Outcomes from elective colorectal cancer surgery during the SARS-CoV-2 pandemic

COVIDSurg Collaborative†

Abstract

Aim: This study aimed to describe the change in surgical practice and the impact of SARS-CoV-2 on mortality after surgical resection of colorectal cancer during the initial phases of the SARS-CoV-2 pandemic.

Method: This was an international cohort study of patients undergoing elective resection of colon or rectal cancer without preoperative suspicion of SARS-CoV-2. Centres entered data from their first recorded case of COVID-19 until 19 April 2020. The primary outcome was 30-day mortality. Secondary outcomes included anastomotic leak, postoperative SARS-CoV-2 and a comparison with prepandemic European Society of Coloproctology cohort data.

Results: From 2073 patients in 40 countries, 1.3% (27/2073) had a defunctioning stoma and 3.0% (63/2073) had an end stoma instead of an anastomosis only. Thirty-day mortality was 1.8% (38/2073), the incidence of postoperative SARS-CoV-2 was 3.8% (78/2073) and the anastomotic leak rate was 4.9% (86/1738). Mortality was lowest in patients without a leak or SARS-CoV-2 (14/1601, 0.9%) and highest in patients with both a leak and SARS-CoV-2 (5/13, 38.5%). Mortality was independently associated with anastomotic leak (adjusted odds ratio 6.01, 95% confidence interval 2.58–14.06), postoperative SARS-CoV-2 (16.90, 7.86–36.38), male sex (2.46, 1.01–5.93), age >70 years (2.87, 1.32–6.20) and advanced cancer stage (3.43, 1.16–10.21). Compared with prepandemic data, there were fewer anastomotic leaks (4.9% versus 7.7%) and an overall shorter length of stay (6 versus 7 days) but higher mortality (1.7% versus 1.1%).

Conclusion: Surgeons need to further mitigate against both SARS-CoV-2 and anastomotic leak when offering surgery during current and future COVID-19 waves based on patient, operative and organizational risks.

KEYWORDS
cancer, colon cancer, COVID-19, pandemic, rectal cancer, SARS-CoV-2, surgery, surgical oncology

1 | INTRODUCTION

During the early phases of the COVID-19 pandemic there was uncertainty about the impact of perioperative SARS-CoV-2 on surgical patients and a growing scarcity of intensive care capacity [1,2]. Guidelines emerged which recommended changing anastomotic practice in favour of forming a defunctioning stoma or end stoma in patients who would have previously only had an anastomosis [3–6].

†A complete list of the investigators is included in Appendix 1.
eligible patients were identified from multidisciplinary team resection or bypass procedures), were excluded. Consecutive the tumour was left intent were eligible. Palliative operations, including those where colonic or rectal cancer resectional surgery with curative All adult patients (aged 18 years and over) who underwent elective colon or rectal cancer surgery in countries affected by the COVID-19 University of Birmingham, UK. Any hospital performing elective surgery without preoperative suspicion of SARS-CoV-2 [13]. Study approvals for participating hospitals were secured by local principal investigators before entry into the study and data collection. The study protocol was either registered as a clinical audit with institutional review or a research study obtaining ethical committee approval, dependent on local and national requirements. Data were collected online and stored on a secure server running the Research Electronic Data Capture (REDCap) web application [14] based in the investigators before entry into the study and data collection. The study protocol was either registered as a clinical audit with institutional review or a research study obtaining ethical committee approval, dependent on local and national requirements. Data were collected online and stored on a secure server running the Research Electronic Data Capture (REDCap) web application [14] based in the University of Birmingham, UK. Any hospital performing elective colon or rectal cancer surgery in countries affected by the COVID-19 pandemic was eligible to participate. Hospitals were required to collect data on consecutive eligible patients from the date of their first recorded case of COVID-19 until 19 April 2020.

2.2 | Patients and procedures

All adult patients (aged 18 years and over) who underwent elective colon or rectal cancer resectional surgery with curative intent were eligible. Palliative operations, including those where the tumour was left in situ (e.g., formation of an end stoma without resection or bypass procedures), were excluded. Consecutive eligible patients were identified from multidisciplinary team

2.3 | Data variables

Baseline patient characteristics included age, sex and American Society of Anesthesiologists (ASA) physical status classification [16]. Age was collected as deciles of years as a categorical variable. ASA status was analysed as grades 1-2 versus grades 3-5. Disease characteristics included baseline tumour, node, metastases (TNM) stage prior to surgery, or neoadjuvant treatment. The TNM stage was used to calculate the patient’s baseline cancer disease stage. Disease stages were grouped for analysis as Stage I or Stage II versus Stage III or Stage IV. For patients with cancers involving the rectum, data on neoadjuvant radiotherapy and the duration of therapy (long-course or short-course radiotherapy) were also analysed. Operative variables collected included the operative procedure performed, if a defunctioning or end stoma was formed, the operative approach (minimally invasive, minimally invasive converted to open, or open), the specialty and grade of the lead surgeon (consultant or trainee, colorectal or general surgeon) and whether a stapled or hand-sewn technique was used for the anastomosis, where applicable. We did not specify the precise nature of minimally invasive surgery as there are many variants, but we know from previous international studies that >95% of minimally invasive operations are laparoscopic [17,18]. For analysis, operative procedures were grouped anatomically into right resection, left resection, rectal resection and total/subtotal/resection with commissurotomy, in situ (e.g., in situ formation of a defunctioning or end stoma without resection or bypass procedures), were excluded. Consecutive eligible patients were identified from multidisciplinary team meetings, operating lists and outpatient or telemedicine clinics. The day of surgery was defined as day zero, with patients followed up for 30 days postoperatively using routine follow-up pathways. Patients who had an operation for suspected cancer which was subsequently shown to be a preinvasive lesion after histological examination (e.g., high-grade dysplasia, carcinoma in situ) were still included in this study. However, patients who had an operation for a suspected cancer but who had a histologically benign lesion were excluded. Elective surgery was defined as any surgery booked in advance of a planned admission to hospital [15]. Patients who were suspected of having, or confirmed to have, SARS-CoV-2 infection at the time of surgery (through nasopharyngeal swab and quantitative reverse transcription polymerase chain reaction, CT thorax or clinical symptoms consistent with COVID-19) were excluded from these analyses.

Despite outbreaks, cancer surgery must continue in order to prevent an overwhelming number of delayed operations, a possible increase in emergency procedures and a significant decline in population health [12]. The extent of new stoma formation during the first phases of the pandemic and the subsequent patient-related outcomes are unknown. The impact of anastomotic leak and postoperative SARS-CoV-2 infection on mortality are also unknown. This study aimed to fill these knowledge gaps and to produce patient-level outcome data that would inform patient selection and informed consent.

2 | METHOD

2.1 | Study design

This was a planned specialty analysis of adult patients undergoing elective colonic and rectal cancer resection in a prospective international multicentre cohort study of patients undergoing elective surgery without preoperative suspicion of SARS-CoV-2 [13]. Study approvals for participating hospitals were secured by local principal investigators before entry into the study and data collection. The study protocol was either registered as a clinical audit with institutional review or a research study obtaining ethical committee approval, dependent on local and national requirements. Data were collected online and stored on a secure server running the Research Electronic Data Capture (REDCap) web application [14] based in the University of Birmingham, UK. Any hospital performing elective colon or rectal cancer surgery in countries affected by the COVID-19 pandemic was eligible to participate. Hospitals were required to collect data on consecutive eligible patients from the date of their first recorded case of COVID-19 until 19 April 2020.

What does this paper add to the literature?

Mortality associated with anastomotic leak and postoperative SARS-CoV-2 during the COVID-19 pandemic was extremely high. A relatively small change in stoma practice was seen. Surgeons need to robustly mitigate against both SARS-CoV-2 and anastomotic leak when offering surgery during future waves of COVID-19, based on patient, operative and organizational factors.
panproctocolectomy. A full list of operative procedures is included in Table S1 in the Supporting Information.

2.4 | Outcomes

The primary outcome measure was mortality within the 30 days following surgery. Secondary outcome measures were anastomotic leak, admission to critical care (including high-dependency areas), postoperative SARS-CoV-2 infection and total length of hospital stay up to 30 days after surgery. Postoperative SARS-CoV-2 infection was defined as a positive swab or CT thorax in line with locally implemented protocols, or a clinical diagnosis of symptoms in keeping with COVID-19 in patients where no swab test or CT scan was available.

2.5 | Change in anastomotic practice due to COVID-19

Data were collected on the intraoperative decision on stoma formation. Where patients had a stoma, surgeons were asked if this was their ‘normal practice’ or a ‘change in practice due to COVID-19’. The group with a stoma created as a change in practice were labelled ‘COVID-end-stoma’ or ‘COVID-defunctioning-stoma’ for tables and analyses. If the patient had a stoma formed and the surgeon indicated a ‘change in practice due to COVID-19’, they were asked to list all the reasons that applied to that case for this change (Figure S1).

2.6 | Prepandemic data

Prepandemic data on colorectal cancer surgery were obtained from published European Society of Coloproctology (ESCP) 2015 Right Hemicolectomy Audit [19–21] and the 2017 Left Colon, Sigmoid and Rectal Resections Audit [18,22] Data. Data from 5792 patients from 54 countries undergoing segmental resection for a colonic or rectal cancer were used for comparison with the equivalent cohort undergoing surgery during the pandemic. These data provided a contemporaneous and detailed comparison of case selection and outcomes during the pandemic and prepandemic periods. Data were not presented in these studies for total or subtotal colectomy, so no comparison was made with these operation types. TNM staging data were not available from the 2015 Right Hemicolectomy Audit and therefore comparison was not made in that field.

2.7 | Statistical analysis

The study was conducted according to guidelines set by the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement for observational studies [23]. The chi-square test was used to compare differences in categorical data apart from when cell sizes were small, when Fisher’s exact tests were used. Continuous nonparametric data are presented as medians and interquartile ranges and median differences between groups were compared using the Mann–Whitney U-test. Missing data are included in summary tables.

For the primary outcome of 30-day mortality, a multilevel logistic regression was used to evaluate the impact of postoperative SARS-CoV-2 and anastomotic leak on death after surgery, summarized using odds ratios (ORs) with 95% confidence intervals (95% CIs). Country was included in the model as a random effect. The model also included clinically plausible preoperative and intraoperative factors in order to adjust for covariates and reduce the risk of confounding factors (age, sex, ASA grade, disease stage and operation type). Chi-square tests and Fisher’s exact tests were used to compare outcomes for those with a COVID-stoma and those without. Similar methods were used to compare pandemic data with published prepandemic data. Analysis was performed used Stata SE version 16.1, (StataCorp, Texas, USA).

3 | RESULTS

3.1 | Patients and disease characteristics

This analysis included 2073 patients undergoing resection of a colonic or rectal cancer in 270 hospitals from 40 countries (Table S2). Of these patients, 1236 (59.6%) were men (Table 1). Overall, 1420 patients (68.7%) were ASA grades 1–2 and 1288 (62.1%) patients had disease Stage I–II. Of 947 patients who had an operation involving the rectum (including panproctocolectomy), 89 (9.4%) received short-course and 206 (21.8%) received long-course neoadjuvant radiotherapy.

Of the 2073 patients, 785 (37.9%) had an open approach and 1186 (57.2%) had a minimally invasive approach. In 102 (4.9%) minimally invasive surgery was attempted with conversion to an open operation. Of patients who had an anastomosis, 85.6% (1474/1722) had a stapled anastomosis. The lead surgeon was more frequent than the rate of 27.2% in the prepandemic era (686/1573) (Table 5). Colorectal trainees were more likely to be the named lead surgeon when defunctioning COVID-stomas were formed (8.3%, 11/133) when compared with colorectal consultants.
TABLE 1 Patients and disease characteristics stratified by operation

| Operation                        | Right-side resection (n = 724) | Left-side resection (n = 367) | Rectal resection (n = 935) | Total/subtotal panproctocolectomy (n = 47) |
|----------------------------------|--------------------------------|------------------------------|---------------------------|-------------------------------------------|
| n                                | %                              | n                            | %                         | n                                        |
| Sex                              |                                |                              |                           |                                           |
| Female                           | 343                            | 135                          | 343                       | 16                                        |
| Male                             | 381                            | 232                          | 592                       | 31                                        |
| ASA grade                        |                                |                              |                           |                                           |
| 1–2                              | 454                            | 244                          | 686                       | 36                                        |
| 3–5                              | 269                            | 123                          | 244                       | 11                                        |
| Missing                          | 1                              | 0                            | 5                         | 0                                         |
| Age (years)                      |                                |                              |                           |                                           |
| <50                              | 42                             | 25                           | 96                        | 11                                        |
| 50–69                            | 268                            | 187                          | 495                       | 16                                        |
| ≥70                              | 414                            | 155                          | 344                       | 20                                        |
| Disease stage                    |                                |                              |                           |                                           |
| I–II                             | 512                            | 216                          | 482                       | 33                                        |
| III                              | 181                            | 78                           | 385                       | 9                                         |
| IV                               | 31                             | 28                           | 68                        | 5                                         |
| Neoadjuvant radiotherapy<sup>a</sup> |                                |                              |                           |                                           |
| Short course                     |                                | 89                           | 9.5%                      | 0                                         |
| Long course                      |                                | 205                          | 21.9%                     | 1                                         |
| None                             |                                | 641                          | 68.6%                     | 33                                        |
| Approach                         |                                |                              |                           |                                           |
| Laparoscopic                     | 395                            | 231                          | 540                       | 19                                        |
| Open                             | 298                            | 109                          | 355                       | 24                                        |
| Conversion                       | 31                             | 27                           | 40                        | 4                                         |
| Anastomotic technique            |                                |                              |                           |                                           |
| Stapled                          | 527                            | 298                          | 619                       | 30                                        |
| Hand sewn                        | 155                            | 36                           | 53                        | 4                                         |
| No anastomosis                   | 37                             | 30                           | 255                       | 13                                        |
| Missing                          | 5                              | 3                            | 8                         | 0                                         |
| Seniority                        |                                |                              |                           |                                           |
| Colorectal consultant            | 488                            | 263                          | 732                       | 38                                        |
| Colorectal trainee               | 61                             | 14                           | 55                        | 3                                         |
| General surgery consultant       | 126                            | 65                           | 124                       | 6                                         |
| General surgery trainee          | 43                             | 23                           | 18                        | 0                                         |
| Missing                          | 5                              | 2                            | 6                         | 0                                         |

Abbreviation: ASA, American Society of Anesthesiologists.

<sup>a</sup>Of patients who had an operation involving the rectum.

Table 2. This contrasts with the prepandemic era when a colorectal trainee was the named lead surgeon in 4.4% (97/2218) of procedures where a stoma was formed. More COVID-end-stomas were formed in patients undergoing rectal resections, in those who had an open approach to surgery and in those who received either no neoadjuvant therapy or long-course neoadjuvant radiotherapy (Table 2). This is also reflected in an increase in the number of end stoma formations in rectal resections during the pandemic era (27.3%, 255/935) when compared with the prepandemic era (23.7%, 613/2579) and a decrease of formation of anastomosis without a defunctioning stoma during the pandemic (37.4%, 350/935) compared with prepandemic levels (42.8%, 1103/2579). The proportion of COVID-stomas compared with all stomas is shown in Table S3.

Of all rectal resections, 7.4% (69/935) received a COVID-stoma (Figure 1), representing 76.7% of all COVID-stomas (n = 90). In right
colonic resections, 11 COVID-stomas were formed (1.5% of 724 right resections), nine were formed in left colonic resections (2.5% of 367 left resections) and one COVID-stoma was formed from the total/subtotal/panproctocolectomy group (2.1% of 47; Table 2).

There were slight but nonsignificant differences in patients who had a COVID-stoma compared with those who did not (Table 3), including a slight increase in anastomotic leak (7.4% versus 4.9%) and intensive care usage (29.9% versus 22.5%) and slight decrease in...
mortality (1.1% versus 1.9%). There was shorter length of stay in the group with a COVID-stoma (4.5 days versus 6.0 days). Similarly, no difference in outcomes was observed in patients undergoing COVID-stoma when stratified by cancer location (Table S4).

3.3 | Reasons for COVID-stoma formation

The reason for change in practice was explored in patients who had a COVID-stoma (stoma formation as a direct result of COVID-19; n = 90). Surgeons were permitted to give more than one reason for change. There was a total of 147 responses. The most common reasons reported for formation of COVID-stoma were ‘recommendation from specialty associations’ (44%, 64/147; Figure S1) and ‘to avoid possible complications requiring critical care’ (39%, 57/147). ‘Wish to reduce length of inpatient stay’ was given in 10% (14/147) and ‘fear of patient suffering COVID-19 postoperatively’ was given in 6% (9/147) of responses. Only 2% (3/147) cited ‘Lack of access to postoperative intensive care’ and one cited ‘very difficult working conditions of full PPE’ as the reasons for COVID-stoma.

3.4 | Outcomes after surgery

Overall, 38 (1.8%) patients died within 30 days of surgery, 78 (3.8%) patients developed postoperative SARS-CoV-2 and 86 (4.9%) patients had an anastomotic leak. Mortality rates are presented in Figure 2, and show an increasing relationship with both anastomotic leak and SARS-CoV-2 infection. In risk-adjusted analyses, significant predictors of 30-day mortality were postoperative SARS-CoV-2, anastomotic leak, male sex, age over 70 years, cancer disease Stage IV and having a total/subtotal/panproctocolectomy (see Table 4 for adjusted ORs).
3.5 | Case selection during the pandemic

Pandemic data are compared with prepandemic data from ESCP-published cohort data in Table 5. There were few differences between patient characteristics across different operations. Overall, during the pandemic, patients selected for surgery were fitter (with lower ASA grade), more stomas were formed and a stapled technique was used more frequently than hand-sewn anastomosis (Table 5). Outcomes following surgery during the pandemic included fewer anastomotic leaks and admissions to critical care; however, mortality was higher during the pandemic than in prepandemic era (Table 5).

In patients who had an anastomotic leak, mortality was 8.6%, (6/70) in the pandemic data. In the prepandemic data, the mortality in those who had a leak was 6.6% (26/395).

4 | DISCUSSION

Mortality associated with an anastomotic leak and postoperative SARS-CoV-2 during the first waves of the COVID-19 pandemic was extremely high. A small change in stoma practice was observed, with fewer than 5% of patients receiving a COVID-stoma when they would usually have had an anastomosis only. Although those patients did not suffer any adverse outcomes, those measures alone did not reduce the overall complication rates seen in this study. In comparison with published mortality data following perioperative SARS-CoV-2 infection alone, the relative risk of death was almost 60% higher in combination with anastomotic leak (24.1% versus 34.8%) [11].

Comparison with previous ESCP cohort data identifies some of the selection bias that took place during these phases of the pandemic. There was an increased use of stapled anastomosis, fewer admissions to intensive care and a shorter length of stay. These all suggest efforts by surgeons and patient to reduce the duration of surgery, resource usage and hospital stay. Rectal cancer patients undergoing surgery seemed to be fitter than in data from the ESCP audits, with a higher proportion of patients of ASA grades 1-2. Slightly fewer patients underwent neoadjuvant therapy compared with before the pandemic, which suggests a greater element of delayed surgery or ‘watch and wait’ strategies during the pandemic. Outcomes from patients who had neoadjuvant therapies and were either delayed or did not have surgery are awaited. There may be an increased flow of patients ‘postpandemic’, both needing surgery and needing monitoring, who will require additional support from already strained surgical systems.

This study had limitations. First, this was an observational study in the first phase of the pandemic, where guideline implementation was incomplete. Data on implementation of guidelines by each hospital or country were not captured in this study. Second, the absolute change in practice presented was small, so firm conclusions cannot be drawn around the safety of the wider adoption of risk-averse practices. Third, comparison with the prepandemic ESCP audit dataset may be biased through undetected patient-, hospital- and country-level differences that could preclude direct comparison, therefore the results must be interpreted with caution and firm conclusions should not be drawn. Fourth, data were not presented for patients who had surgery delayed due to COVID-19 or had an alternative treatment strategy. We therefore present an incomplete picture of the care of colorectal cancer patients during the pandemic. Fifth, change in practice to COVID-stoma was reported by the surgeon and is therefore subjectively reported. We attempted to overcome this by comparing the total stoma rate with prepandemic rates, showing an increased rate of stoma formation during the pandemic. Sixth, despite guidance and concerns around
TABLE 4 Adjusted and unadjusted regression model of predictors for 30-day mortality

| Mortality | Univariable | Multivariable |
|-----------|-------------|---------------|
|           | n | % | OR | 95% CI | OR | 95% CI | P |
| Anastomotic leak | No | 27/1954 | 1.4% | - | - | - | - |
| | Yes | 11/93 | 11.8% | 9.21 | 4.32–19.64 | 6.01 | 2.58–14.06 | <0.001 |
| SARS-CoV-2 | No | 23/1995 | 1.2% | - | - | - | - |
| | Yes | 15/78 | 19.2% | 20.41 | 10.17–41.00 | 16.90 | 7.86–36.38 | <0.001 |
| Age (years) | <70 | 13/1140 | 1.1% | - | - | - | - |
| | >70 | 25/933 | 2.7% | 2.39 | 1.21–4.69 | 2.87 | 1.32–6.20 | 0.008 |
| Sex | Female | 7/837 | 0.8% | - | - | - | - |
| | Male | 31/1236 | 2.5% | 3.05 | 1.34–6.96 | 2.46 | 1.01–5.93 | 0.045 |
| ASA grade<sup>a</sup> | 1–2 | 19/1420 | 1.3% | - | - | - | - |
| | 3–5 | 19/647 | 2.9% | 2.23 | 1.17–4.24 | 1.57 | 0.76–3.26 | 0.223 |
| Disease stage | I–II | 17/1288 | 1.3% | - | - | - | - |
| | III | 15/653 | 2.3% | 1.76 | 0.87–3.54 | 2.00 | 0.91–4.20 | 0.088 |
| | IV | 6/132 | 4.6% | 3.56 | 1.38–9.19 | 3.43 | 1.16–10.21 | 0.026 |
| Operation | Right resection | 9/724 | 1.2% | - | - | - | - |
| | Left resection | 6/367 | 1.6% | 1.32 | 0.47–3.74 | 1.45 | 0.47–4.48 | 0.524 |
| | Rectal resection | 19/935 | 2.0% | 1.65 | 0.74–3.66 | 1.60 | 0.65–3.93 | 0.302 |
| Total/subtotal/panproctocolectomy | 4/47 | 8.5% | 7.39 | 2.19–24.96 | 9.06 | 2.21–37.15 | 0.002 |

Statistically significant P values are indicated in bold.

<sup>a</sup>American Society of Anesthesiologists (ASA) physical status classification [16].

Aerosolization, this study showed that laparoscopic approaches continued. The reasons for this, including surgeon and patient attitudes, deserve further exploration by way of additional qualitative research. Finally, although case selection and more elective stomas can potentially reduce postoperative risks, further robust strategies are needed to mitigate against morbidity and mortality and further exploration is required.

Clear data and safe strategies are needed to continue to provide safe surgery during future pandemic waves. This study highlights several patient, operative and organizational factors that may bring benefit and need further testing. At a patient level, selection of fitter patients, who will benefit most from curative surgery during peaks of pandemics, is logical. This has been previously recommended to both conserve critical care capacity and avoid exposing high-risk patients to nosocomial SARS-CoV-2 transmission [3,9]. At an operative level, the avoidance of leaks seems paramount. Forming stomas alone is not necessarily the solution, as they carry their own risks and morbidity. Selecting lower-risk patients for anastomosis, use of defunctioning stomas and more liberal use of end stomas in high-risk patients might be best supported through formal risk stratification for anastomotic leak [23,24]. At an organizational level, the prevention of postoperative SARS-CoV-2-related infections is paramount. This seems best approached by identifying preoperative, presymptomatic carriers (i.e. preoperative swab testing) and by providing COVID-19-free surgical pathways. Both of these areas require further evidence to best define exactly which measures they include (e.g. number of swabs, role of computed tomography of the thorax, components of COVID-19-free pathways). With an estimated 3 000 000 cancer operations postponed around the world [12], and more accruing during second waves, efficient measures to safely discharge patients early and protect them from the risk of in-hospital transmission should continue.

5 | DATA AVAILABILITY SHARING

Data-sharing requests will be considered by the management group upon written request to the corresponding author. If agreed, de-identified participant data will be available, subject to a data-sharing agreement.

CONFLICT OF INTEREST

There are no conflicts of interest to declare.

FUNDING INFORMATION

This report was funded by a National Institute for Health Research (NIHR) Global Health Research Unit Grant (NIHR 16.136.79) using UK aid from the UK Government to support global health research, The Association of Coloproctology of Great Britain and Ireland, Bowel & Cancer Research, Bowel Disease Research Foundation, Association of Upper Gastrointestinal Surgeons, British Association of Surgical Oncology, British Gynaecological Cancer Society; European Society of Coloproctology, NIHR Academy, Sarcoma UK, Vascular Society for Great Britain and Ireland and Yorkshire Cancer Research. The funders
**TABLE 5** Comparison of patient and disease characteristics and outcomes of patients undergoing elective cancer operations currently (during the pandemic) alongside composite data from the ESCP 2015 and 2017 audits (pre-pandemic)

| Right | Pre-pandemic | During pandemic | P-value | Left | Pre-pandemic | During pandemic | P-value | Rectum | Pre-pandemic | During pandemic | P-value |
|-------|--------------|-----------------|---------|------|--------------|-----------------|---------|--------|--------------|-----------------|---------|
| Sex   | Male         | 1151 (51.7%)    | 381 (52.6%) | 0.676 | Male         | 589 (59.6%)    | 232 (63.2%) | 0.228  | Male         | 1617 (62.7%)    | 592 (63.3%) | 0.738 |
|       | Female       | 1074 (48.3%)    | 343 (47.4%) |        | Female       | 400 (40.4%)    | 135 (36.8%) |        | Female       | 962 (37.3%)     | 343 (36.7%) |        |
| Age (years) | <50 | 104 (4.7%) | 42 (5.8%) | 0.312 | <50 | 64 (6.5%) | 25 (6.8%) | 0.434 | <50 | 210 (8.1%) | 96 (10.3%) | 0.061 |
|        | 50–69        | 876 (39.3%)     | 268 (37.0%) |        | 50–69        | 469 (47.4%)    | 187 (50.1%) |        | 50–69        | 1336 (51.8%)    | 495 (52.9%) |        |
|        | ≥70          | 1245 (56.0%)    | 414 (57.2%) |        | ≥70          | 456 (46.1%)    | 155 (42.1%) |        | ≥70          | 1033 (40.1%)    | 344 (36.8%) |        |
| ASA grade | 1–2 | 1379 (62.0%) | 454 (62.8%) | 0.694 | 1–2 | 617 (62.7%) | 244 (66.5%) | 0.198 | 1–2 | 1685 (66.0%) | 686 (73.8%) | <0.001 |
|        | 3–5          | 846 (38.0%)     | 269 (37.2%) |        | 3–5          | 367 (37.3%)    | 123 (33.5%) |        | 3–5          | 868 (34.0%)     | 244 (26.2%) |        |
| Approach | Minimally invasive | 1211 (54.4%) | 395 (54.7%) | <0.001 | I–II | 468 (50.8%) | 261 (71.1%) | <0.001 | I–II | 1421 (56.8%) | 479 (51.5%) | <0.001 |
|        | Open         | 813 (36.5%)     | 298 (41.0%) |        | III | 375 (40.6%) | 78 (21.4%) |        | III | 821 (32.8%) | 383 (41.2%) |        |
|        | Conversion   | 201 (9.1%)      | 31 (4.3%)  |        | IV | 79 (8.6%) | 28 (9.6%) |        | IV | 261 (10.4%) | 68 (7.3%) |        |
| Operation | Anastomosis | 2194 (98.6%) | 677 (93.5%) | <0.001 | Minimally invasive | 519 (53.6%) | 231 (62.9%) | 0.001 | Short course | 177 (7.2%) | 89 (9.5%) | 0.001 |
|        | Anastomosis + defunction | 6 (0.3%) | 10 (1.4%) |        | Open | 356 (36.8%) | 109 (29.7%) |        | Long course | 679 (27.5%) | 205 (21.9%) |        |
|        | End stoma    | 25 (1.1%)       | 37 (5.1%)  |        | Conversion | 93 (9.6%) | 27 (7.4%) |        | None | 1611 (58.1%) | 641 (68.6%) |        |
| Anatomotic technique<sup>a</sup> | Stapled | 1381 (62.8%) | 527 (77.3%) | <0.001 | Anastomosis | 922 (93.3%) | 316 (86.1%) | <0.001 | Minimally invasive | 1315 (54.2%) | 540 (57.8%) | <0.001 |
|        | Hand sewn    | 819 (37.2%)     | 155 (22.7%) |        | Anastomosis + defunction | 18 (1.8%) | 21 (5.7%) |        | Open | 867 (35.8%) | 355 (38.0%) |        |
|        |             |                |            |        | End stoma | 48 (4.9%) | 30 (8.2%) |        | Conversion | 243 (10.0%) | 40 (4.2%) |        |

(Continues)
| Right                          | Prepandemic | During pandemic | P-value | Left                          | Prepandemic | During pandemic | P-value | Rectum | Prepandemic | During pandemic | P-value |
|-------------------------------|-------------|----------------|---------|-------------------------------|-------------|----------------|---------|---------|-------------|----------------|---------|
| Seniority                     |             |                |         | Anastomotic technique<sup>a</sup> |             |                |         | Operation |             |                |         |
| Colorectal surgeon            | 1465 (58.3%)| 488 (67.9%)    | <0.001 | Stapled                       | 685 (72.9%)| 298 (89.2%)    | <0.001 | Anastomosis| 1103 (42.8%)| 350 (37.4%)    | 0.012   |
| Colorectal trainee            | 333 (13.2%) | 61 (8.5%)      |         | Hand sewn                     | 255 (27.1%)| 36 (10.8%)     |         | Anastomosis + defunction | 863 (33.5%)| 330 (35.3%)    |         |
| General surgeon               | 467 (18.6%) | 126 (17.5%)    |         | Anastomosis + defunction      | 613 (23.7%)| 255 (27.3%)    |         | End stoma | 613 (23.7%)| 255 (27.3%)    |         |
| General surgical trainee      | 250 (9.9%)  | 44 (6.1%)      |         | Anastomosis + defunction      | 613 (23.7%)| 255 (27.3%)    |         |         |             |                |         |
| Anastomotic leak<sup>a</sup>  |             |                |         | Seniority                     |             |                |         | Anastomotic technique<sup>a</sup> |             |                |         |
| No                            | 2056 (93.5%)| 662 (96.4%)    | 0.005  | Colorectal surgeon            | 705 (71.3%)| 263 (72.1%)    | <0.001 | Stapled | 1811 (92.1%)| 619 (92.1%)    | 0.998   |
| Yes                           | 144 (6.5%)  | 25 (3.6%)      |         | Colorectal trainee            | 88 (8.9%)  | 14 (3.8%)      |         | Hand sewn | 155 (7.9%) | 53 (7.9%)       |         |
| General surgeon               |             |                |         | General surgeon               | 170 (17.2%)| 65 (17.8%)     |         |         |             |                |         |
| General surgical trainee      |             |                |         | General surgical trainee      | 26 (2.6%)  | 23 (6.3%)      |         |         |             |                |         |
| Intensive care                |             |                |         | Anastomotic leak<sup>a</sup>  |             |                |         | Seniority |             |                |         |
| No                            | 1605 (72.1%)| 578 (79.8%)    | <0.001 | No                            | 869 (92.5%)| 323 (95.9%)    | 0.031  | Colorectal surgeon | 2078 (80.7%)| 732 (78.8%)    | 0.087   |
| Yes                           | 620 (27.9%) | 158 (20.2%)    |         | Yes                           | 71 (7.5%)  | 14 (4.1%)      |         | Colorectal trainee | 112 (4.4%) | 55 (5.9%)       |         |
|                              |             |                |         | General surgeon               | 355 (13.8%)| 124 (13.4%)    |         | General surgical trainee | 31 (1.2%) | 18 (1.9%)       |         |
|                              |             |                |         | General surgical trainee      | 31 (1.2%)  | 18 (1.9%)      |         |         |             |                |         |
| Death                         |             |                |         | Intensive care                |             |                |         | Anastomotic leak<sup>a</sup>  |             |                |         |
| No                            | 2188 (98.3%)| 715 (98.8%)    | 0.155  | No                            | 693 (70.1%)| 299 (81.5%)    | <0.001 | No | 1786 (90.8%)| 636 (93.5%)    | 0.030   |
| Yes                           | 37 (1.7%)   | 9 (1.2%)       |         | Yes                           | 295 (29.9%)| 68 (18.5%)     |         | Yes | 180 (9.2%) | 44 (6.5%)       |         |

(Continues)
| | Preparademic | During pandemic | During pandemic | Preparademic | Length of stay (days), median (IQR) | P-value | Right | Length of stay (days), median (IQR) | P-value | Rectum | Length of stay (days), median (IQR) | P-value | Rectum | Length of stay (days), median (IQR) | P-value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intensive care | No | Yes | No | Yes | 1.707 (66.2%) | 0.254 | 692 (74.0%) | <0.001 | 670 (63.8%) | 0.261 | 243 (26.0%) | 0.289 | 916 (99.0%) | 0.279 | 16 (2.0%) | 0.261 |
| Death | No | Yes | No | Yes | 7 (0.7%) | <0.001 | 6 (1.6%) | <0.001 | 7 (0.7%) | <0.001 | 6 (1.6%) | <0.001 | 19 (2.0%) | <0.001 | 7 (0.7%) | <0.001 |
| Length of stay (day, median) (IQR) | 7 (5–10) | | 6 (4–8) | | 7 (5–10) | | 6 (4–8) | | 7 (5–10) | | 6 (4–8) | | 7 (5–10) | | 6 (4–8) | |

Statistically significant P-values are indicated in bold.

References

1. Ranney ML, Griffith V, Jha AK. Critical supply shortages—the need for ventilators and personal protective equipment during the Covid-19 pandemic. N Engl J Med. 2020;382:e41.
2. Xie J, Tong Z, Guan X, Du B, Qiu H, Slutsky AS. Critical care crisis and some recommendations during the COVID-19 epidemic in China. Intensive Care Med. 2020;46(5):837–840.
3. American College of Surgeons. COVID-19: elective case triage guidelines for surgical care. Available from: https://www.facs.org/-/media/files/covid19/guidance_for_triage_of_nonemergency_surgical_procedures.pdf. Accessed 27th March 2020
4. The Royal College of Surgeons of Edinburgh. Intercollegiate General Surgery Guidance on COVID-19. Available from: https://www.rcsed.ac.uk/news-public-affairs/news/2020/march/intercollegiate-general-surgery-guidance-on-covid-19-update. Accessed 27th March 2020
5. Aj B, Brown C, Abdelrahman T, RI H, RJ E, Ansell J, et al. International surgical guidance for COVID-19: Validation using an international Delphi process-Cross-sectional study. Int J Surg. 2020;79:309–16.
6. Association of Coloproctology of Great Britain and Ireland. Urgent Intercollegiate General Surgery Guidance on COVID-19. Available from: https://www.acpgbi.org.uk/news/urgent-intercollegiate-general-surgery-guidance-on-covid-19-. Accessed 27th March 2020
7. Lisi G, Campanelli M, Spoletoni D, Carlini M. The possible impact of COVID-19 on colorectal surgery in Italy. Colorectal Dis. 2020;22:641–2.
8. Willan J, King AJ, Jeffery K, Biezns N. Challenges for NHS hospitals during covid-19 epidemic. BMJ. 2020;20:m1117.
9. COVIDSurg Collaborative. Global guidance for surgical care during the COVID-19 pandemic. Br J Surg. 2020;107:1097–103.
10. Wang Y, Wang Y, Chen Y, Qin Q. Unique epidemiological and clinical features of the emerging 2019 novel coronavirus pneumonia (COVID-19) implicate special control measures. J Med Virol. 2020;92:568–76.
11. Collaborative C. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. Lancet. 2020;396:1286–96.
12. CovidSurg Collaborative. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. Br J Surg. 2020;107:1097–103.
13. CovidSurg Collaborative. Elective cancer surgery in COVID-19-free surgical pathways during the SARS-CoV-2 pandemic: An International, Multicentre, Comparative Cohort Study. J Clin Oncol. 2020;22:641–2.
14. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009;42:377–81.
15. National Confidential Enquiry into Patient Outcome and Death. The NCEPOD Classification of Intervention 2004. Available from: https://www.ncepod.org.uk/classification.html. Accessed 27th March 2020
16. American Society of Anesthesiologists. ASA Physical Status Classification System 2019. Available from: https://www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system.html. Accessed 27th March 2020

NHI or the UK Department of Health and Social Care.
17. The European Society of Coloproctology Collaborating Groups. The impact of conversion on the risk of major complication following laparoscopic colonic surgery: an international, multicentre prospective audit. Colorectal Dis. 2018;20(5):69–89.

18. The European Society of Coloproctology Collaborating Group. Safety of primary anastomosis following emergency left sided colorectal resection: an international, multi-centre prospective audit. Colorectal Dis. 2018;20(5):47–57.

19. European Society of Coloproctology Collaborating Group. The impact of stapling technique and surgeon specialization on anastomotic failure after right-sided colorectal resection: an international multi-centre, prospective audit. Colorectal Dis. 2018;20:1028–40.

20. European Society of Coloproctology Collaborating Group, Battersby N, Bhangu A, Chaudhri S, El-Hussuna A, Frasson M, et al. Relationship between method of anastomosis and anastomotic failure after right hemicolecotomy and ileo-caecal resection: an international snapshot audit. Colorectal Dis. 2017;19:e296–311.

21. European Society of Coloproctology Collaborating Group. Predictors for anastomotic leak, postoperative complications, and mortality after right colectomy for cancer: results from an international snapshot audit. Dis Colon Rectum. 2020;63:606–18.

22. The European Society of Coloproctology Collaborating Group. An international multicentre prospective audit of elective rectal cancer surgery; operative approach versus outcome, including transanal total mesorectal excision (TaTME). Colorectal Dis. 2018;20(5):33–46.

23. Sammour T, Leser M, Thomas ML, Lawrence MJ, Hunter A, Moore JW. A simple web-based risk calculator (www.anastomoticleak.com) is superior to the surgeon’s estimate of anastomotic leak after colon cancer resection. Tech Coloproctol. 2017;21:35–41.

24. Frasson M, Flor-Lorente B, Rodríguez JLR, Granero-Castro P, Hervás D, Alvarez Rico MA, et al. Risk factors for anastomotic leak after colon resection for cancer. Ann Surg. 2015;262:321–30.

SUPPORTING INFORMATION
Additional supporting information may be found online in the Supporting Information section.

How to cite this article: COVIDSurg Collaborative. Outcomes from elective colorectal cancer surgery during the SARS-CoV-2 pandemic. Colorectal Dis. 2020;00:1–18. https://doi.org/10.1111/codi.15431

APPENDIX 1

WRITING GROUP (‘DENOTES JOINT FIRST AUTHORS) Elizabeth Li*, James C. Glasbey*, Dmitri Nepogodiev*, Joana F. F. Simoes*, Omar M. Omar, Mary L. Venn, Jonathan P. Evans, Kaori Futaba, Charles H. Knowles, Ana Minaya-Brago, Helen Mohan, Manish Chad, Peter Pockney, Salomone Di Saverio, Neil Smart, Abigail Vallance, Dale Vimalachandran, Richard J. W. Wilkin, Aneel Bhangu (Overall guarantor).

STATISTICAL ANALYSIS
Omar M. Omar (Lead statistician), Elizabeth Li, James C. Glasbey, Aneel Bhangu.

COVIDSURG OPERATIONS COMMITTEE
Kwabena Siaw-Acheampong, Ruth A. Benson, Edward Bywater, Daoud Chaudhry, Brett E. Dawson, Jonathan P. Evans, James C. Glasbey, Rohan R. Gujirji, Emily Heritage, Conor S. Jones, Sivesh K. Kamarajah, Chetan Khatri, Rachel A. Khaw, James M. Keatley, Andrew Knight, Samuel Lawday, Elizabeth Li, Harvinder S. Mann, Ella J. Marson, Kenneth A. McLean, Siobhan C. Mckay, Emily C. Mills, Dmitri Nepogodiev, Gianluca Pellino, Maria Picciocchio, Elliott H. Taylor, Abhinav Tiwari, Joana F. F. Simoes, Isobel M. Trout, Mary L. Venn, Richard J. W. Wilkin, Aneel Bhangu.

INTERNATIONAL CANCER LEADS (*DENOTES SPECIALTY PRINCIPAL INVESTIGATOR)
James C. Glasbey (Chair); Colorectal: Neil J. Smart*, Ana Minaya-Brago*, Jonathan P. Evans, Gaetano Gallo, Susan Moug, Francesco Pata, Peter Pockney, Salomone Di Saverio, Abigail Vallance, Dale Vimalachandran.

DISSEMINATION COMMITTEE
Joana F. F. Simoes (Chair); Tom E. F. Abbott, Sadi Abukhalaf, Michel Adamina, Adesoji O. Ademuyiwa, Arnav Agarwal, Murat Akkulak, Ehab Alameer, Derek Alderson, Felix Alakolako, Markus Albertsmiers, Osaíd Alser, Muhammad Alshaar, Sattar Alshyrdya, Alexis P. Arnaud, Knut Magne Augusted, Faris Ayarsa, José Azevedo, Brittany K. Bankhead-Kendall, Emma Barlow, David Beard, Ruth A. Benson, Ruth Blanco-Colino, Amanpreet Brar, Ana Minaya-Brago, Kerry A. Breen, Chris Bretherton, Igor Lima Buarque, Joshua Burke, Edward J. Curuana, Mohammad Chaar, Sohini Chakrabortee, Peter Christensen, Daniel Cox, Moises Cukier, Miguel F. Cunha, Giana H. Davidson, Anant Desai, Salomone Di Saverio, Thomas M. Drake, John G. Edwards, Muhammed Elhadi, Sameh Emile, Shebani Farik, Marco Fiore, J. Edward Fitzgerald, Samuel Ford, Tatiana Garmanova, Gaetano Gallo, Dhruv Ghosh, Gustavo Mendonça Atade Gomes, Gustavo Grecinos, Ewen A. Griffiths, Madalegna Gründl, Constantine Halkias, Ewen M. Harrison, Intisar Hisham, Peter J. Hutchinson, Shelley Hwang, Arda Isik, Michael D. Jenkinson, Pascal Jonker, Haytham M. A. Kaafarani, Debby Keller, Angelos Koliás, Schelto Krujf, Ismail Lawani, Hans Lederhuber, Seyzi Leventoglu, Andrey Litvin, Andrew Loehrer, Markus W. Löffler, Maria Aguilera Lorena, Maria Marta Madolo, Piotr Major, Janet Martin, Hassan N. Mashbari, Dennis Mazingi, Symeon Metallidis, Ana Minaya-Brago, Helen M. Mohan, Rachel Moore, David Moszkowicz, Susan Moug, Joshua S. Ng-Kamstra, Mayaba Maimbo, Ionut Negoi, Milagros Niquen, Faustin Ntirenganya, Maricarmen Olivos, Kacimi Oussama, Oumaima Outani, Marie Diane Parreno-Sacadalam, Francesco Pata, Carlos Jose Perez Rivera, Thomas D. Pinkney, Willemijn van der Plas, Peter Pockney, Ahmad Qureshi, Dejan Radenkovic, Antonio Ramos-De la Medina, Keith Roberts, April C. Roslan, Martin Rutegård, Irène Santos, Sohei Satoi, Raza Sayyed, Andrew Schache, Andreas A Schnitzbauer, Justina O. Seyi-Olagiye,
COLLABORATING AUTHORS (*DENOTES SITE PRINCIPAL INVESTIGATOR)
Argentina: Alurralde C., Caram E. L., Eskinazi D.* (Sanatorio 9 De Julio SA); Badra R., Garcia J.S., Lucchini S.M.* (Sanatorio Allende).

Australia: Cecire J., Salindera S., Sutherland A. (Coffs Harbour Health Campus); Ahn J.H., Chen S., Gauri N., Jang S., Jia F., Mulligan C., Yang W., Ye G., Zhang H. (Conrad Reaptation General Hospital); Moss J.*, Richards T., Thian A., Vo U. G. (Fiona Stanley Hospital); Bagraith K., Chan E., Ho D., Jeyarajan E., Jordan S., Nolan G. J., Von Papen M., Wullschleger M. (Gold Coast University Hospital); Egoroff N., Gani J., Lott N., Pockney P.* (John Hunter Hospital); Phan D., Townsend D.* (Lismore Base Hospital); Bong C., Gundara E., H., Yang W., Ye G., Zhang H. (Concord Repatriation General Hospital).

Belgium: Flamey N., Pattyn P.* (Az Delta); Oosterlinck W.* (UZ Leuven).

Bulgaria: Sokolov M.* (University Hospital); Bork U.*, Fritzmann J., Praetorius C., Weitz J., Welsch C.*, Kamphues C.*, Lauscher J. C., Loch F. N., Schineis C. (Charité University Medicine, Campus Benjamin Franklin); Becker R.*, J onescheit J. (Heilig-Geist Hospital Bensheim); Beyer H. van Ramshorst, Raghavan Vidya, Dale Vimalachandran, Oliver J. Warren, Duane Wedderburn, Naomi Wright, EuroSurg, European Society of Coloproctology (ESCP), Global Initiative for Children's Surgery (GICS), GlobalSurg, GlobalPaedSurg, ItsURG, PTSurg, SpainSurg, Italian Society of Colorectal Surgery (ICCR), Association of Surgeons in Training (ASiT), Irish Surgical Research Collaborative (ISRC), Transatlantic Australasian Retropertioneal Sarcoma Working Group (TARPSWg), Italian Society of Surgical Oncology (SICO).

Estonia: Helminen O., Huhta H., Kauppila J. H.* (Oulu University Hospital).

France: Beyme C., Jouffret L.*, Marie-Macon L. (Centre Hospitalier Avignon); Lakks Z.*, Manfredelli S. (CHU Besançon); Chebaro A.*, El Amrani M., Lecolle K., Piensen G.*, Pruvot F. R., Zerbib P. (CHU Lille); Ballouhey Q.*, Barrat B., Taibi A. (CHU Limoges); CIPAL INVESTIGATORS

Croatia: Bačić G., Karlović D., Kršul D., Zelić M.* (University Hospital Center Rijeka); Bakmaz B., Ćoza I., Dijan E., Katusic Z., L., Mihanovic J.*, Rakvin I. (Zadar General Hospital).

Denmark: Ebbehøj A. L., Krarup P., Schlesinger N., Smith H.* (Bispebjerg Hospital).

Colombia: Abdeldayem H., Abdelkader Salama I.*, Balabel M., Fayed Y., Sherif M.* (Alexandria Main University Hospital); Eldaly A. S.* (Menishawey Hospital); Amira G., Sallam I.*, Sherif M., Sherif A. (Mcr Cancer Center); Ghaly G.*, Hamdy R., Morsi A., Salem H.*, Sherif G. (National Cancer Institute); Abdeldayem H., Abdellakter Salama I.*, Balabel M., Fayed Y., Sherif A. E.* (National Liver Institute, Menoufia University).

Finland: Kauppila J. H.*, Sarjanoja E. (Länsi-Pohja Central Hospital); Helminen O., Huhta H., Kauppila J. H.* (Oulu University Hospital).

Germany: Bork U.*, Fritzmann J., Prateriosis C., Weitz J., Welsch C.*, Kamphues C.*, Lauscher J. C., Loch F. N., Schineis C. (Charité University Medicine, Campus Benjamin Franklin); Becker R.*, Jonescheit J. (Heilig-Geist Hospital Bensheim); Perfler M., Reim W., Quante M.*, Steidle C., Überrück L., Yurttas C.* (University Hospital Halle (Saale)); Bertolani E., Königsrainer A.*, Löffler M. (Gold Coast University Hospital).
Sweden: Älgå A.*, Heinius G., Nordberg M., Pieniowski E. (Stockholm South General Hospital); Löfgren N., Rutegård M.* (Umea University Hospital).

Switzerland: Arigoni M., Bernasconi M., Christoforidis D.*, Di Giuseppe M., La Regina D., Mongelli F. (Ente Ospedaliero Cantonale); Chevallay M., Dwidar O., Giamas E., Sauvain M. (Pourtalès Neuchatel Hospital); Adamina M.*, Crugnale A. S., Guglielmetti L., Peros G. (Kantonsspital Winterthur).

Turkey: Aghayeava A.*, Hamzaoglu I., Sahin I. (Acibadem Altunizade Hospital); Akaydin E., Aliyeva Z., Aytac E., Baca B., Ozben V.*, Ozmen B. B. (Acibadem Atakent Hospital); Arikar A. E.*, Bilgin I. A.*, Kara H., Karahasanoglu T., Urs C. (Acibadem Maslak Hospital); Dincer H. A., Erol T. (Hacettepe University Hospital); Alhamed A., Ergun S.*, Ozcelik M. F., Sanli A. N., Uludağ S. S.*, Velidedeoglu M.*, Zengin A. K. (Istanbul University – Cerrahpaşa Medical Faculty); Bozkurt M. A., Kara Y.*, Kocatas A. (Karapınar University Faculty of Medicine); Azamat İ. F., Balik E.*, Bozkurt E., Kuldak S. (Koc University Medical School); Gökalz K., Güler S. A., Köken H., Tatar O. C.*, Utkan N. Z., Yıldırım A.*, Yüksel E. (Kocaeli University Teaching Hospital); Akin E., Altintopkak F.*, Cakmak G., Celebi F., Demir H., Dikici E., firat N., Günnüllü E., Kamburoğlu M. B., Küçük I. F., Mentazis S. (Sakarya University Faculty of Medicine); Çolak E.*, Kucuk G. O., Uyanik M. S., Çolak E.*, Kucuk G. O., Uyanik M. S. (Samsun Training and Research Hospital); Göksöy B.* (Sehit Prof. Dr. İlhan Varank Training and Research Hospital); Bozkurt E., Milhanlı M., Tanal M.*, Yetkin S. G. (Sisli Hamidiye Etfal Training and Research Hospital); Akalin M., Arican C., Avci E. K., Aydin C., Demirli Atçç S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabçı E., Kirmizi Y., Öğücü H., Salımoğlu S., Sert İ., Tugmen C., Tuncer K., Uslu G., Yeşilyurt S.*, Emiroğlu M., Kaya T., Kebabç
R., Sohrabi C., Thaha M.*, Venn M. (Royal London Hospital); Atherton R.*, Brocklehurst M., McAleer J., Parkin E.* (Royal Preston Hospital); Aladeojebi A., Ali M., Gaunt A.* (Royal Stoke University Hospital); Hammer C., Stebbing J. (Royal Surrey County Hospital); Bhasin S., Bodla A. S., Burahee A., Crichton A., Fossett R., Yassin N.* (Royal Wolverhampton NHS Trust); Brown S.*, Lee M., Newman T., Steele C. (Sheffield Teaching Hospital NHS Foundation Trust); Baker A., Konstantinou C., Ramcharan S.*, Wilkin R. J. W. (South Warwickshire NHS Foundation Trust); Lawday S., Lyons A.* (Southmead Hospital); Chung E., Hagger R., Hainsworth A., Karim A., Owen H., Ramwell A., Williams K.* (St George's Hospital); Hall J. (Stepping Hill Hospital); Harris G., Royle T.*, Watson L. J. (Sunderland Royal Hospital); Asaad P., Brown B., Duff S.*, Khan A., Murch F., Wadham B. (The University Hospital of South Manchester); McCluney S., Parmar C.*, Shah S. (The Whittington Hospital); Babar M. S., Goodrum S., Whitmore H. (Torbay and South Devon NHS Trust); Balasubramaniam D.*, Jayasankar B.*, Kapoor S., Ramachandran A. (Tunbridge Wells Hospital); Beech N., Chand M.*, Green L., Kiconco H., McEwen R. (University College London Hospital); Pereca J.* (University Hospital Ayr); Gash K.*, Gourbault L., MacCabe T., Newton C.* (University Hospitals Bristol NHS Foundation Trust); Baig M., Bates H., Dunne N., Khajuria A., Ng V., Sarma D. R., Shortland T., Tewari N.* (University Hospitals Coventry and Warwickshire NHS Trusts); Akhtar M. A.*, Brunt A., McIntyre J., Milne K., Rashid M. M., Sgrò A., Stewart K. E., Turnbull A. (Victoria Hospital Kirkcaldy); Aguilar Gonzalez M.*, Talukder S.* (West Suffolk Hospital); Eskander P., Hanna M., Olivier J.* (Weston General Hospital); Magee C.*, Powell S.* (Wirral University Teaching Hospital); Flindall I., Hanson A., Mahendran V. (Worcestershire Royal Hospital); Green S., Lim M., MacDonald L., Miu V., Onos L., Sheridan K., Young R.* (York Teaching Hospitals NHS Trust); Alam F., Griffiths O., Houlden C., Kohli V. S., Lala A. K., Seymour Z.* (Ysbyty Gwynedd).

USA: Haynes A.*, Hill C., Leede E., McElhinney K., Olson K. A., Riley C., Thornhill M. (Dell Seton Medical Center at the University of Texas); Etchill E., Gabre-Kidan A.*, Jenny H., Kent A., Ladd M. R., Long C., Malapati H., Margalit A., Rapaport S., Rose J., Stevens K., Tsai L., Vervoort D., Yesantharao P., Bigelow B. (Johns Hopkins Hospital); Klaristenfeld D.* (Kaiser Permanente San Diego Medical Center); Huyhn K. (Kaiser Permanente West Los Angeles); Azam M., Choudhry A.*, Marx W. (SUNY Upstate University Hospital); Abel M. K., Boeck M., Chern H., Kornblith L.*, Nunez-Garcia B., Ozgediz D., Glencer A., Sarin A., Varma M. (University of California, San Francisco (UCSF)); Abbott D., Acher A., Aiken T., Barrett J., Foley E., Schwartz P., Zafar S. N.* (University of Wisconsin); Hawkins A.*, Maiga A. (Vanderbilt University Medical Center).