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Rapid Research Communication

Effect of the SARS-CoV-2 pandemic on mortality related to high-risk emergency and major elective surgery

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These data show large reductions in both elective and emergency activity that are concerning for unmeasured morbidity and mortality within the community. The risk of mortality following high-risk EGS and major elective surgery during the first wave of the pandemic did not differ when compared with date-matched patient cohorts from 2019. The prevalence of concomitant SARS-CoV-2 infection in this surgical population is low.

Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic has had a significant impact on the provision of surgery globally. Early reports[1–3] of significant morbidity and mortality in surgical patients with SARS-CoV-2 has led to treatment delays and secondary harm in some cases. There is an urgent need to establish the true impact of SARS-CoV-2 on the risks associated with major elective and emergency surgery in comparison with 'normal' practice.

The aim of this study was to compare the case mix and mortality of major elective and high-risk emergency surgery in England during the pandemic against the preceding year.

Methods

The Hospital Episode Statistics (HES) Admitted Patient Care database was interrogated to identify admitted care episodes for adult patients with diagnostic codes relating to high-risk emergency general surgical (EGS) conditions (defined by an associated crude mortality rate greater than 5 per cent[4,5] including gastrointestinal ulcer; hernia, bowel ischaemia, bowel obstruction, diverticulitis, peritonitis, liver and biliary conditions, and miscellaneous; *Table S1* and *Appendix S1*), and major elective surgery across several surgical subspecialties (colectomy, any rectal resection (proctectomy)[6], cystectomy (bladder)[7], oesophagectomy, gastrectomy, pancreatectomy, coronary artery bypass graft)[8], open abdominal aortic aneurysm (AAA) repair[9], endovascular aortic aneurysm repair (EVAR)[9], and carotid endarterectomy[10]; *Table S2* and *Appendix S1*)[11,12].

Full details of the study methodology, including statistical analysis, are described in *Appendix S1*.

The cohorts were matched by calendar date, diagnostic codes, procedural codes and admission method. Patients with invalid data recorded for age or sex were excluded. The start date was 3 February 2020 before the national lockdown. The end date was 2 August 2020, 12 weeks after the national lockdown. A date-matched cohort from 2019 was compared. Case mix and mortality in 2020 were compared with values in 2019.

Concurrent SARS-CoV-2 was identified, in any secondary diagnostic field within the same episode, by the emergency ICD-10 codes: U071 (SARS-CoV-2 confirmed by laboratory testing) or U072 (clinical or epidemiological SARS-CoV-2 where laboratory confirmation was inconclusive or not available).

Thirty-day mortality was defined as a death occurring in hospital within 30 days of admission.

Logistic regression analysis was performed to adjust for potential confounders of mortality. Adjusted odds ratios (ORs) for SARS-CoV-2 infection and year of admission were calculated.

Results

High-risk emergency general surgical admissions

Between February and August 2020, 49 889 patients were admitted, representing a 15.0 per cent reduction in high-risk EGS admissions compared with 2019 (*Fig. 1* and *Table 1*). The rate of laparoscopy was proportionally less in 2020 (3.0 per cent *versus* 3.6 per cent in 2019; $P < 0.0001$). The 30-day mortality rate was unchanged between 2020 and 2019 (8.8 *versus* 8.5 per cent respectively; $P = 0.068$). In the 2020 cohort, 2.1 per cent of patients (1027 of 49 889) were diagnosed with SARS-CoV-2 infection. The 30-day mortality rate for high-risk EGS admissions was 8.8 per cent overall, compared with 16.7 per cent in patients with concurrent SARS-CoV-2 infection (*Table 3*).

Logistic regression analysis was performed to investigate the impact of concurrent SARS-CoV-2 on 30-day mortality. Adjusting for potential confounders of age, sex, ethnicity, Carstairs quintile,

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Lay summary

The coronavirus pandemic has had a significant impact on the provision of surgery globally. This research looked at how the pandemic has affected rates of surgery in England using administrative data. Specifically, it examined the characteristics of patients who were admitted and mortality when patients contracted coronavirus. It found that the overall risk of death did not change in 2020 compared with the same time period in 2019. It did find that the risk of death increased with coronavirus infection. The authors recommend preventive measures to ensure patient safety when restarting elective surgery during the pandemic.

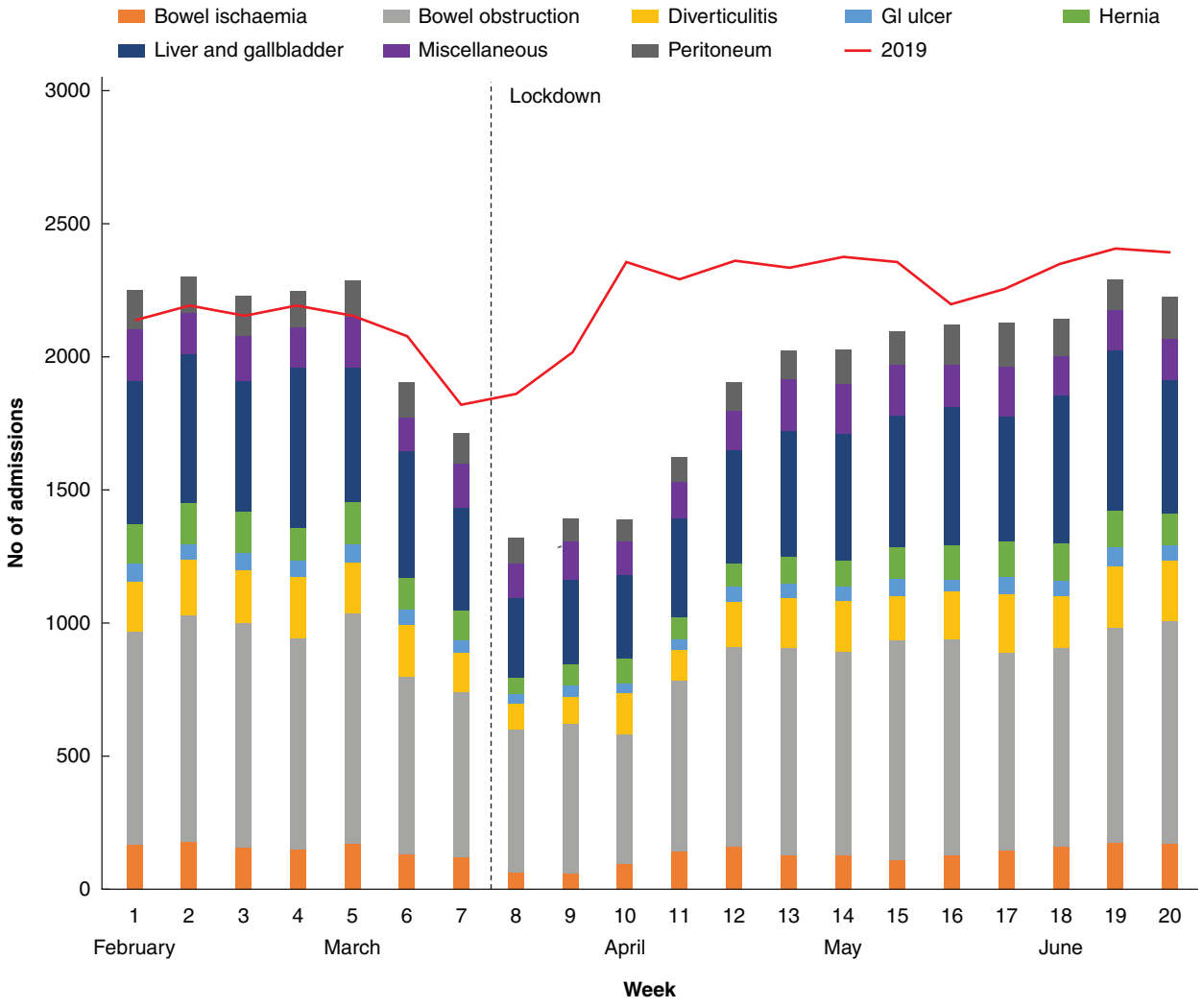

Fig. 1 Admissions for emergency surgical diagnosis by week from February to June 2020

National lockdown was announced by the UK government on 23 March 2020 (week 8). GI, gastrointestinal.

Charlson score, surgical diagnosis, operative treatment and year of admission, the adjusted OR for death at 30 days with SARS-CoV-2 infection was 2.03 (95 per cent c.i. 1.70 to 2.43; $P < 0.001$) (*Table 3*). Year of admission was not a significant confounder.

Major elective surgery

Some 14 721 patients were admitted in 2020, a reduction of 37.6 per cent from 2019 (*Fig. 2* and *Table 2*). The volume of carotid endarterectomy decreased by 42.5 per cent, open AAA repair by 51.7 per cent, EVAR by 51.6 per cent, gastrectomy by 62.2 per

Table 1 Characteristics of 108 603 patients admitted with a high-risk emergency general surgical diagnosis in 2019 and 2020

	2019 (*n*=58 714)	2020 (*n*=49 889)	P*
Mean age (years)	67.8	68.0	0.117†
Sex ratio (M : F)	27 041 : 31 673	23 628 : 26 261	<0.001
Charlson score			0.090
≤2	23 748 (40.4)	19 926 (39.9)	
>2	34 966 (59.6)	29 963 (60.1)	
Ethnicity			<0.001
White	49 693 (84.6)	41 953 (84.1)	
Mixed	278 (0.5)	240 (0.5)	
Asian	1949 (3.3)	1516 (3.0)	
Black	1108 (1.9)	844 (1.7)	
Chinese or other	844 (1.4)	829 (1.7)	
Not known/not stated	4842 (8.2)	4507 (9.0)	
Deprivation quintile			<0.001
1 (least deprived)	11 842 (20.2)	10 139 (20.3)	
2	12 346 (21.0)	10 820 (21.7)	
3	12 033 (20.5)	10 173 (20.4)	
4	11 099 (18.9)	9514 (19.1)	
5 (most deprived)	10 931 (18.6)	8963 (18.0)	
6 (not assigned)	463 (0.8)	280 (0.6)	
Emergency surgical diagnosis			<0.001
Bowel ischaemia	4196 (7.1)	3507 (7.0)	
Bowel obstruction	21 219 (36.1)	18 612 (37.3)	
Diverticulitis	5510 (9.4)	4586 (9.2)	
Gastrointestinal ulcer	1677 (2.9)	1341 (2.7)	
Hernia	3436 (5.9)	2854 (5.7)	
Liver and biliary	13 728 (23.4)	11 839 (23.7)	
Peritonitis	4244 (7.2)	3130 (6.3)	
Miscellaneous	4704 (8.0)	4020 (8.1)	
Treatment			<0.001
Non-operative	24 222 (41.3)	20 000 (40.1)	
Operative	34 492 (58.7)	29 889 (59.9)	
Surgical approach			<0.001
Open	33 250 of 34 492 (96.4)	28,988 of 29 889 (97.0)	
Laparoscopic	1242 of 34 492 (3.6)	901 of 29 889 (3.0)	
Status at 30 days			0.068
Alive	53 725 (91.5)	45 494 (91.2)	
Dead	4989 (8.5)	4395 (8.8)	

Values in parentheses are percentages. *χ^2 test, except independent-samples *t* test.

cent, colectomy by 28.3 per cent, and rectal resection by 27.7 per cent. In-hospital 30-day elective mortality did not differ between 2020 and 2019 (1.0 per cent *versus* 1.0 per cent respectively; $P=0.740$). Concurrent SARS-CoV-2 infection was diagnosed in 0.8 per cent (116 of 14 721), with an associated 30-day mortality rate of 15.5 per cent (*Table 3*). Deaths in patients with concurrent SARS-CoV-2 represented 0.1 per cent of all major elective operations. Adjusting for the potential confounders of age, sex, ethnicity, Carstairs quintile, Charlson score, procedure, and year of admission, the adjusted OR for death at 30 days in patients with concurrent SARS-CoV-2 infection was 18.23 (95 per cent c.i. 10.44 to 32.63; $P<0.001$) (*Table 3*). Year of admission was not a significant confounder. SARS-CoV-2 cases amongst high-risk EGS admissions and major elective surgery by week before and during the pandemic are shown in *Fig. S1*. Additional analyses are presented in full in *Appendix S2*.

Discussion

This study has suggested that mortality associated with high-risk EGS admissions and major elective surgery undertaken during the first wave of the pandemic was not increased. Although the number of patients with concurrent SARS-CoV-2 infection was extremely low, mortality was significantly increased in this group, justifying preventive measures. In SARS-CoV-2-positive patients, or patients with significant co-morbidity, the findings of this study support consideration of non-surgical management strategies, where safe.

The mortality rate associated with SARS-CoV-2 was significantly less than reported previously, although the populations are not directly comparable[1–3,13]. This is possibly due to a lack of inclusion bias in HES data. Second, these data did not aggregate outcomes from different healthcare systems, at different stages of their pandemic curve. Most of the reported literature has originated from North America and Europe, but some are from healthcare systems without equivalent resources to mitigate risk. Finally, this study encompasses a longer period, not relying solely on data from early in the pandemic, when there was less testing and under-representation of patients with minimally symptomatic SARS-CoV-2 infection. The present experience is, however, congruent with smaller, statistically matched, cohort studies from the literature[14].

It is unclear why SARS-CoV-2 infection results in proportionally greater mortality in elective compared with emergency surgery, although this may be multifactorial.

This study used administrative healthcare data with quantified accuracy[15,16]. These data must be interpreted with caution given the novelty of the SARS-CoV-2 ICD-10 code[17]. It is feasible that the code was not employed consistently during the pandemic (used for major pulmonary complications not due to SARS-CoV-2), as this study found that one-quarter of SARS-CoV-2 diagnoses were not based on laboratory

Table 2 Characteristics of 38 327 patients admitted for major elective surgery in 2019 and 2020

	2019 (*n*=23 606)	2020 (*n*=14 721)	*P**
Mean age (years)	65.1	65.4	0.060†
Sex ratio (M : F)	14 631 : 8975	9005 : 5716	0.113
Charlson score			0.181
≤2	10 542 (44.7)	6677 (45.4)	
>2	13 064 (55.3)	8044 (54.6)	
Ethnicity			<0.001
White	18 286 (77.5)	11 006 (74.8)	
Mixed	89 (0.4)	46 (0.3)	
Asian	728 (3.1)	336 (2.3)	
Black	322 (1.4)	157 (1.1)	
Chinese or other	328 (1.4)	216 (1.5)	
Not known/not stated	3853 (16.3)	2960 (20.1)	
Deprivation quintile			0.003
1 (least deprived)	5568 (23.6)	3605 (24.5)	
2	5633 (23.9)	3445 (23.4)	
3	4701 (19.9)	3052 (20.7)	
4	4006 (17.0)	2515 (17.1)	
5 (most deprived)	3519 (14.9)	2006 (13.6)	
6 (unassigned)	179 (0.8)	98 (0.7)	
Operation			<0.001
Colectomy	6636 (28.1)	4756 (32.3)	
Rectal resection	5374 (22.8)	3883 (26.4)	
Gastrectomy	1926 (8.2)	728 (4.9)	
Oesophagectomy	796 (3.4)	533 (3.6)	
Pancreatectomy	886 (3.8)	623 (4.2)	
Cystectomy	880 (3.7)	621 (4.2)	
CABG	4222 (17.9)	2066 (14.0)	
Carotid endarterectomy	1265 (5.4)	727 (4.9)	
Open AAA repair	532 (2.3)	257 (1.7)	
EVAR	1089 (4.6)	527 (3.6)	
Status at 30 days			0.740
Alive	23 367 (99.0)	14 577 (99.0)	
Dead	239 (1.0)	144 (1.0)	

Values in parentheses are percentages. CABG, coronary artery bypass graft; AAA, abdominal aortic aneurysm; EVAR, endovascular repair. χ^2 test, except independent-samples *t* test.

Table 3 Thirty-day mortality in high-risk emergency surgery and major elective surgery with adjusted odds ratios for year of admission and SARS-CoV-2 positivity

	Status at 30 days*		Total	Adjusted odds ratio†	*P*
	Alive	Dead			
High-risk emergency surgery					
Year					
2019	53 725 (91.5)	4989 (8.5)	58 714	1.00 (reference)	
2020	45 494 (91.2)	4395 (8.8)	49 889	1.03 (0.99, 1.08)	0.193
SARS-CoV-2					
Negative	44 639 (91.4)	4223 (8.6)	48 862	1.00 (reference)	
Positive	855 (83.3)	172 (16.7)	1027	2.03 (1.70, 2.43)	<0.001
Total	45 494	4395	49 889		
Major elective surgery					
Year					
2019	23 367 (99.0)	239 (1.0)	23 606	1.00 (reference)	
2020	14 577 (99.0)	144 (1.0)	14 721	0.87 (0.70, 1.09)	0.233
SARS-CoV-2					
Negative	14 479 (99.1)	126 (0.9)	14 605	1.00 (reference)	
Positive	98 (84.5)	18 (15.5)	116	18.23 (10.44, 31.83)	<0.001
Total	14 577	144	14 721		

Values in parentheses are *percentages and †95 per cent confidence intervals. SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

confirmation. HES data do not include BMI, which influences prognosis[18].

This study was unable to differentiate whether patients acquired SARS-CoV-2 before or during hospital inpatient admission. Patients may have contracted SARS-CoV-2 in the community after discharge and therefore were not captured by this methodology, potentially leading to under-reporting. It was also impossible to differentiate between symptomatic and asymptomatic patients, along with the possible impact of a gradual increase in routine preoperative swabbing[19].

The primary outcome measure was mortality. Morbidity associated with SARS-CoV-2 was not investigated. Several strategies

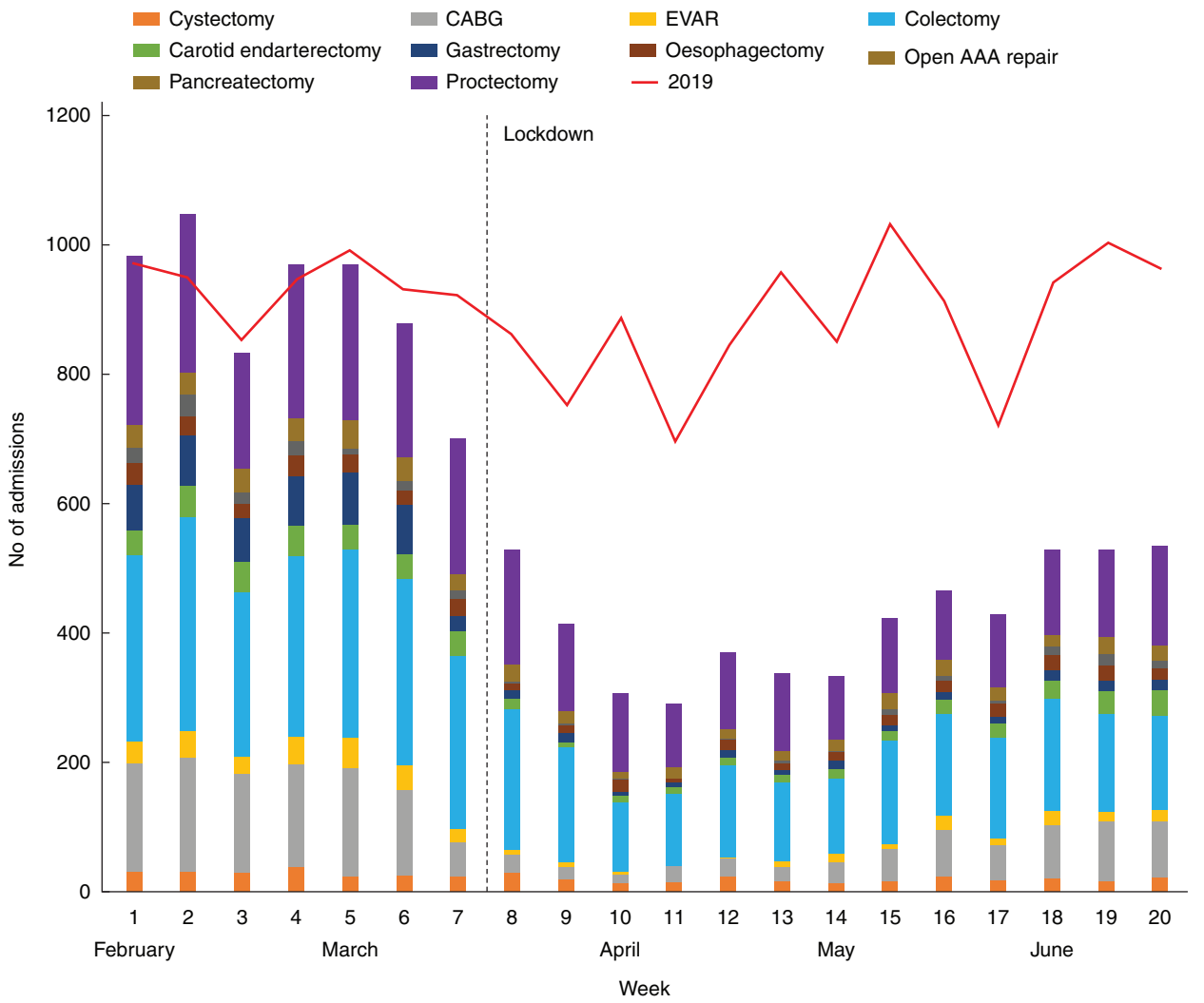

Fig. 2 Admissions for major elective surgery by week from February to June 2020

National lockdown was announced by the UK government on 23 March 2020 (week 8). CABG, coronary artery bypass graft; EVAR, endovascular repair; AAA, abdominal aortic aneurysm.

were advocated during the first wave of the pandemic to mitigate surgical risk, including non-operative strategies where appropriate, avoidance of laparoscopy, and minimizing anastomosis in favour of defunctioning stomas in colorectal surgery[20]. The extent to which these strategies were adopted, and their efficacy, was not investigated. Although the relationship between geographical region and mortality was beyond the scope of this study, it will be the focus of future research.

There was a marked volume reduction for high-risk emergency general and major elective surgery. No evidence was found to support a change in patient demographics. It is likely that some high-risk surgery was deferred either by patients or by the health service. It is unknown to what extent harm has occurred within the latter patient groups.

There were large reductions in both elective and EGS activity that are concerning for unmeasured morbidity and mortality. Concurrent SARS-CoV-2 infection in patients undergoing surgery significantly increased the mortality risk. However, infection rates in surgical pathways during the first wave of the pandemic in England were low. Continued safe operating throughout the pandemic will be important to mitigate indirect harm to patients incurred through treatment delays, and work must continue to develop safe pathways for this to happen. The overall mortality risk associated with high-risk emergency general and major elective surgery in the first wave of the pandemic did not differ from that in historical controls.

Disclosure: The authors declare no conflict of interest.

Supplementary material

Supplementary material is available at *BJS* online.

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