

# National Vascular Registry: Short Report



## Impact of the COVID-19 pandemic on vascular surgery in the UK (Jan 2020 – Dec 2021)

June 2023



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## EXECUTIVE SUMMARY

In this short report, we present key findings from NVR data throughout 2020 and 2021 in relation to COVID-19 and its impacts on patients undergoing vascular surgery. We previously reported on data in the NVR as at 25 September 2020, which showed that a concomitant COVID-19 infection in patients undergoing vascular surgical procedures significantly increased the risk of respiratory complications and mortality. Here we update this analysis, using data through to the end of 2021, and explore whether the COVID-19 vaccination programme provided protection to patients against this life-threatening complication. 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.

Between March 2020 and Dec 2021, confirmed postoperative COVID-19 diagnoses were most common among non-elective procedures, extending from 18.4% (non-elective AAA repair) to 27.5% (major lower limb amputation). For elective procedures, the reported rates of confirmed postoperative COVID-19 diagnoses were lower, ranging from 1.6% (elective AAA repair) to 4.1% (lower-limb bypass).

We calculated the standardised mortality ratio (SMR) to examine how postoperative mortality varied over time. There was only a modest rise during the first COVID-19 wave (Mar-Jun 2020: SMR=1.09) with a larger rise during the second wave (Nov 2020-Feb 2021: SMR=1.42). There was a different pattern for respiratory complications after surgery, with higher rates observed in both wave 1 (Standardised incidence ratio, SIR = 1.49) and wave 2 (SIR=1.52). One reason for the SMR being worse during the second wave is that the alpha variant of coronavirus (which was dominant in the second wave) was more virulent than the original coronavirus.

The period March to December 2021 was associated with rates of respiratory complications and in-hospital postoperative mortality returning to levels observed pre-pandemic in 2019. The association between these changes and the vaccine roll-out was explored using time-series information on the number of individuals who had received their first vaccine. The analysis suggests the vaccine may have produced a reduction of around 10% in the odds of a respiratory complication and postoperative in-hospital mortality. However, these estimates are not sufficiently precise to produce a statistically significant result at a 5% level.

### Please cite this report as:

Cromwell D, Atkins E, Johal A, Li Q, Waton S, Harkin D, Williams R, Pherwani A. *Impact of the COVID-19 pandemic on vascular surgery in the UK (Jan 2020 – Dec 2021). May 2023 Update*. London: The Royal College of Surgeons of England, 2023.

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## INTRODUCTION

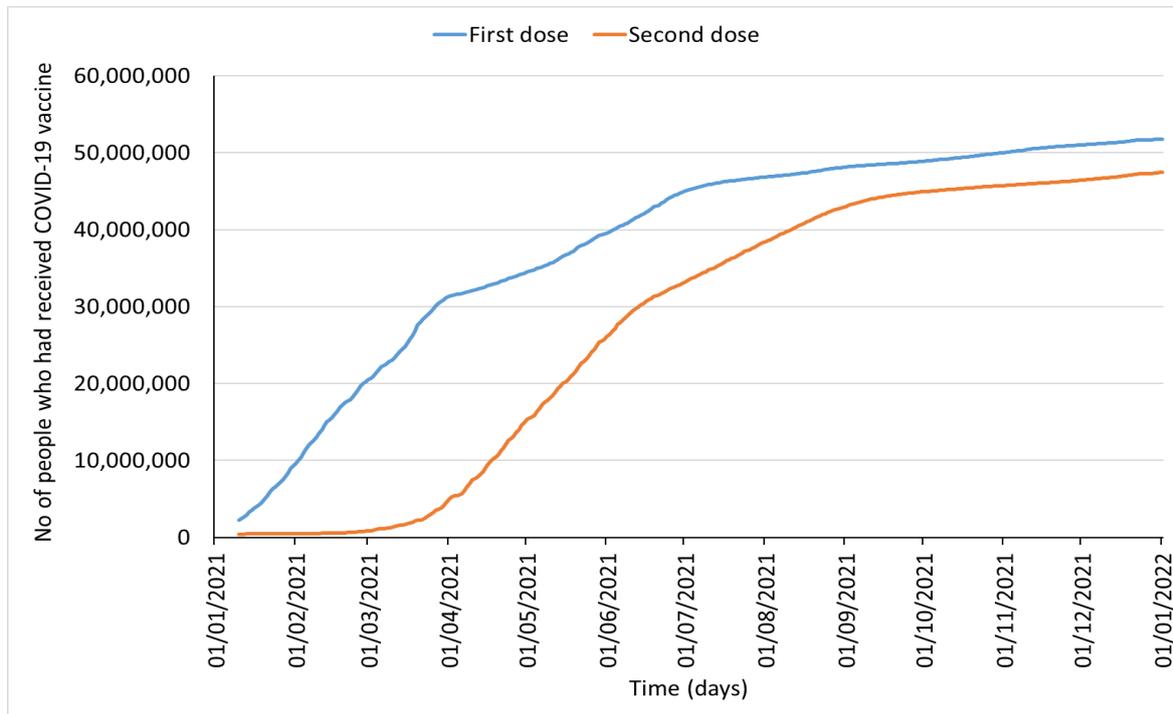
As number of people diagnosed with COVID-19 grew rapidly in early 2020, there was considerable concern about the ability of the National Health Service (NHS) to meet the demand from COVID-19 patients. Guidance for vascular services recommended the deferral of elective arterial and venous surgery, as well as surgery for asymptomatic carotid disease and claudication [VSGBI 2020]. Emergency vascular services were maintained but vascular teams were recommended to consider therapeutic options that reduced the need for admission to critical care postoperatively and the risk of in-hospital coronavirus infection among patients and staff.

For patients having surgery, the risk of respiratory complications was a particular concern. The short-term postoperative mortality rate among patients having surgery who contracted SARS-CoV-2 was estimated to be 38.0% if they had a respiratory complication [COVIDSurg 2020]. The earlier analysis of National Vascular Registry (NVR) data found a similar high rate of in-hospital postoperative mortality (42.6%) among patients who had COVID-19 and a respiratory complication after undergoing vascular surgery between March and October 2020 [Cromwell et al 2021].

In the UK, the first wave of the pandemic lasted from mid-March to June 2020. The UK government undertook a phased lifting of the lockdown restrictions (introduced on 23 March 2020) during June and August 2020. However, COVID-19 infections among the general population began to rise again during the Autumn of 2020, and the UK government ordered a new lockdown on 6 January 2021. Despite this, the situation was being helped by the roll-out of COVID-19 vaccines from December 2020; this process focused on giving individuals the two dose vaccines from Pfizer–BioNTech and AstraZeneca. By 1 April 2021, 54% of the public had received one dose of vaccine [GOV.UK 2023]; by 1 July, this had risen to 78.3% of the population and 57.8% had received their second dose (see Figure 1 overleaf).

In this short report, we provide an update on the response of vascular services to the COVID-19 pandemic between January 2020 and December 2021, and its potential effect on short-term surgical outcomes. In particular, we examine the risk of a respiratory complication after a vascular procedure over this time period and whether the COVID vaccination provided protection to patients against this complication.

**Figure 1: The roll-out of COVID-19 two-dose vaccines in England. Figures were available from early January 2023 from the GOV.UK website**



## METHODS

The NVR collects information on arterial procedures for:

- patients who have a repair procedure for abdominal aortic aneurysm (AAA),
- patients who undergo carotid endarterectomy, and
- patients with peripheral arterial disease (PAD) who undergo either lower limb (LL) revascularisation (endovascular / bypass surgery) or LL 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.

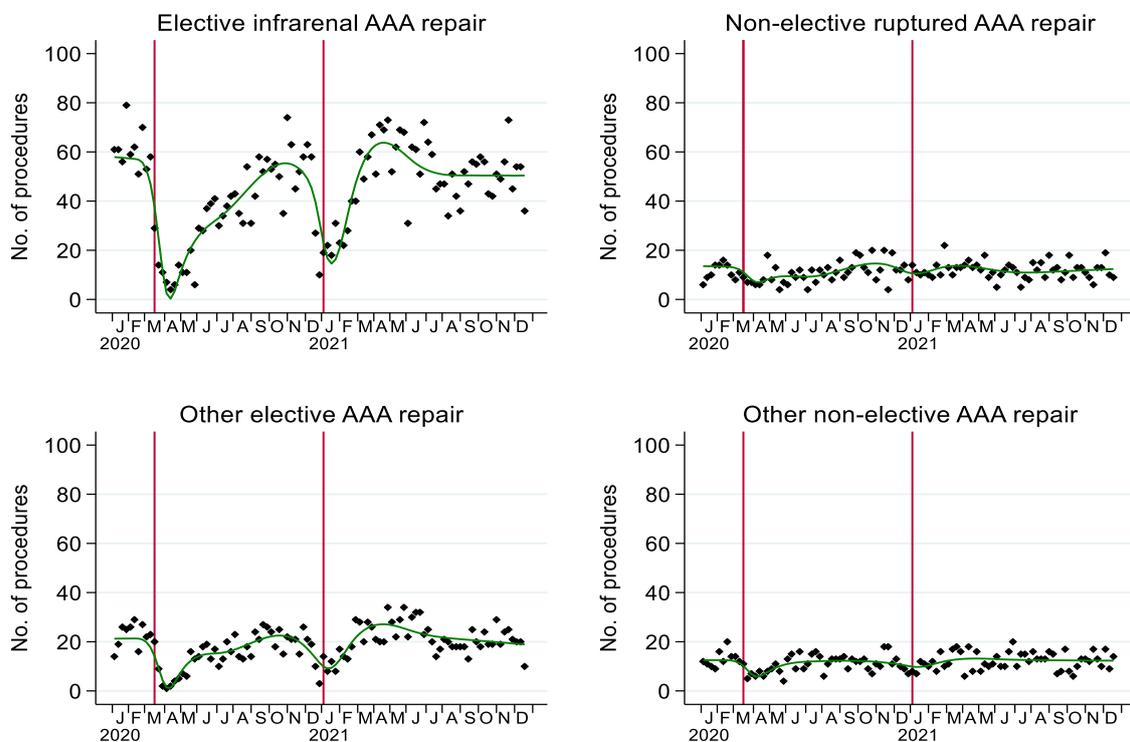
The results in this report are based on data extracted from the NVR data collection system for the NVR 2022 Annual Report [Waton et al 2022], which covered patients whose operation was performed between January 2019 and December 2021. NHS vascular units had been requested to submit data on operations performed during 2021 by July 2022, and so the majority of records analysed in the report had been completed and “locked”. Estimated case-ascertainment rates for 2020 and 2021 were high for AAA repair (elective infra-renal 2020: 93%; 2021: 91%), carotid endarterectomy (96%; 93%), lower limb major amputation (88%; 94%) and lower limb bypass (85%; 86%), but were less for lower limb endovascular revascularisation (48%; 45%) [Waton et al 2022]. Despite these high overall rates, a few NHS vascular units had low case-ascertainment or a high number of un-locked records. The analysis was therefore restricted to the data from 78 NHS vascular units (out of 91 in the UK) whose case ascertainment over 2020 and 2021 was consistent with their 2019 figures.

Patterns of activity were analysed on a weekly basis (Sunday to Saturday), starting from Sunday 5 January 2020 and extending until 25 December 2021. Procedures in the 52 weeks from 6 January 2019 to 4 January 2020 were used as a reference cohort. Changes over time were examined by calendar year or using the following five periods that capture the waves of COVID-19 in intervals of similar duration:

- 06/01/2019 to 29/02/2020 (pre-pandemic),
- 01/03/2020 to 30/06/2020 (wave 1),
- 01/07/2020 to 31/10/2020,
- 01/11/2020 to 28/02/2021 (wave 2), and
- 01/03/2021 to 25/12/2021.

The vascular procedures covered by the NVR were categorised as follows. AAA repair procedures were split into four groups (elective infra-renal, other elective (e.g., complex AAA), ruptured AAA, and other non-elective), while the lower-limb procedures were split into elective and non-elective groups. Carotid endarterectomies and lower-limb major amputations were treated as single groups.

**Figure 2: Weekly (Sun-Sat) number of AAA repairs in NHS vascular units from 5 January 2020 to 25 December 2021, by type of repair. Left red line denotes the week of 15-21 March 2020; middle red line denotes the week of 3-9 January 2021.**

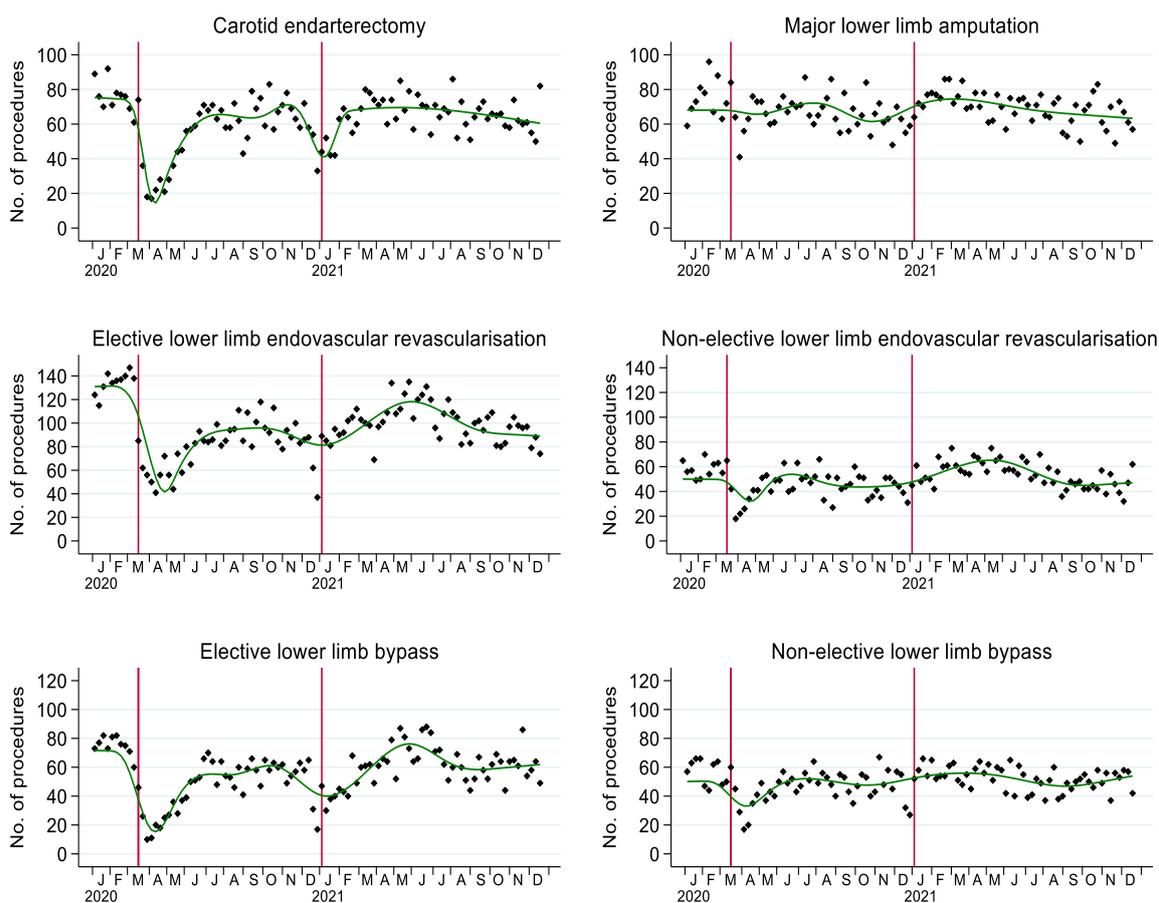


## RESULTS

### *Provision of vascular procedures*

The analysis included a total of 76,181 vascular procedures during the three years between 6 January 2019 and 25 December 2021. There were 27,483 performed in 2019 but this dropped to 23,359 in 2020, a reduction of 15%, corresponding to 85% of the 2019 figure. In 2021, there were 25,339 procedures, a reduction of 7.8%, corresponding to 92.2% of the 2019 level; this illustrates the more limited disruption of the lockdown period starting on 6 January 2021 and the attempt to restore activity to pre pandemic levels in 2021. Figures 2 and 3 show the weekly activity during 2020 and 2021.

**Figure 3: Weekly (Sun-Sat) number of carotid endarterectomies and lower limb procedures in NHS vascular units between 5 January 2020 and 25 December 2021. Left red line denotes the week of 15-21 March 2020; middle red line denotes the week of 3-9 January 2021.**



### ***Patients undergoing vascular surgery who had a confirmed COVID-19 diagnosis***

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, questions asked whether a patient had:

- a pre-operative COVID-19 diagnosis
- a postoperative respiratory complication
- a postoperative COVID-19 diagnosis

The analysis of the COVID-19 responses was limited to the 44,287 vascular procedures performed between 15 March 2020 and 25 December 2021. Data on the impact of COVID-19 had been submitted for 42,136 procedures, and vascular units reported that the provision of care had been affected for 6,360 (15.1%) procedures.

The proportion of patients who had a confirmed COVID-19 diagnosis is summarised in Table 1. The proportions were considerably higher among non-elective procedures, which might be expected given the inability of hospital staff to screen for the infection prior to admission. The higher rates of confirmed COVID-19 diagnoses after a non-elective procedure are likely to reflect the limited time available for testing prior to the patient going to theatre.

**Table 1: Proportion of patients reported to have a laboratory-confirmed COVID-19 diagnosis (pre-operative and postoperative) among vascular procedures (1 Mar 2020 - 25 Dec 2021)**

	Elective AAA repair	Elective LL endovascular	Elective LL bypass	Carotid Intervention
Pre-operative	1.1%	1.7%	2.1%	4.0%
Postoperative	1.6%	1.6%	4.1%	2.5%
	Non-elective AAA repair	Non-elective LL endovascular	Non-elective LL bypass	Amputation
Pre-operative	3.0%	9.7%	12.1%	15.9%
Postoperative	18.4%	19.1%	25.3%	27.5%

KEY: AAA = abdominal aortic aneurysm; LL = lower limb

### ***Risk of respiratory complications and mortality after a vascular procedure***

Respiratory complications increase the risk of postoperative mortality for many surgical procedures. The earlier NVR COVID-19 report showed that outcomes after arterial vascular procedures were (on average) worse if a patient became infected with SARS-CoV-2 [Cromwell et al 2021], findings that were consistent with the results from other studies. In this section, we provide additional information on postoperative outcomes which reflect the longer time period covered by this report. We have not included carotid endarterectomy procedures in this analysis because postoperative in-hospital death was uncommon.

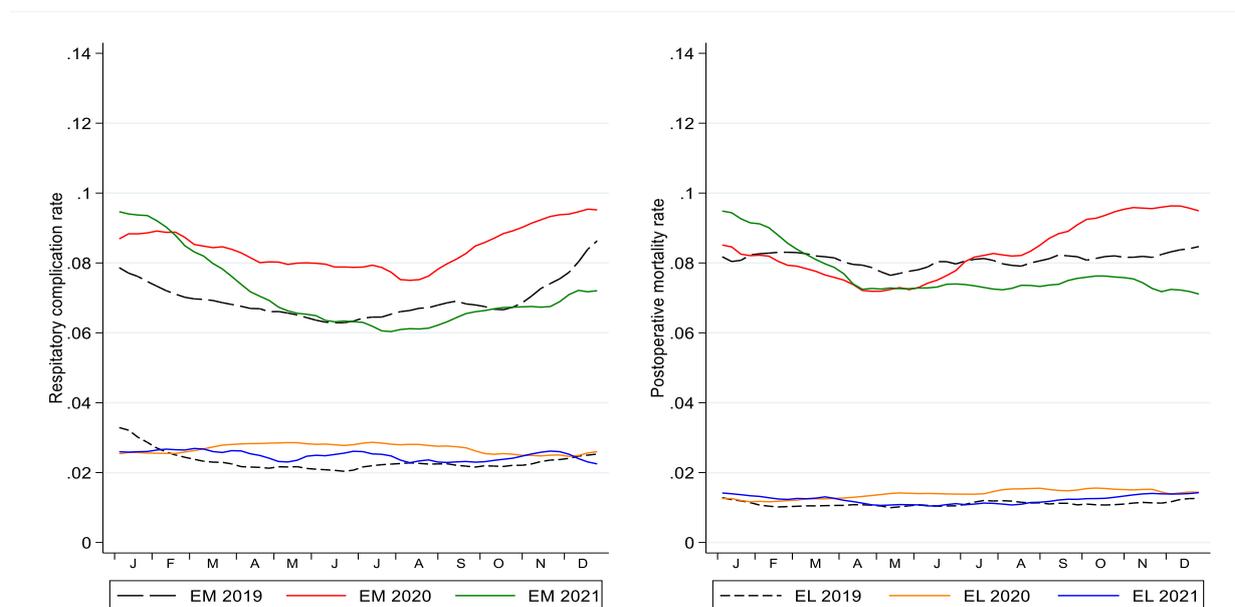
The in-hospital mortality rates for AAA repair and PAD vascular procedures performed between January 2019 and December 2021 were:

- 2.8% for patients without SARS-CoV-2, and no respiratory complication
- 5.4% for patients with SARS-CoV-2, and no respiratory complication
- 28.3% for patients without SARS-CoV-2, but with a respiratory complication
- 41.4% for patients with SARS-CoV-2, and with a respiratory complication

Unadjusted rates of respiratory complications and postoperative in-hospital mortality for non-elective and elective vascular procedures are summarised in Figure 4. The rates are estimated from weekly data, and the figures for the 2019 calendar year (shown as dashed lines) provide a comparison period for 2020 and 2021. The respiratory complications and postoperative mortality for non-elective procedures exhibit noticeable changes during 2020 and 2021, with a large rise occurring during the second wave at the end of 2020 and start of 2021 (red line and green line in Figure 4, respectively). However, in 2021, there was a return to the levels of respiratory complications recorded in 2019, and the decrease coincided with the widespread roll-out of the COVID-19 vaccines (see Figure 1). In 2021, the unadjusted weekly rate of mortality after a non-elective vascular procedure also decreased from the peak in December 2020 to a level below that observed in 2019.

For elective procedures, the baseline rates of respiratory complications and postoperative mortality were much lower, and the absolute differences in the rates between the years was much less as a consequence of this. However, similar changes over time can be observed, with the highest rates being in 2020.

**Figure 4. Unadjusted rates of respiratory complications and postoperative in-hospital mortality for non-elective (EM) and elective (EL) vascular procedures (Jan 2019 – Dec 2021). Rates estimated from weekly figures using a smoothing function**



A feature of Figure 4 was the lack of a noticeable rise in adverse outcomes during the first COVID-19 wave. Possible reasons for this are the pronounced change in the number of procedures performed during this period as well as changes in the characteristics of the patients being operated on. Consequently, standardised mortality ratios (SMR) for the various time periods were calculated that took into account changes in the mix of patients having vascular interventions. This involved fitting a logistic regression model to the data from 2019 and using this to predict the number of deaths in each of the five time periods. The SMRs for the various time periods were produced by dividing the observed number of deaths with the predicted number. An equivalent approach was used to calculate a standardised incidence ratio (SIR) for the risk of respiratory complications. The models contained variables for patient age, sex, ASA grade, the presence of ischaemic comorbidity, mode of admission and type of procedure.

The SMR figures suggest there was only a slight rise in postoperative mortality during the first COVID-19 wave, and confirm the greatest effect was during the second wave (Table 2). However, adjusting for differences in patient case-mix over time, the SIR for respiratory complications was raised in the wave 1 and wave 2 periods. There are many possible reasons for the SMR being worse for the second wave but it is likely to reflect the alpha variant of coronavirus (which was dominant in the second wave) being more virulent than the original coronavirus.

**Table 2: Standardised ratios for respiratory complications and in-hospital postoperative mortality for the periods of the COVID-19 pandemic**

	Respiratory complication		In-hospital postoperative mortality	
	SIR	95% CI	SMR	95% CI
Mar – Jun 2020 (wave 1)	1.49	1.33 to 1.65	1.09	0.96 to 1.23
Jul – Oct 2020	1.11	0.99 to 1.23	1.14	1.01 to 1.27
Nov 2020 – Feb 2021 (wave 2)	1.52	1.37 to 1.67	1.42	1.26 to 1.57
Mar – Dec 2021	1.03	0.96 to 1.11	0.98	0.91 to 1.06

Table 2 also confirmed the period from March to December 2021 was associated with rates of respiratory complications and in-hospital postoperative mortality returning to pre-pandemic levels observed in 2019. To explore the contribution of the COVID-19 vaccines to this, we used the weekly time-series information on the number of patients who had received their first dose. We created a logistic regression model for in-hospital postoperative mortality that included the patient characteristics from the SMR model and added a variable for whether or not a patient had a COVID-19 infection, and the weekly time series information on the level of vaccination (expressed as the proportion of the total number vaccinated on 11 September

2022). A model with the same explanatory variables was created for the respiratory complication rate.

**Table 3: Association between postoperative outcomes and the variables for vaccine roll-out and whether an individual was infected with coronavirus for patients undergoing vascular procedures (2019 – 2021)**

	Adjusted odds ratio	95% CI	p value
<b><i>Respiratory complication</i></b>			
Proportion of individuals who had their first dose	0.90	0.81 to 1.01	0.063
Infected with coronavirus	19.0	16.4 to 22.0	>0.001
<b><i>Postoperative in-hospital mortality</i></b>			
Proportion of individuals who had their first dose	0.92	0.82 to 1.05	0.223
Infected with coronavirus	4.93	4.15 to 5.88	>0.001

The association between the postoperative outcomes and the variable for the extent of the vaccine roll-out is summarised in Table 3. The results suggest the vaccine might have produced a reduction of around 10% in the odds of a respiratory complication and postoperative in-hospital mortality. However, these estimates are not sufficiently precise to produce a statistically significant result at a 5% level (ie, p value<0.05) although the strength of evidence for a reduction in respiratory complications is close to this common threshold.

## DISCUSSION

This report provides an insight into how the COVID-19 pandemic affected the provision of arterial procedures within NHS vascular units during 2020 and 2021. The results extend those provided in previous NVR Annual Reports and COVID-19 reports as well as other publications [Rolls et al 2020; Vern 2020; Birmpili et al 2023].

The COVID-19 pandemic had a significant impact on vascular surgery activity across all regions and all nations of the United Kingdom. The first wave (March-June 2020) had the greatest impact on activity, particularly elective procedures. There was recovery in activity from the summer of 2020 but this was briefly interrupted by the second wave of the pandemic in the winter of 2020/21.

Among patients undergoing vascular procedures during 2020 and 2021, we found the in-hospital postoperative mortality rate was increased for those with a coronavirus infection.

This was particularly high among infected patients who had a respiratory complication [=41.4%], a result consistent with other studies [COVIDSurg 2020 and Abbot et al 2021]. Fortunately, the impact of the COVID-19 pandemic on short-term postoperative mortality after vascular procedures was modest at a population level across waves 1 and 2 of the pandemic. We note that there were measures such as advice to elective patients to self-isolate pre-surgery, and COVID-19 screening of patients where possible, which aimed to reduce the likelihood of infection.

Moreover, there was no excess mortality after wave 2 in the last six months of 2021 among patients having vascular interventions. This was despite the emergence of the alpha coronavirus variant that was estimated to be more transmissible and was associated with an increased risk of hospitalisation and mortality than the original virus [Grint et al 2022].

The better outcomes among vascular patients towards the end of 2021 are likely to reflect various factors. First, there was greater knowledge of how to prevent coronavirus infections among surgical patients as well as more effective care for infected patients. Another possible contributing factor was the widespread uptake of the COVID-19 vaccines within the UK and the effectiveness of the vaccine at reducing the severity of the disease among those infected. The analysis described in this report suggests vaccination might have reduced the odds of a respiratory complication and postoperative mortality by around 10%. However, this analysis is limited by the reliance on time-series information about the roll-out of the vaccines. Ideally, the analysis would have had information on the vaccine status of the vascular patients but this was not available.

A key strength of the analysis is the ability to compare a period of normal service provision with care delivered after the start of the COVID-19 pandemic. The population-based coverage of the NVR is also a strength. There are several weaknesses, though. First, the analysis excluded a number of vascular units with low case-ascertainment. Second, the questions on whether the COVID-19 pandemic affected the provision of care were not mandatory. While this information was reported for the majority of procedures, there was a lack of testing in the early stages of the pandemic, and this might have introduced some bias into the estimates of COVID-19 confirmed diagnoses. The completeness of data items on respiratory complications and hospital deaths was very good, reflecting their status as standard NVR data items.

## **CONCLUSION**

This update of the NVR COVID-19 report has examined the potential benefit of the UK COVID-19 vaccination programme to vascular patients. These patients are generally perceived at significant risk of complications after their procedure on account of their age, the presence of comorbidities, and the urgent nature of their presentation. The report findings suggest the vaccination programme had a modest benefit to patients in reducing the risk of respiratory complications, and therefore has a public health message relevant for both national and international audiences.

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National Vascular Registry: 2022 Annual Report. London: The Royal College of Surgeons of England, November 2022.

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