1%	1170 (7.2%)	90.1%	13 772 (85.1%)	64.0%	16 175	62.2%
<b>Gastroscopy*</b>								
January	6111 (11.2%)	95.9%	3711 (6.8%)	94.8%	44 797 (82.0%)	104.0%	54 619	102.4%
February	5709 (11.3%)	92.1%	3270 (6.5%)	94.8%	41 622 (82.3%)	105.1%	50 601	102.7%
March	3887 (10.3%)	59.2%	3038 (8.1%)	77.6%	30 800 (81.6%)	70.9%	37 725	70.0%
April	507 (9.0%)	9.3%	1501 (26.6%)	42.5%	3634 (64.4%)	9.0%	5642	11.4%
May	314 (3.7%)	4.9%	2464 (28.8%)	63.7%	5768 (67.5%)	13.9%	8546	16.5%
June	999 (5.2%)	15.8%	3055 (15.9%)	87.3%	15 155 (78.9%)	37.5%	19 209	38.3%
July	1676 (6.0%)	26.4%	3531 (12.7%)	91.0%	22 703 (81.3%)	51.0%	27 910	51.0%
August	2100 (6.5%)	38.1%	3269 (10.1%)	86.8%	26 882 (83.4%)	65.7%	32 251	64.3%
September	3222 (7.6%)	58.8%	3817 (9.1%)	112.6%	35 079 (83.3%)	87.3%	42 118	85.9%
October	3966 (8.3%)	67.8%	3636 (7.6%)	97.0%	40 277 (84.1%)	91.9%	47 879	89.6%
<b>All procedures*</b>								
January	14 857 (12.1%)	93.9%	5297 (4.3%)	87.3%	102 626 (83.6%)	104.7%	122 780	102.4%
February	13 776 (12.0%)	91.8%	4757 (4.1%)	92.1%	96 504 (83.9%)	106.3%	115 037	103.7%
March	9746 (11.2%)	60.2%	4251 (4.9%)	71.7%	72 795 (83.9%)	73.1%	86 792	71.3%
April	1135 (10.8%)	8.5%	1970 (18.8%)	38.5%	7371 (70.4%)	8.0%	10 476	9.5%
May	856 (4.7%)	5.7%	3469 (19.1%)	61.5%	13 845 (76.2%)	14.5%	18 170	15.6%
June	2583 (5.9%)	17.2%	4404 (10.1%)	86.7%	36 674 (84.0%)	39.5%	43 661	38.7%
July	4305 (6.7%)	28.6%	5281 (8.3%)	95.2%	54 196 (85.0%)	53.5%	63 782	52.3%
August	5353 (7.3%)	39.0%	4870 (6.6%)	82.8%	63 075 (86.1%)	66.0%	73 298	63.6%
September	7879 (8.5%)	56.3%	5629 (6.1%)	113.5%	79 237 (85.4%)	84.3%	92 745	82.1%
October	9273 (10.0%)	60.2%	5422 (5.8%)	98.3%	90 628 (97.7%)	87.0%	105 716	84.5%

Data are n (%) unless specified. \*The differences in proportions of planned or surveillance, unscheduled, and waiting list procedures were significant for each individual endoscopic procedure between January and October, 2020 (colonoscopy p<0.0001; flexible sigmoidoscopy p=0.0005; gastroscopy p=0.0003; and all procedures p=0.0001).

**Table 1: Number of endoscopy procedures, with percentages, compared with same month in 2019 from January to October, 2020**

surveillance and waiting list combined] procedures in April, 2019, and April, 2020). As endoscopy services started to recover, there was a reversal of this trend (table 1). Recovery for planned or surveillance procedures was slower than waiting list procedures. For all procedures in April, 2020, planned or surveillance and waiting list procedures were at 8.5% of April, 2019, levels for planned or surveillance procedures and 8.0% for waiting list procedures. However, in October, 2020, planned or surveillance procedures were at 60.2% of October, 2019, levels, compared with 87.0% for waiting list procedures. The differences between the monthly proportions of unscheduled, planned or surveillance, and waiting list procedures were significant for all endoscopic procedures combined (planned *vs* unscheduled  $p=1.0$ ; planned *vs* waiting list  $p=0.0041$ ; unscheduled *vs* waiting list  $p=0.0002$ ).

Figure 3 shows the number of patients on the waiting list at the end of each month for each endoscopic procedure. A marked increase was observed in the number of patients on the overall waiting list since March, 2020, increasing from 102 891 patients to a peak of 177 557 patients in September, 2020 (72.6% increase). The most recent data from October, 2020, suggest that the waiting lists for all three procedures have started to decrease.

We developed some future projections for potential strategies and solutions. For scenario 1, which predicts a sustained recovery to a plateau, we created five hypothetical scenarios whereby endoscopic capacity would recover at a steady rate based on the trajectory during the study period, until plateauing at a fixed capacity. These were set at 90%, 100%, 110%, 120%, and 130% of what would be expected capacity in the absence of COVID-19. These states would be reached between October, 2020, and April, 2021, depending on procedure and capacity level (appendix p 4). We estimated that there would be a residual backlog in January, 2021, of 162 735 (95% CI 143 775–181 695) colonoscopy procedures, 119 025 (107 398–130 651) flexible sigmoidoscopy procedures, and 194 087 (172 564–215 611) gastroscopy procedures attributable to the first wave of the pandemic in March, 2020, before recovery at 100% capacity (figure 4). Importantly, this backlog would remain long-term unless there was additional intervention. Even at 130% capacity, it would take until November, 2021, to catch up with the pandemic backlog for colonoscopy; June, 2022, to catch up with the pandemic backlog for flexible sigmoidoscopy; and December, 2021, to catch up with the pandemic backlog for gastroscopy. Conversely, recovery to 90% capacity would add an additional 4551 (95% CI 4249–4852) colonoscopies, 2453 (2259–2646) flexible sigmoidoscopies, and 5213 (4871–5555) gastroscopies (12 217 [11 401–13 031] total endoscopic procedures) per month to the backlog, with these figures increasingly in line with the background upward trend in demand.

For scenario 2, we made estimations for a further lockdown from December, 2020, with a reduction of

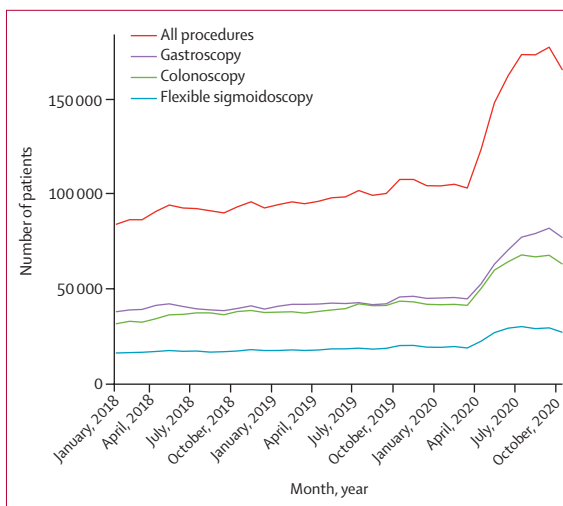
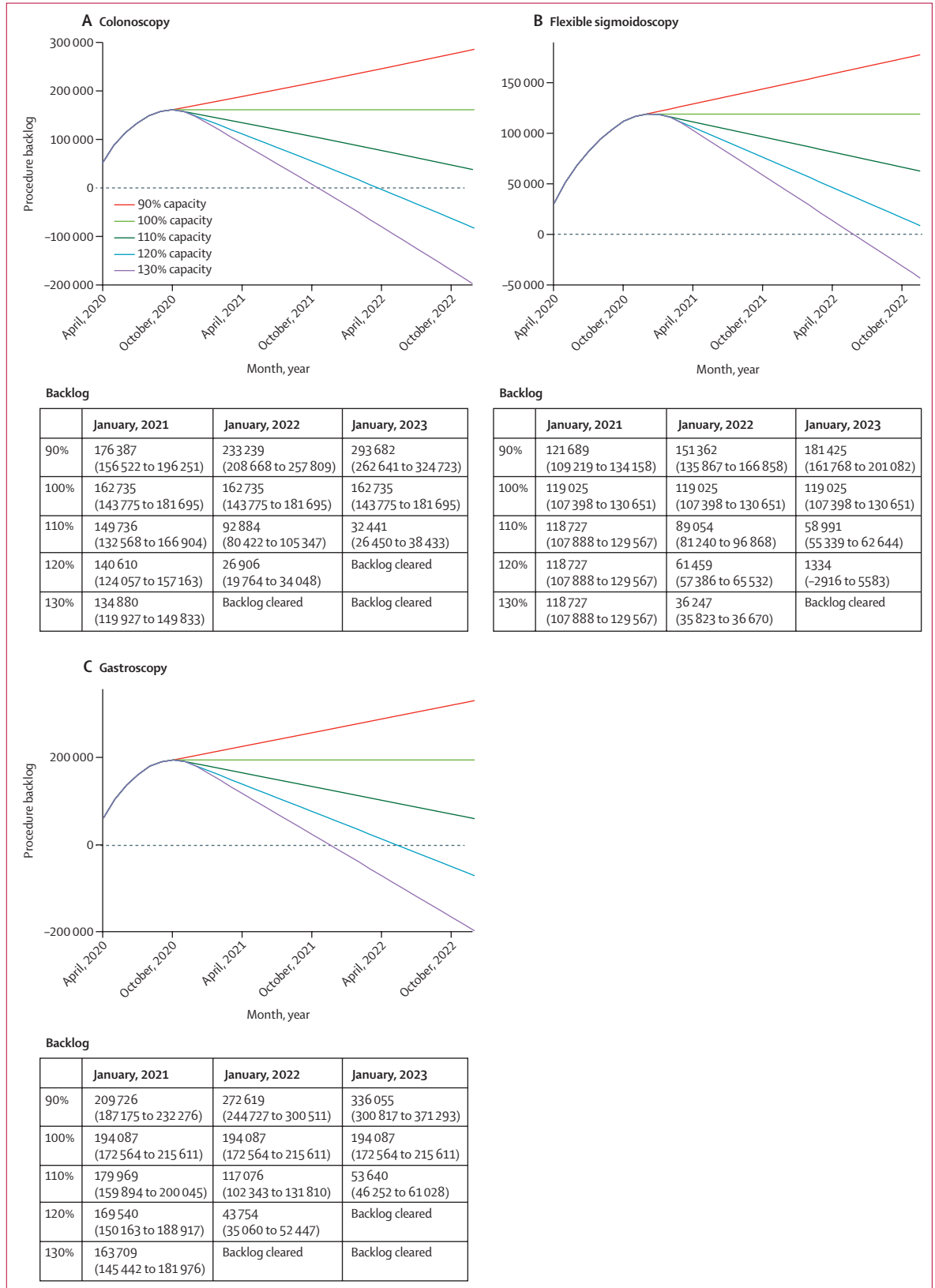


Figure 3: Number of patients on procedure waiting lists at the end of the month from January, 2018, to October, 2020

endoscopic activity. To our knowledge, there are no published studies or models to suggest what a further reduction in endoscopic activity might look like. We therefore created five hypothetical scenarios. These mimicked the pattern seen early in the pandemic, with a sharp decrease in procedures followed by a slow recovery to 100% capacity. These scenarios ranged from a drop to 60% capacity for a 2-month lockdown to 20% capacity for a 6-month lockdown. These hypothetical scenarios would represent a less severe slowdown in services, with units having learnt from their previous experience and improved contingency planning (appendix p 5). We estimate that a 2-month lockdown could add an additional 15.4% (73 359 cases [95% CI 68 404–78 314]) to the total backlog, while a 4-month lockdown could add 43.8% (208 269 cases [193 797–222 740]), and a 6-month lockdown could add 82.5% (392 796 cases [364 768–420 825]) to the total backlog (table 2).

For scenario 3, we propose using FIT triaging for colonoscopy. Loveday and colleagues suggested that using a FIT cutoff of 10  $\mu\text{g}$  haemoglobin per g could reduce urgent 2-week-wait suspected cancer endoscopies to 18% of usual requirements, if we assume the remaining 82% of patients are not offered endoscopy.<sup>8</sup> NHS England has recommended that a threshold of more than 10  $\mu\text{g}$  haemoglobin per g is used to proceed to colonoscopy, with patients who have concentrations less than the threshold offered safety netting.<sup>10</sup> Data for the proportion of procedures that were on a 2-week-wait pathway was unavailable, but we estimated this proportion using data for indications for colonoscopy. Data from the Dutch Gastrointestinal Endoscopy Audit registry showed that 29% of all colonoscopy referrals had an indication of changes in bowel habit, iron deficiency, chronic diarrhoea, or abdominal complaints.<sup>11</sup> Furthermore, data provided by NED comprising 92 879 colonoscopies in 2019 showed that 31.8% of



**Figure 4: Estimation of potential procedural backlog related to first pandemic wave in March, 2020**  
 Estimation of colonoscopy (A), flexible sigmoidoscopy (B), and gastroscopy (C) procedural backlog based on trajectory from October, 2020, before reaching a plateau at a set capacity level, with estimated backlog in January, 2021; January, 2022; and January, 2023, shown in the tables. Data in tables are n (95% CI).

	Colonoscopy		Flexible sigmoidoscopy		Gastroscopy		Total	
	Estimated additional procedures	Percentage of potential backlog (n=162 735)	Estimated additional procedures	Percentage of potential backlog (n=119 025)	Estimated additional procedures	Percentage of potential backlog (n=194 087)	Estimated additional procedures	Percentage of potential backlog (N=475 847)
2 months	27 354 (25 521–29 187)	16.8%	14 721 (13 542–15 899)	12.4%	31 284 (29 204–33 365)	16.1%	73 359 (68 404–78 314)	15.4%
3 months	50 257 (46 844–53 669)	30.9%	26 999 (24 805–29 194)	22.7%	57 371 (53 498–61 245)	29.6%	134 627 (125 403–143 852)	28.3%
4 months	77 835 (72 482–83 188)	47.8%	41 744 (38 302–45 187)	35.1%	88 690 (82 613–94 766)	45.7%	208 269 (193 797–222 740)	43.8%
5 months	110 113 (102 446–117 781)	67.7%	58 958 (54 027–63 889)	49.5%	125 243 (116 539–133 948)	64.5%	294 315 (273 586–315 043)	61.9%
6 months	147 117 (136 749–157 485)	90.4%	78 643 (71 975–85 310)	66.1%	167 037 (155 267–178 806)	86.1%	392 796 (364 768–420 825)	82.5%

Data are estimate (95% CI) or percentage.

**Table 2: Estimated additional procedures added to the backlog by months of reduced activity**

procedures had at least one indication of acute or chronic changes in bowel habit, anaemia, abdominal pain, or weight loss, although the true figure might be lower, as around 27 000 procedures had more than one indication recorded.<sup>12</sup> Assuming these referrals would be suitable for FIT triaging at 10 µg haemoglobin per g, FIT triaging could lead to a reduction of performed colonoscopy procedures to 73.9% (1–[0.82×0.318]) if using NED data, or 76.2% (1–[0.82×0.29]) if using Dutch data, equating to 11 866 (95% CI 11 080–12 652) or 10 821 (10 104–11 538) fewer colonoscopies per month. However, from our logistic regression model, we estimated that it would still take until December, 2021, to January, 2022, to clear the pandemic-related backlog (appendix p 6).

## Discussion

For the first time, to our knowledge, we present an analysis of national data to show an urgent gap in endoscopy service provision as an indirect effect of the COVID-19 pandemic. We have shown that the pandemic directly led to a decrease in the number of endoscopic procedures done, with a partial recovery as COVID-19 infections and hospital admissions started to fall. Furthermore, potential solutions are challenging even if greater than normal capacity is achieved or FIT triaging can be fully implemented.

Endoscopic activity was at its lowest in April, 2020, decreasing to 9.5% of procedures compared with 1 year earlier. We also noted regional differences in endoscopy provision as well as changes in the case mix of procedures. A similar overall pattern was seen in the NED database, which recorded the trough in the week beginning March 30, 2020, although no regional differences were seen.<sup>3</sup> This result is probably because the NED analysis only included data up until May 31, 2020, and regional differences might not have been apparent then.

As a comparison, a national study from the Netherlands, which entered a nationwide lockdown on March 12, 2020, showed a drop to 29% for colonoscopy and 37% for

gastroscopy when comparing between January and April, 2020.<sup>13</sup> Meanwhile, a global web-based survey done between April and May, 2020, covering 252 centres from 55 countries suggested an average of 83% reduction when comparing activity between baseline and during the COVID-19 pandemic.<sup>14</sup> These results would suggest that endoscopy in England might have been affected to a greater degree than in other countries around the world, even though there was broad consensus among worldwide guidelines.<sup>15</sup> A host of reasons, ranging from decision making at the local level, hesitancy at accessing cancer services, preserving personal protective equipment (PPE), and staffing issues might be the cause of this difference.<sup>16</sup>

Our data also show that recovery has been somewhat slow and that there are some substantial inter-regional differences. 6 months on from the start of the first peak of the pandemic in March, 2020, the number of patients on waiting lists had started to fall, but approximately 50% more patients were on a waiting list in October, 2020, than in the previous year. Meanwhile, capacity in October, 2020, remained at 84.5% compared with the previous year, with a slower recovery for planned or surveillance procedures (60% of October, 2019, levels) compared with waiting list procedures (87% of October, 2019, levels). Conversely, there have been more unscheduled procedures than in the previous year: this finding might be a manifestation of altered health behaviour during the first peak of the pandemic, with delayed presentation of medical conditions subsequently leading to emergency complications.<sup>1</sup> These findings show the need for a targeted approach regionally to aid recovery with appropriate resource allocation. Equally, there should be a dedicated strategy to ensure that planned or surveillance procedures do not lag far behind waiting list procedures during the recovery.

Endoscopy services face further challenges in increasing capacity back to pre-pandemic levels. Staffing remains a key concern: redeployment, staff absence due to self-isolation or shielding, and additional administrative burden due to COVID-19 mitigation measures such as telephone



triaging and pre-procedural SARS-CoV-2 testing all create additional barriers in service recovery.<sup>5,10</sup> In addition, the requirement for PPE, especially with gastroscopy (an aerosol-generating procedure) and infection control measures such as deep cleaning and leaving a time gap between procedures all lead to decreased room use and efficiency.<sup>5,17</sup>

Our work on future projections, based on extrapolation of historical pre-pandemic demand, also shows that there could be a backlog of nearly half a million endoscopic procedures attributable to the pandemic. We also quantified the scale of the challenge faced in the recovery phase: if only 90% capacity is reached, which might well be realistic given the current constraints, each month will add an additional 12 217 (95% CI 11 401–13 031) endoscopic procedures to the potential backlog. Furthermore, following the surge in COVID-19 cases since December, 2020, it is likely that endoscopy services have been curtailed, and even a short 2-month disruption could add an additional 73 359 (95% CI 68 404–78 314) cases to the potential backlog. There is therefore a need to preserve progress made on recovery and catch up by increasing capacity to above normal levels.<sup>18,19</sup> One option is to use the private sector to provide this additional capacity for a short period to catch up, or to create additional capacity during evenings and weekends. However, a UK study from 2017 showed that only 55% of endoscopy units were meeting cancer wait targets, with shortages of endoscopists and nursing staff cited as reasons for missing the target.<sup>20</sup> 82% of English NHS trusts already do ad-hoc weekend work, hence increasing capacity further for a sustained period might not be possible.<sup>20</sup>

Temporary increases in waiting list and unscheduled capacity could be achieved by reducing cancer screening programmes and reallocating this capacity. As an example, it was expected for the Bowel Scope Screening Programme to have done 256 000 flexible sigmoidoscopies in 2020.<sup>21</sup> Under our projections, reallocating this capacity could create an additional 87% capacity per month, eliminating the pandemic-related backlog by May, 2021. However, this reallocation of screening capacity for other purposes must be balanced against the risk of an overall increase in preventable deaths.<sup>22</sup> Furthermore, the latest British Society of Gastroenterology guidelines for post-polypectomy surveillance suggest that adoption would lead to a decrease to 20% of the level of polyp surveillance workload in 2019.<sup>23</sup> 10·4% of colonoscopies in a Dutch series had an indication of adenoma surveillance, so theoretically, adherence to these guidelines could generate an extra 8·3% of capacity.<sup>11</sup>

Strategies to enhance triaging could also be used to reduce the rate of additional cases being added to the backlog. Enhanced vetting of referrals has been used in 77% of recovery plans and has helped to reduce demand.<sup>23</sup> FIT has increasingly been used across the NHS to triage patients for lower gastrointestinal

investigation, and recommendations were released in March, 2020, for FIT triaging to be used for patients who were symptomatic in primary care.<sup>8,24</sup> We show here that FIT could reduce the colonoscopy backlog, if patients with haemoglobin concentrations less than a set FIT threshold are not offered endoscopy. Studies have found that FIT with 10 µg or less haemoglobin per g has a negative predictive value of greater than 99%, with the colorectal cancer risk in patients who are symptomatic similar to the baseline risk.<sup>24–26</sup> However, it has also been argued that FIT should be used as a triaging rather than a diagnostic tool, to guide timing of the procedure rather than replace it.<sup>27</sup> If used in this way, it might have limited effect in the long term to reduce colonoscopy demand. In addition, there remains debate as to how patients with a FIT of 10 µg or less haemoglobin per g ought to be followed up.<sup>24</sup> Cytosponge and colon capsule endoscopy in lieu of gastroscopy and colonoscopy have both been touted as possible alternatives, although neither are used in routine clinical practice.<sup>28,29</sup>

An alternative to colonoscopy could be to use CT colonography. We attempted to assess data for changes to CT colonography use during the pandemic. Unfortunately, these data are not collected by NHS England. Advantages of CT colonography include decreased PPE use, improved ability to socially distance compared with colonoscopy, and shorter patient visit times.<sup>30</sup> However, ensuring adequate CT capacity and expertise to perform and report the procedures might be barriers to implementation.<sup>31</sup>

There are also wider implications for our work; although we have quantified the effect of the pandemic on endoscopy, other procedure-heavy specialties such as cardiology and surgery have also faced similar challenges.<sup>32,33</sup> Of particular concern is the effect on cancer waiting lists and pathways; it has been estimated that diagnostic delays might lead to a 16% increase in colorectal cancer deaths and 5·9% increase in oesophageal cancer deaths over 5 years.<sup>19</sup> Furthermore, diagnostic delays due to a further lockdown could lead to 1231 additional cancer-related deaths and 22 635 life-years lost.<sup>18</sup> This possibility is especially pertinent as countries experience subsequent waves of the pandemic, leading to increased health-care resource use and further risking the recovery of hospital services. The focus on cancer might very much be a small part of a much wider problem; we might not fully know the effect of the pandemic on other gastrointestinal diseases, other health services, and health outcomes for some years, not only in England but also globally. However, given that this issue is global and interdisciplinary, it could afford novel opportunities for collaboration going forward.

The first important limitation of the study relates to the size of the waiting list. Although endoscopic activity remains less than expected levels, endoscopy waiting lists started to decrease as of October, 2020. This finding suggests that deferred patients might have already been

referred or might no longer require endoscopic investigation. An alternative explanation is that this result is a reflection of both a reduction in general practice consultations by a third and reduction in referrals to secondary care by half.<sup>34,35</sup> With COVID-19 being a dynamic situation with a resurgence of cases from December, 2020, the full effect on endoscopic waiting lists might still not be fully known and potentially be worse than feared. A second limitation is that in our backlog calculation we have assumed that endoscopy will eventually return to pre-pandemic levels of practice and demand, and that over time, referral patterns will even out back to pre-pandemic trends. Some recovery plans, such as enhanced vetting of referrals or changes in referral pathways could be retained long term and continue to reduce demand for endoscopy services. This situation would mean that the estimated backlog figures presented here might be an overestimate of the actual backlog of procedures. However, any excess capacity could easily be filled by expansion of cancer screening or surveillance programmes.<sup>23</sup> Third, our study excludes endoscopic retrograde cholangiopancreatographies and procedures done as part of the Bowel Cancer Screening Programme and the Bowel Scope Screening Programme, which were suspended in the first wave of the pandemic. Fourth, data for the number of referrals to endoscopy were unavailable, which would have been a better measure of demand. Although data for the number of patients on the waiting list is available per procedure, these data only provide a snapshot of the number of people at the end of a month at a given timepoint, and also exclude unscheduled or planned or surveillance procedures; hence it was not used as a surrogate for referrals. Also, our scenarios for a further slowdown are hypothetical in nature and might not reflect real-world practice. Finally, we made assumptions on the number of colonoscopy referrals, which might be amenable to FIT triaging by using data for endoscopic indications. In addition, guidelines for FIT triaging were introduced from March, 2020, onwards within different regions, hence the effect of FIT triaging as predicted in our model might be less pronounced.

Our research shows the enormous strain the COVID-19 pandemic has put on NHS endoscopy in England. This issue has become even more pertinent with the rapid rise in COVID-19 hospital admissions in December, 2020, and January, 2021, leading to further disruption of endoscopic services. Without major structural reforms, this disruption will lead to a growing backlog of cases. Strategies to increase endoscopy capacity and preserve endoscopy services in the event of subsequent waves of infection must be implemented immediately. Triaging with FIT testing should be implemented, with further urgent research deployed to ensure risk stratification of patients reduces unnecessary demand but also provides a safety net for those at highest risk.

#### Contributors

KMAH was responsible for study conception, data analysis, and manuscript preparation. MDR was responsible for collection of data, manuscript preparation, and supervisory oversight. AB, ML, and LBL were responsible for study conception, data analysis, manuscript preparation, and supervisory oversight. KMAH, AB, ML, and LBL verified data. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

#### Declaration of interests

KMAH has received a British Society of Gastroenterology-Norgine travel award for travel and conference expenses unrelated to this work. ML has received an unrestricted educational grant from Pfizer for research unrelated to this work. ML has also received honoraria from Pfizer, EMD Serono, Roche, and Bristol Myers Squibb unrelated to this work. All other authors declare no competing interests.

#### Data sharing

Data used in this study are openly available from NHS England.

#### Acknowledgments

This work was supported by the Wellcome/EPSCRC Centre for Interventional and Surgical Sciences (WEISS) at University College London (203145Z/16/Z). LBL is also funded by the National Institute for Health Research (NIHR) UCLH Biomedical Research Centre. The views expressed are those of the author(s) and not necessarily those of the National Health Service, the NIHR, or the UK Department of Health. ML is Scientific Director of DATA-CAN, the UK's Health Data Research Hub for Cancer, which is funded through the Industry Strategy Challenge Fund. Patients and the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

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For data see <https://www.england.nhs.uk/statistics/statistical-work-areas/diagnostics-waiting-times-and-activity/monthly-diagnostics-waiting-times-and-activity/>

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