

National Vascular Registry: Short Report



Impact of the Covid-19 pandemic on the provision of vascular surgery in the UK National Health Service

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SUMMARY

In this short report, we present preliminary results on the impact that the Covid-19 pandemic has had on the provision of NHS vascular care in the UK and its potential impact on short-term surgical outcomes. The analysis covered: (a) patients who had a repair procedure for abdominal aortic aneurysm (AAA); (b) patients who had carotid endarterectomy, and (c) patients with peripheral arterial disease (PAD) who had either lower limb revascularisation (endovascular / bypass surgery) or major amputation.

Patterns of activity were examined on a weekly basis, with the week of 15-21 March 2020 taken as the start of the pandemic. Activity was most affected during April 2020, with only 12% of the normal number of elective infra-renal AAA repairs being performed. The numbers of emergency procedures were more similar to the levels of activity seen in early 2020 (eg, activity was 76% of normal levels for non-elective ruptured AAA repair and 83% for lower-limb major amputation). The effect of the pandemic in April was broadly similar across geographical regions. However, the provision of surgery began to rise in May and, by July, some regions were delivering up to 80% of their normal elective workload. However, the degree of variation between the regional levels of activity was greater in July compared with April, suggesting vascular services were resuming at different speeds.

Few patients who had vascular procedures between 15 March and 4 July were reported to have laboratory-confirmed coronavirus (2.2%). Among patients with coronavirus, the risk of postoperative in-hospital death was higher than among those without an infection, particularly if a patient had a respiratory complication. During this period, the in-hospital mortality rate among patients who had surgery for AAA or PAD and did not experience a respiratory complication was 2.9% if they had not contracted coronavirus but 6.1% if they had. Among patients with a respiratory complication, the mortality rate was 27.9% for patients without coronavirus and 38.2% for patients with coronavirus. However, the estimated excess mortality during the pandemic period was modest overall due to the limited number of Covid-19 infections.

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INTRODUCTION

In March 2020, the World Health Organization declared a global pandemic in response to the spread of coronavirus SARS-CoV-2 and the resultant rise in the incidence of Covid-19. In the UK, the number of people diagnosed with Covid-19 began as a trickle in February 2020 but rose rapidly in early March, which led to the UK governments introducing a series of measures designed to stop the spread of the virus. Social distancing was recommended on 16 March, and a national lockdown came into force on 23 March.

At this time, there was considerable concern about the ability of NHS hospitals to meet the demand from Covid-19 patients, particularly as many patients needed respiratory support in critical care units. Normal services within NHS hospitals were re-organised, with some theatres and recovery rooms being converted to provide critical care, and staff and equipment being redeployed. The Vascular Society of Great Britain & Ireland (VSGBI) issued guidance recommending the deferral of elective arterial and venous surgery, as well as surgery for asymptomatic carotid disease and claudication [VSGBI 2020]. Surgeons were also recommended to balance the risk of abdominal aortic aneurysm (AAA) surgery with the possibility of the aneurysm rupturing; an AAA diameter greater than 7cm was suggested as a potential threshold for intervention. Emergency vascular services were maintained but vascular teams were recommended to consider therapeutic options (such as endovascular procedures instead of open surgery in suitable patients) that reduced the need for admission to critical care / high-dependency units postoperatively and the risk of in-hospital coronavirus infection among patients and staff.

Many UK vascular units were able to submit data to the National Vascular Registry (NVR) on patients receiving arterial procedures during 2020. In this short report, we use this information to present preliminary results on the impact that the Covid-19 pandemic had on the provision of vascular care and its potential effect on short-term surgical outcomes.

METHODS

The NVR collects information on arterial procedures for: (a) patients who have a repair procedure for abdominal aortic aneurysm (AAA), (b) patients who undergo carotid endarterectomy, and (c) patients with peripheral arterial disease (PAD) who undergo either lower limb revascularisation (endovascular / bypass surgery) or lower limb major amputation. Covid-19 specific data items were introduced into the AAA and PAD procedure datasets in April 2020. These were extended to carotid procedures in June 2020.

The results in this report are based on data extracted from the NVR data collection system on 25 September 2020, which covered patients whose operation was performed in 2019 and 2020. The deadline for NHS vascular units to submit data on operations performed during 2019 had already passed, and so the majority of records had been “locked” for analysis. Estimated case-ascertainment in 2019 for AAA repair, carotid endarterectomy and lower limb bypass exceeded 90%, but was less for lower limb endovascular revascularisation (47%) and lower limb amputation (81%).

The records for procedures performed in 2020 were not always complete. While many NHS vascular units had been able to enter data for their 2020 activity, others were only able to submit details on a fraction of their workload, or had focused submissions on specific procedures. Consequently, the results for each procedure were restricted to the data from 81 NHS vascular units (out of a total of 91 in the UK) whose activity in the NVR between January and March 2020 was similar to that during 2019.

Patterns of activity were examined on a weekly basis (Sunday to Saturday), with 2020 activity figures starting from Sunday 5 January 2020, and extending until 1 August (a total of 30 weeks). Procedures in the 52 weeks from 6 January 2019 to 4 January 2020 were used as a reference cohort. The week of 15-21 March 2020 was taken as the start of the pandemic period as it covered the introduction of social distancing (16 March) and the national lockdown (23 March). To examine regional patterns of activity, the Government Office Regions were used to split England into 9 geographical areas.

The analysis of patient outcomes and the responses to the Covid-19 data items was restricted to a slightly shorter period, which ended on 4 July 2020 (26 weeks from 5 January 2020). This was to allow sufficient time after the operation for patients to complete their hospital stay and for staff to enter the follow-up information.

In some instances, it was necessary to define a number of categories for the range of vascular procedures covered by the NVR. AAA repair procedures were split into four groups (elective infra-renal, other elective (eg, complex AAA), ruptured AAA, and other non-elective), while the lower-limb procedures were split into elective and non-elective groups. Carotid endarterectomies were treated as a single entity.

RESULTS

Provision of vascular procedures

The analysis included a total of 37,223 vascular procedures, with 26,135 performed in 2019 and 5,212 and 5,876 performed in the 2020 pre-Covid (5 Jan-14 Mar) and 2020 Covid periods (15 Mar-1 Aug), respectively.

Figures 1 and 2 show the weekly activity during 2020. This reveals that the drop in vascular activity after 15 March was particularly severe for the elective procedures. The period of the greatest reduction in service provision was between weeks 13-17 (29 March to 2 May) which covered the month of April. The level of activity was lowest for elective AAA repair procedures (Table 1). There was least change during April for non-elective ruptured AAA repair and lower-limb major amputation, where the level of activity was 76% and 83% of the rate in early 2020, respectively.

Figure 1: Weekly (Sun-Sat) number of AAA repairs in NHS vascular units from 5 January to 1 August 2020, by type of repair. The red line denotes the week of 15-21 March.

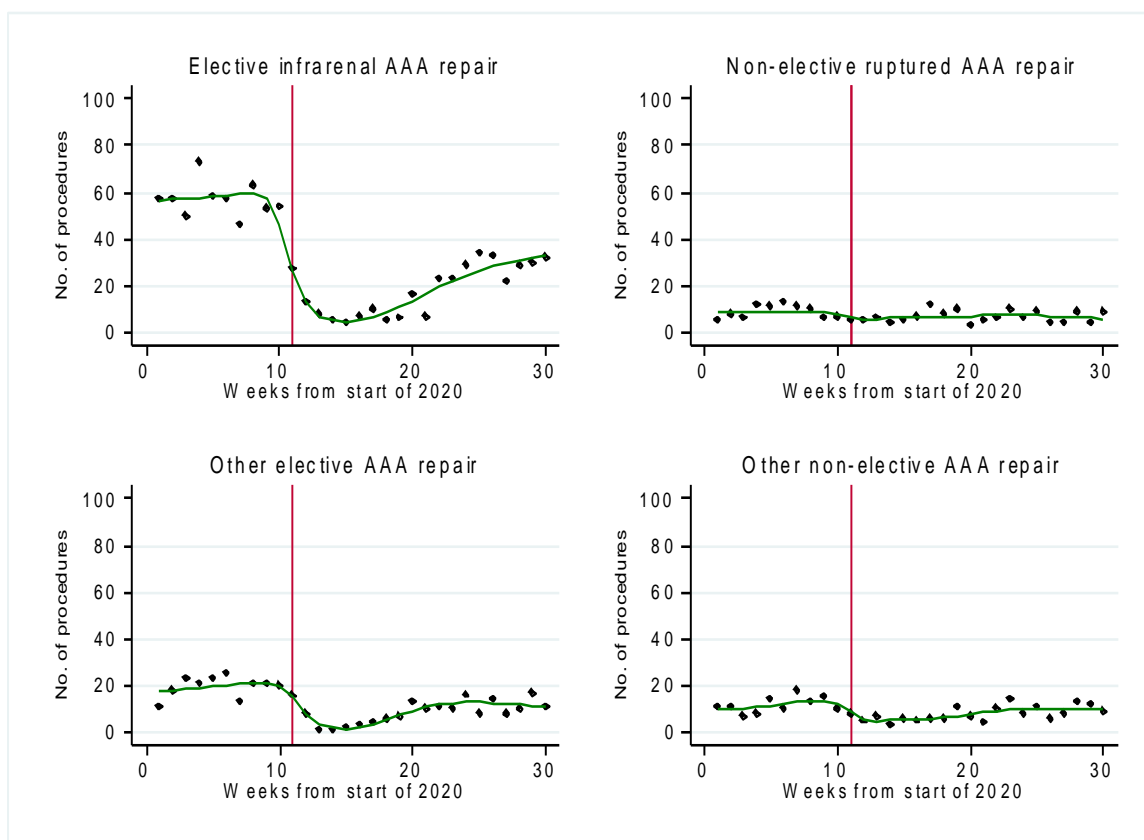


Table 1: Percentage reduction in vascular activity during April compared with the pre-Covid-19 period in 2020. Activity is expressed as average no. of procedures per week

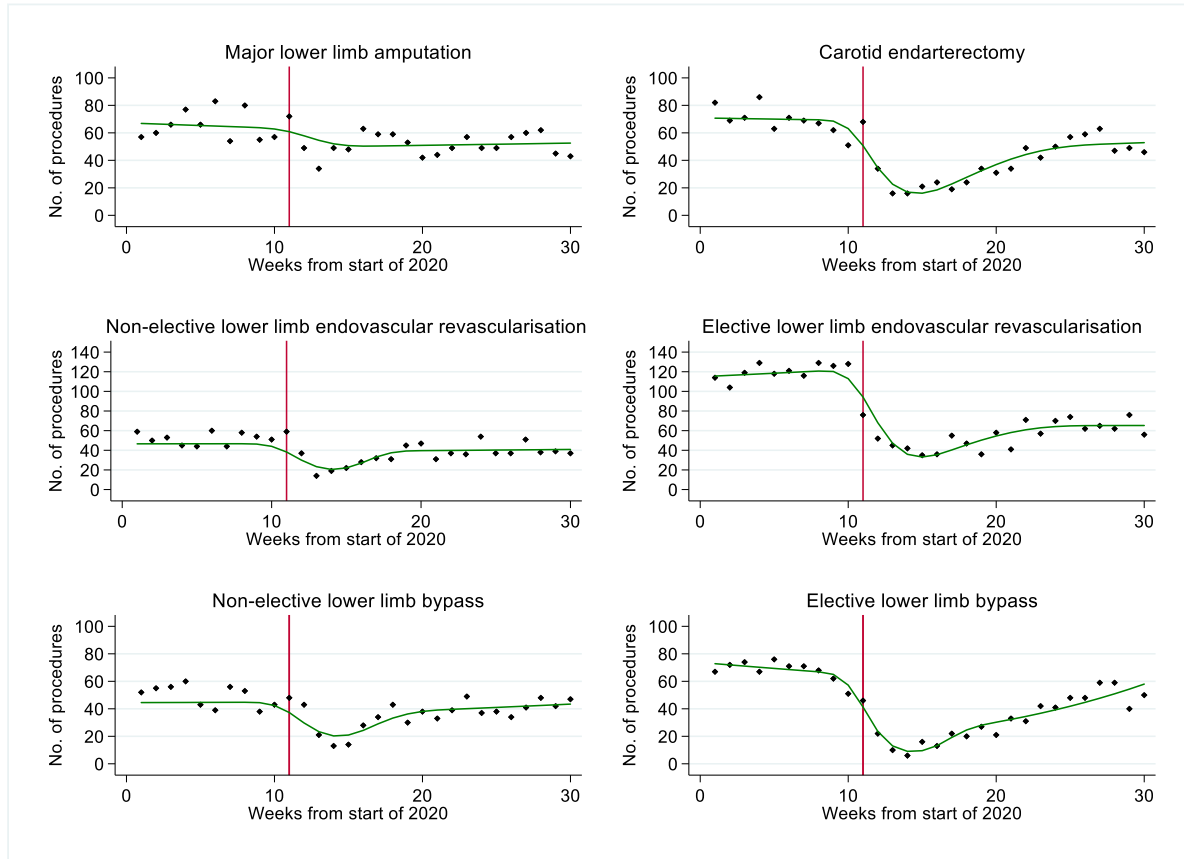
Procedure	Pre Covid-19 2020	April 2020	April as % of Pre-Covid
Infrarenal elective AAA repair	56.8	6.8	12%
Other elective AAA	19.6	2.2	11%
Ruptured AAA repair	8.9	6.8	76%
Other non-elective AAA repair	11.7	5.4	46%
Carotid endarterectomy	32.7	12.5	38%
Lower limb major amputation	54.0	45.0	83%
Lower limb endovascular revasc: elective	120.4	42.6	35%
Lower limb endovascular revasc: non-elective	51.8	23.0	44%
Lower limb bypass: elective	67.9	13.4	20%
Lower limb bypass: non-elective	49.5	22.0	44%

KEY:

The period "Pre Covid-19 2020" covered the weeks from 5 January to 14 March 2020;

The period "April 2020" extended from 29 March to 2 May so that it covered a whole number of weeks.

Figure 2: Weekly (Sun-Sat) number of lower limb procedures and carotid endarterectomies in NHS vascular units from 5 January and 1 August 2020, by type of procedure. The red line denotes the week of 15-21 March



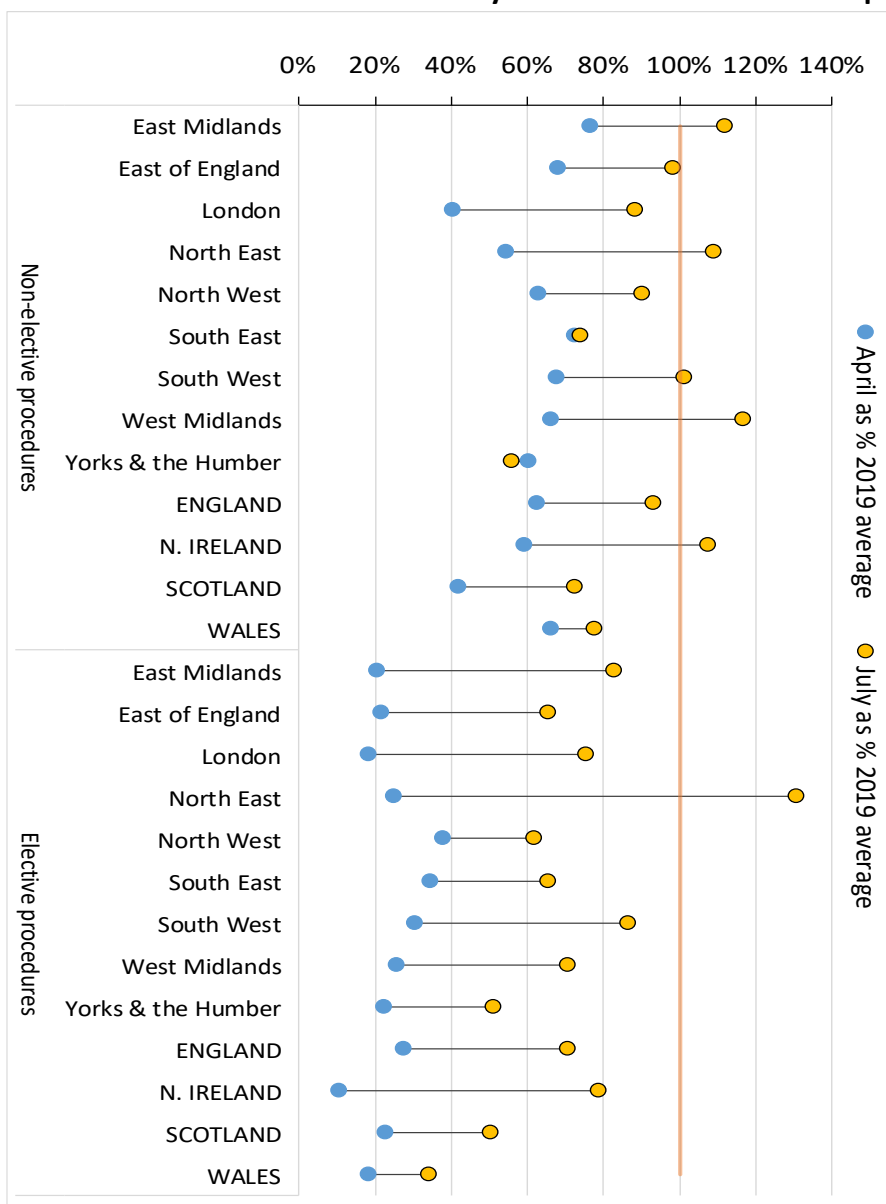
There was a small shift from open surgery to endovascular procedures in the Covid-19 period. Focusing on the four groups of AAA repair, the proportion of patients who had endovascular procedures in the 2019 and 2020 Covid-19 periods, respectively, were:

- 62% and 64% for elective infra-renal AAA repair
- 76% and 86% for other elective (eg, complex) AAA repair
- 36% and 45% for repair of ruptured AAA, and
- 62% and 72% for other non-elective AAA repair.

There was also a modest shift in the proportion of patients who had an elective AAA repair and whose aneurysm diameter exceeded 7cm. In 2019, 9.8% of the elective infra-renal AAA repairs and 19.4% of the other elective AAA repairs were performed for patients with an aneurysm diameter greater than 7cm. In the Covid-19 period, the proportions were 19.7% and 29.0%, respectively. The changes among patients undergoing non-elective AAA repair were not statistically significant ($p\text{-value} > 0.05$).

The impact of the Covid-19 pandemic on activity in the month of April was broadly similar across the geographical regions of the UK (Figure 3). Non-elective activity within each region was approximately 50-70% of normal levels, whereas elective activity was between 10-40% of normal activity. By July 2020, the number of elective procedures was increasing in all regions, although activity was typically no more than 80% of normal levels. There was, though, greater variation between regions, suggesting vascular services were resuming surgery at different speeds across the regions.

Figure 3: Percentage of change in activity by region for the months of April and July 2020 after the lockdown was announced. 2019 activity was used as the reference period



Footnote:

Carotid endarterectomies were classified as elective procedures

Lower limb major amputations were classified as non-elective procedures

Responses to questions on how Covid-19 affected patient care

The NVR added a small number of questions on how the Covid-19 pandemic had affected patient care. The first asked if there had been an impact (Yes / No) and, if Yes, the data items captured:

- whether a patient had Covid-19 symptoms on admission or a pre-operative Covid-19 diagnosis
- whether the timing of the procedure was affected (eg, delay after admission, postponed)
- whether the planned AAA or lower limb revascularisation procedure was altered
- whether a patient had a respiratory postoperative complication
- whether a patient had a postoperative Covid-19 diagnosis

The analysis of the Covid-19 responses was limited to the 4,424 vascular procedures performed in the 16 weeks between 15 March and 4 July 2020, to allow for long stays in hospital. Data were provided on whether the provision of care had been affected by the pandemic for 3,613 patients. Vascular units reported the care of 788 (22%) patients had been affected. Of these, information on the type of impact was provided for 683 patients. Few patients were reported with preoperative symptoms or confirmed Covid-19 diagnoses:

- mild symptoms were reported for 46 patients, while severe symptoms were reported for 10 patients
- laboratory-confirmed Covid-19 diagnoses were found in 31 patients, among whom 19 had lower limb amputation and only 4 were elective admissions

Among the 3,613 patients, therefore, confirmed preoperative Covid-19 diagnoses were less than 1% for each of the five main types of procedures, with the exception of lower limb amputation (3%).

Table 3 shows the reported impact of the Covid-19 pandemic on the timing of the procedures. For non-elective procedures, the impact was modest across all of the five main types. The principal impact of the pandemic had been on the scheduling of elective AAA repairs; 36% of patients had their procedures delayed because it was either cancelled or could not be scheduled due to a lack of resources. Changes in the threshold of treatment were reported to have affected only 5% of patients. There were only 13 reported instances of patients having a different procedure to the one originally planned among the 3,613 patients for whom a response was given.

Table 3: Reported impact of the Covid-19 pandemic on the timing of the procedures performed between 15 March and 4 July 2020.

Timing of care affected	AAA repair	Lower limb Amputation	Carotid endarterectomy	Lower limb endovascular	Lower limb bypass
No. of patients	501	691	386	1250	785
% timing affected	29.9%	7.5%	9.8%	7.2%	13.2%
Non-elective patients	183	n/a	n/a	497	433
% timing affected	8.2%			3.8%	8.5%
Elective patients	318	n/a	n/a	753	352
% timing affected	42.5%			9.4%	19.0%

Footnote: Responses given for 3613 of 4424 procedures

The final two questions asked about whether or not Covid-19 was diagnosed postoperatively and the frequency of specific postoperative respiratory complications (pneumonia, respiratory failure with ventilator support >48 hour, acute respiratory distress syndrome, and pulmonary embolism). Few patients who underwent vascular procedures between 15 March and 4 July had laboratory confirmed coronavirus postoperatively (2.2%). The number of patients with respiratory complications was also low overall, being highest for AAA repair (4.2%) and amputation procedures (5.4%) and least for carotid endarterectomy (0.8%). Among patients with respiratory complications, there was a laboratory-confirmed Covid-19 diagnosis in around half of these cases (Table 4). A diagnosis of Covid-19 was uncommon among patients without a respiratory complication.

Table 4: Proportion of patients who had a laboratory diagnosis of Covid-19 among vascular procedures performed between 15 March and 4 July 2020, stratified by elective and non-elective admissions

	Elective procedures		Non-elective procedures	
	No. of patients (%)	Lab Covid-19 diagnosis	No. of patients (%)	Lab Covid-19 diagnosis
No respiratory complication	1,781 (98.4)	0.1%	1,729 (95.8)	1.2%
Respiratory complication	28 (1.6)	42.9%	75 (4.2)	57.3%

Footnote: Lab Covid-19 diagnosis means laboratory-confirmed Covid-19 diagnosis

Postoperative outcomes

An early study into the potential impact of Covid-19 on surgical outcomes reported that half of the patients with perioperative SARS-CoV-2 experienced a postoperative respiratory complication, and that 30-day mortality in these patients was 38.0% [COVIDSurg 2020]. Respiratory complications are known to increase the risk of postoperative mortality and are a risk for many surgical procedures. Table 5 summarises the prevalence of respiratory complications after vascular procedures performed in 2019 and the different rates of in-hospital mortality among patients with and without a respiratory complication (excluding

carotid endarterectomy for which the complication was uncommon). Table 5 illustrates the greater risk of in-hospital mortality associated with respiratory complications, and highlights the potential for worse outcomes if the prevalence of respiratory complications rose during the Covid-19 pandemic. Fortunately, the reported levels of complications during the Covid-19 period (15 Mar – 4 Jul) were only slightly higher than normal.

While this is reassuring, the NVR data are consistent with reports from other studies that postoperative outcomes are (on average) worse if a patient becomes infected with SARS-Cov-2. The in-hospital mortality rates for AAA repair and PAD vascular procedures performed between January 2019 and June 2020 were:

- 2.9% for patients without SARS-Cov-2, and no respiratory complication
- 6.1% for patients with SARS-Cov-2, and no respiratory complication
- 27.9% for patients without SARS-Cov-2, but with a respiratory complication
- 38.2% for patients with SARS-Cov-2, but with a respiratory complication

The impact of this at a population level looks to be modest. Expected mortality rates for the AAA and PAD procedures for the 2020 Covid-19 period (ie, rates expected had there been no pandemic) were produced using prognostic models for each vascular procedure fitted to the data from 2019. These were then combined with the observed mortality rates for the 2020 Covid-19 period to estimate the levels of excess mortality, expressed as a standardised mortality ratio (observed / expected). For the period between 15 March 2020 and 4 July 2020, the overall standardised mortality ratio (SMR) was estimated to be 1.11 (95% CI 0.95 to 1.29). Estimates for non-elective and elective procedures were 0.94 (95% CI 0.79 to 1.11) and 1.18 (95% CI 0.82 to 1.63).

Table 5: In-hospital mortality rates for vascular procedures performed in 2019, stratified by whether patients had a respiratory complication, and the prevalence of complications

Type of procedure	2019 In hospital mortality		Complication rate	
	No resp. complication	With resp complication	2019	2020 Covid-19 period
Elective infra-renal AAA repair	0.7%	8.9%	3.9%	5.0%
Elective other AAA repair	4.0%	15.6%	6.3%	7.6%
Ruptured AAA repair	33.0%	43.8%	23.7%	21.5%
Other emergency AAA repair	4.5%	31.1%	9.6%	9.0%
Major amputation: non-elective	6.8%	35.0%	9.6%	10.8%
Major amputation: elective	3.4%	15.2%	5.1%	7.1%
LL endovascular: non-elective	3.9%	27.1%	2.1%	5.0%
LL endovascular: elective	0.5%	14.3%	0.3%	0.5%
LL bypass: non-elective	2.5%	37.1%	4.4%	8.0%
LL bypass: elective	0.7%	9.1%	2.7%	4.0%

Footnote: : LL = lower limb; resp = respiratory

DISCUSSION

The analysis of a provisional dataset from the NVR described in this report reveals the serious impact that the Covid-19 pandemic had on the provision of arterial procedures within NHS vascular units between April and July 2020. The results corroborate reports from individual NHS trusts [Rolls et al 2020; Vern et al 2020]. The peak of the pandemic in April (not surprisingly) corresponded to the lowest level of activity, but from the end of May, vascular units were able to increase provision such that, by July, elective activity across the UK had returned to 56% of the 2019 average and non-elective activity was at 79% of the 2019 average. The degree to which activity has continued to increase since July is unclear, and the situation requires ongoing monitoring.

The CovidSurg study published earlier in 2020 highlighted the high short-term postoperative mortality rate among patients who contract SARS-CoV-2 and who experience a postoperative respiratory complication [COVIDSurg 2020]. They estimated the 30-day mortality rate for these patients to be 38.0% overall. Among the relatively small sample of patients in this dataset with SARS-CoV-2, we found a similar in-hospital postoperative mortality rate (38.2%) for infected patients who have a respiratory complication. A positive message from the NVR data, however, is that few patients who had surgery were reported to have contracted SARS-CoV-2. We cannot rule out the potential for under-reporting of Covid-19 because of incomplete data and the lack of testing within hospitals. Nonetheless, the incidence of respiratory complications during the Covid-19 pandemic period was only slightly higher than normal, and the overall standardised mortality ratio for patients who had either AAA or PAD procedures was estimated to be 1.11 (95% CI 0.95 to 1.29). This modest increase in the excess mortality for the period from 15 March to 4 July suggests that, despite the challenges of restricted service provision, vascular procedures were able to be delivered safely.

A key strength of the analysis is the ability to compare a period of normal service provision with care delivered after the introduction of the national lock-down. The population-based coverage of the NVR is also a key strength. There are several weaknesses, though. The NVR does not have complete coverage of all surgical activity and not all hospitals were able to upload data on procedures performed in 2020. This may have affected our results in several ways. First, the patterns of regional activity may be inaccurate within those regions from which we did not have high levels of case ascertainment. Second, it could have led to the number of patients who had different procedures than planned being under-reported. The impact of this may be greatest in relation to the reported use of lower-limb endovascular procedures, as a change from a planned bypass procedure, because of the comparatively low case-ascertainment of this procedures. Surveys of vascular units report a greater level of substitution [VERN 2020].

It may also be too early to establish the full impact of the pandemic. For example, while the results did not show NHS vascular units adopting different criteria for treatment selection (eg, the recommended treatment threshold of 7cm for AAA), it is likely that patients whose

surgery was delayed until their AAA reached 7cm in size have not yet reached this threshold and had their surgery. In addition, changes were small in the case-mix / risk profiles of patients who had surgery in the Covid-19 pandemic period compared with the patients who had their operation in 2019, but there may be greater changes in the coming months as the backlog of patients requiring treatment (created by the pandemic) have surgery or endovascular procedures.

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