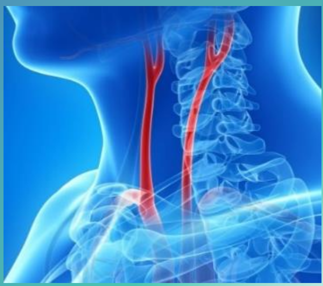

NATIONAL VASCULAR REGISTRY

2021 Annual Report

April 2022 – Updated version with case ascertainment information

Royal College of Surgeons of England
ADVANCING SURGICAL CARE

VASCULAR SOCIETY
OF GREAT BRITAIN AND IRELAND

British Society of Interventional Radiology
Registered Charity No: 1084852

HQIP
Healthcare Quality Improvement Partnership

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Royal College of Surgeons of England
ADVANCING SURGICAL CARE

The Royal College of Surgeons of England is an independent professional body committed to enabling surgeons to achieve and maintain the highest standards of surgical practice and patient care. As part of this, it supports Audit and the evaluation of clinical effectiveness for surgery. Registered charity no: 212808

The RCSEng managed the publication of the 2021 Annual report.

VASCULAR SOCIETY
OF GREAT BRITAIN AND IRELAND

The Vascular Society of Great Britain and Ireland is the specialist society that represents vascular surgeons. It is one of the key partners leading the audit. Registered charity no: 1102769

British Society of Interventional Radiology
Registered Charity No: 1084852

The British Society of Interventional Radiology is the specialist society that represents interventional radiologists. It is again, one of the key partners leading the audit. Registered charity no: 1084852

Commissioned by

HQIP
Healthcare Quality Improvement Partnership

The Healthcare Quality Improvement Partnership (HQIP) aims to promote quality improvement in patient outcomes, and in particular, to increase the impact that clinical audit, outcome review programmes and registries have on healthcare quality in England and Wales. HQIP is led by a consortium of the Academy of Medical Royal Colleges, the Royal College of Nursing and National Voices.
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Acknowledgements

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We would like to acknowledge the support of the vascular specialists and hospital staff who have participated in the National Vascular Registry and the considerable time devoted to data collection.

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Foreword

It is a pleasure to recommend to you the 2021 National Vascular Registry report, which summarises the data staff have worked hard to enter over the last year. Surgical outcome data is an increasingly important aspect of practice, but as interventions change, different measures need to be prioritised. Datasets therefore evolve over time as differing aspects of care are addressed. The future challenge will be to capture the most relevant data in order to shape good practice going forward.

As the COVID-19 pandemic continues to impact on practice, it is useful to consider the lessons we have learned over the last year. Team working and interaction with other specialties was a very important aspect of care during the first wave of the pandemic. In fact, most vascular surgeons had already been working within a team, often with a weekly responsibility for managing emergency admissions and ward patients. Collaboration with interventional radiologists (often with hybrid approaches), elderly care physicians, anaesthetic and critical care doctors is now crucial to get the best outcomes for our often frail and elderly patient cohort. Outcomes should be openly discussed at regular Morbidity and Mortality meetings and shared responsibility for decision making is now the norm with weekly MDT meetings.

This year's report predictably reflects the COVID-19 influence on the elective workload with numbers reduced for most elective and indeed emergency procedures (following guidance from the VSGBI, BSIR, NHS England Vascular CRG and GIRFT). The disease process itself has caused new presentations with novel thrombotic occlusions and has clearly caused increased mortality after major surgery. As such, we felt publication of individual surgical mortality for this year was unhelpful and we are grateful to HQIP for supporting this stance. Going forward, with the already noted move towards team working and often multi-consultant involvement in complex procedures, it may be time to reconsider the role of individual outcome results in the public domain.

Looking at the data in more detail, there was a 35% reduction in aortic procedures, 32% reduction in lower limb bypass and angioplasty and 28% reduction in carotid endarterectomy numbers compared with last year. Amputation numbers remain similar year on year, but mortality was greater in 2020 with an increase in respiratory complications. This is entirely consistent with periods of interruption for planned care and the pressure on both hospital and critical care bed bases. Even after the crux of maximum COVID-19 patient admission rates had passed, the impact of re-deployed staff, reduced diagnostic capacity and protracted critical care patient recovery times, meant that many hospitals did not return to a full service for many months.

Although it may be difficult to predict the number of patients "yet to present", this may not be as significant in vascular services compared with other specialties with large waiting lists. The majority of index cases measured by NVR are emergent or urgent and we are fortunate that NAAASP data allows an accurate estimate of screen-detected aortic aneurysm case numbers. Nevertheless, there is a backlog in most large units and there is a continued need for patients with aneurysms to be prioritised for admission in addition to those with cancer.

There are a number of success stories from this year's report. Firstly, it is clear that there was an improvement in times to lower limb revascularisation at the height of the first wave of the pandemic. Some of the measures put in place during this time (hot clinics, tele-medicine, prioritised diagnostics and emergency-only operating) have clearly had a positive impact and need to remain a part of everyday practice. Day case interventional radiology services played a large part in this and collaboration between vascular surgeons and interventional radiology colleagues was instrumental in achieving these results. It is also a pleasure to report that the NVR team won the HQIP 'Audit team of the year award' in November 2020, which is an excellent accolade to reward their amazing performance over many years.

Looking to the future, it is crucial that the dataset incorporates measures that will allow us to better manage patients. New for this year, is the introduction of revision aortic datasets and device data for aneurysm patients and although the latter is not mandatory at the moment, just under 60% has been completed, even in such a difficult year. This will provide a valuable insight into durability in future years and potentially allow us to identify failing devices at an earlier stage. Accurate data will remain crucially important and it is vital we continue to achieve this.

Mr Mike Jenkins
President of the Vascular Society of Great Britain and Ireland

Dr Ian McCafferty
President of the British Society of Interventional Radiology

Recommendations

Recommendation	Page(s)	Audience
1) Ensure that patients waiting for elective AAA repair who had their procedure postponed during the COVID-19 pandemic are prioritised with other time critical and life threatening conditions on NHS waiting lists.	Page 13 of main report	NHS Trusts and vascular specialists
2) Evaluate measures to increase access to endovascular repair of ruptured aneurysms in suitable patients (anatomically and physiologically). This may require: • Improving network pathways for vascular surgery, working in collaboration with interventional radiology and anaesthesia • 24/7 access to hybrid operating theatres • developing teams with the required expertise to deliver in and out of hours care including nursing staff and radiographers • addressing workforce for both vascular surgery and interventional radiology.	Page 31 of main report	NHS Trusts, vascular specialists and commissioners
3) Ensure that patients with CLTI receive care as recommended in the VSGBI Quality Improvement Frameworks (QIF) for peripheral arterial disease and amputation, namely: • patients admitted non-electively with CLTI have their revascularisation procedure within 5 days • patients undergoing major amputation are admitted in a timely fashion to a recognised arterial centre with agreed protocols and timeframes for transfer from networked hospitals • patients should have routine DVT and antibiotic prophylaxis according to local policy.	Pages 36-41 of main report; Pages 50-54 of main report	NHS Trusts and vascular specialists
4) Ensure that data on implanted medical devices for all aortic repairs are entered on the NVR.	Page 21 of main report	NHS Trusts and vascular specialists
5) Commissioning of Vascular units to perform complex AAA repair should be conditional on the unit submitting data on all cases to the NVR so that the safety of the service can be monitored.	Page 22 of main report	NHS Trusts
6) Vascular units within a region should collaborate to ensure that the provision of complex AAA care meets recommended standards on access and safety.	Page 27 of main report	NHS Trusts
7) Improve completeness of data entry into the NVR on all lower limb revascularisation and major amputation procedures. This should include: a. provision of administrative support, with a network data manager, supporting vascular specialists to enter their data b. better recording of 'hybrid' procedures involving both open and endovascular techniques.	Pages 32-33 of main report	NHS Trusts and vascular specialists
8) Consider studies to look at the management of patients with symptomatic carotid disease with appropriate consideration given to modern and aggressive medical management.	Pages 59-60 of main report	VSGBI and vascular specialists
9) Review whether the minimum recommended number of carotid procedures should be revised.	Page 59 of main report	VSGBI

1. Introduction

The National Vascular Registry (NVR) was established in 2013 to measure the quality and outcomes of care for adult patients who undergo major vascular procedures in NHS hospitals, and to support vascular services to improve the quality of care for these patients.

Each year, the NVR has published an annual report that describes clinical practice in the previous calendar year, and reports outcomes for the previous three-year period. In this Annual Report, the information relating to activity in 2020 is presented alongside figures for 2019 so that it is possible to see the impact that the COVID-19 pandemic had on the delivery of NHS vascular services. We have also provided some preliminary results for the period between 1 January 2021 and 1 May 2021, to show the impact on activity during the second wave of the COVID-19 pandemic. These are presented in the last section of chapter 1.

The NVR publishes information on emergency and elective procedures for the following patient groups:

1. patients who have a repair procedure for abdominal aortic aneurysm (AAA)
2. patients with peripheral arterial disease (PAD) who undergo either (a) lower limb angioplasty/stent, (b) lower limb bypass surgery, or (c) lower limb amputation
3. patients who undergo carotid endarterectomy or carotid stenting.

The NVR was designed as a procedure-based audit. Although vascular units provide care to patients with a variety of conditions that affect blood circulation (conditions that are part of the broad spectrum of cardiovascular disease), not all patients will receive a procedure within the scope of the NVR.

The NVR is commissioned by the Healthcare Quality Improvement Partnership (HQIP) on behalf of NHS England, as part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP). Clinical audits commissioned by HQIP typically cover NHS hospitals in England and Wales. The NVR encourages all NHS hospitals in England, Wales, Scotland and Northern Ireland to participate in the Registry, so that it continues to support the work of the Vascular Society of Great Britain and Ireland (VSGBI) to improve the care provided by vascular services within the UK. It is mandatory for individual clinicians to collect data on the outcomes of these procedures for medical revalidation, and the NVR is designed to facilitate this. Outcome information also plays a crucial role in the commissioning of vascular services.

1.1 The 2021 Annual Report

The aim of this report is to give a "state of the nation" description of the care provided by NHS vascular units, and outcomes delivered to patients. The 2021 Annual Report includes a particular focus on the COVID-19 pandemic that hit the UK in spring 2020.

The report is aimed at those who provide, receive, commission and regulate vascular services. This includes clinicians and other healthcare professionals working within hospital vascular units, clinical commissioners, and regulators, as well as patients and the public who are interested in knowing how NHS vascular services are delivered.

More information about the various vascular diseases described in this report can be found on the Circulation Foundation website at:

https://www.circulationfoundation.org.uk/

The outcome indictors adopted by the NVR were chosen to help vascular specialists monitor and, where possible, reduce the risk associated with the procedure. Short-term survival after surgery is the principal outcome measure for all arterial procedures, but this report also provides information about other outcomes, such as the types of complications that occur.

The NVR process measures are linked to standards of care that are drawn from various national guidelines. These focus on (i) specific aspects of care before and after the vascular intervention, and (ii) the time taken by patients to move along the care pathway. An overall framework for vascular services is described by the "Provision of Services for Patients with Vascular Disease" published by the Vascular Society [VSGBI 2018]. Standards of care specific to the various conditions / arterial procedures are described within the following documents listed below. However, the VSGBI and other organisations made a number of recommendations for the delivery of care to vascular patients as the NHS responded to the COVID-19 pandemic. These are referenced at appropriate places within the chapters of the report.

For elective AAA repair

- The Vascular Society. "Quality Improvement Framework for AAA" [VSGBI 2012]
- Standards and outcome measures for the National AAA Screening Programme (NAAASP) [NAAASP 2020].

For peripheral arterial disease

- The Vascular Society. "A Best Practice Clinical Care Pathway for Peripheral Arterial Disease" [VSGBI 2019]
- The Vascular Society. "A Best Practice Clinical Care Pathway for Major Amputation Surgery" [VSGBI 2016]
- National Institute for Health and Clinical Excellence (NICE). Guidance for peripheral arterial disease (CG147) [NICE 2012].

For carotid endarterectomy

- National Institute for Health and Clinical Excellence (NICE). Stroke: The diagnosis and acute management of stroke and transient ischaemic attacks (NG128) [NICE 2019]
- National Stroke Strategy [DH 2007] and its associated publication "Implementing the National Stroke Strategy – an imaging guide" [DH 2008].

1.2 Publication of information on the VSQIP website

There are supplementary materials that accompany this report available on the NVR website at: www.vsqip.org.uk. These include data tables containing individual NHS Trust results, and an organisational data viewer.

The website also provides access to:

- all previous Annual Reports
- information on the performance of each NHS organisation
- links to resources that support local services quality improvement initiatives
- information on how the Registry collects and analyses patient data
- links to other sources of information about vascular conditions.

The results from the NVR are used by various other national health care organisations. In particular, the NVR has worked with HQIP and the Care Quality Commission (CQC) intelligence team to create a dashboard to support their inspections.

1.3 How to read this report

The results in this report are based primarily on vascular interventions that took place within the UK between 1 January 2018 and 31 December 2020. As noted above, the scope of the NVR extends only to patients who underwent a procedure. Details of patients who were admitted to hospital with a vascular condition (e.g. a ruptured AAA) but were not operated upon, are not captured.

The data used in this report was extracted from the NVR IT system in June 2021. This was to allow sufficient time for NHS hospitals to enter follow-up information about the patients having these vascular interventions, and to provide a period in which NHS consultants could check the completeness and accuracy of their data. Only records that were locked by NHS staff (i.e. the mechanism used in the IT system for a hospital to indicate that data entry is complete) were included in the analysis of the 2018-20 audit period. The data submission deadline was slightly later in 2021 than in previous years due to the impact of the COVID-19 pandemic on hospital services.

Results are typically presented as totals and/or percentages, medians and interquartile ranges (IQR). Where appropriate, numerators and denominators are given. In a few instances, the percentages do not add up exactly to 100%, which is typically due to the rounding up or down of the individual values, or where multiple responses can be recorded.

Where individual NHS Trust and Health Board results are given, the denominators are based on the number of cases for which the question was applicable and answered. The number of cases included in each analysis may vary depending on the level of information that has been provided by NHS services and the total number of cases that meet the inclusion criteria for each analysis. Details of data submissions are given in the NHS Trusts tables available on the NVR website.

For clarity of presentation, the terms NHS Trust or Trusts have been used generically to describe NHS Trusts and Health Boards. A list of NHS vascular units for which results are published is provided in Appendix 2.

Unless stated otherwise, results are presented for all four UK nations. Where case-ascertainment is mentioned, NVR cases have been compared to HES in England, PEDW in Wales, SMR01 in Scotland and HIS in Northern Ireland.

The case ascertainment rates (especially for 2020) should be interpreted with caution. This is due to the impact of the National Data Opt-Out. The opt-out allows patients in England to indicate that they do not want their confidential patient information to be shared for purposes beyond their individual care across the health and care system. This includes HES data, and as a result, the number of patients included in the extract of HES data provided to the NVR team in 2021 is lower (the opt-out rate doubled from 2.7% in October 2020 to 5.4% in September 2021). Due to the COVID-19 pandemic, the volume of many NVR procedures was significantly lower in 2020, and as a result the increase in opt-out rates has a larger effect on case ascertainment rates, particularly at NHS trust level. When compared to HES data, many trusts had case ascertainment rates of well over 100%. Therefore case ascertainment rates are shown in categories in the outcomes section of the VSQIP website.

Funnel plots are used to assess whether there are systematic differences in mortality rates between NHS organisations. This is a widely used graphical method for comparing the outcomes of surgeons or hospitals. In these plots, each dot represents an NHS organisation. The solid horizontal line is the national average. The vertical axis indicates the outcome with dots higher up the axis showing trusts with a higher stroke and/or death rate. The horizontal axis shows NHS Trust activity with dots further to the right showing the trusts that perform more operations. The benefit of funnel plot is that it shows whether the outcomes of NHS Trusts differ from the national average by more than would be expected from random fluctuations. Random variation will always affect outcome information like mortality rates, and its influence is greater among small samples. This is shown by the funnel-shaped dotted lines. These lines define the region within which we would expect the outcomes of NHS Trusts to fall if their outcomes only differed from the national rate because of random variation.

The postoperative mortality rates for each NHS vascular unit are adjusted to take into account differences in the case mix of patients treated at each organisation. The risk adjusted rates were derived using multivariable logistic models. These models estimate the likelihood of postoperative death for each individual having a procedure, and these probabilities were then summed to calculate the predicted number of events for each NHS Trust. This year, the structure of the regression models were reviewed so that they could capture how the COVID-19 pandemic might have affected postoperative mortality. We used the daily UK figures on the number of patients hospitalised with COVID-19 as a measure of the pressure experienced by hospitals during which the risk associated with vascular procedures might have differed from the normal level.

Waiting times plots are used to show the comparison of NHS Trusts. In these plots the median time is represented by a black dot. The interquartile ranges (IQRs) are shown by horizontal green lines. Any horizontal lines in red indicate that the upper quartile is beyond the upper limit of the x axis of the graph (usually as a result of a small volume of procedures). The vertical red line on the graphs represent the current national average or the national target.

1.4 Changes to the NVR IT system

A number of changes were made to the NVR IT system in 2020 and 2021, which will enhance the information that can be provided in future annual reports. In particular, changes were implemented in the AAA repair dataset that allowed the capture of details on implanted medical devices. This was the culmination of 2-3 years of work involving the Association of British HealthTech Industries (ABHI) and Northgate Public Services (the developer of the NVR IT system), and was supported by the Vascular Society of Great Britain & Ireland (VSGBI) and the British Society of Interventional Radiology (BSIR). More information about this innovation can be found in the NVR short report "Developing and implementing implantable medical device capture for aortic aneurysm repair."

In summary, changes were made to the NVR IT system in order to allow users to record the following:

All procedures:

- The on-going impact of the COVID-19 pandemic, especially if there are further waves
- the effect a recent COVID-19 infection has on post-operative outcomes
- if outcomes are impacted by whether a patient has been vaccinated against COVID-19 and how many doses of the vaccine they have had.

AAA repair:

- The number of devices used per manufacturer for both open and endovascular repairs
- longer-term outcomes, such as re-intervention rates and the types of re-interventions procedures performed.

Lower limb revascularisation:

- More detail as to where delays occur in the pre-operative pathway (e.g. referral and imaging)
- better classification of hybrid procedures.

Lower limb amputation:

- More robust ways of collecting information on antibiotic and DVT prophylaxis.

1.5 Preliminary results on the impact of the COVID-19 pandemic on NHS vascular services in early 2021

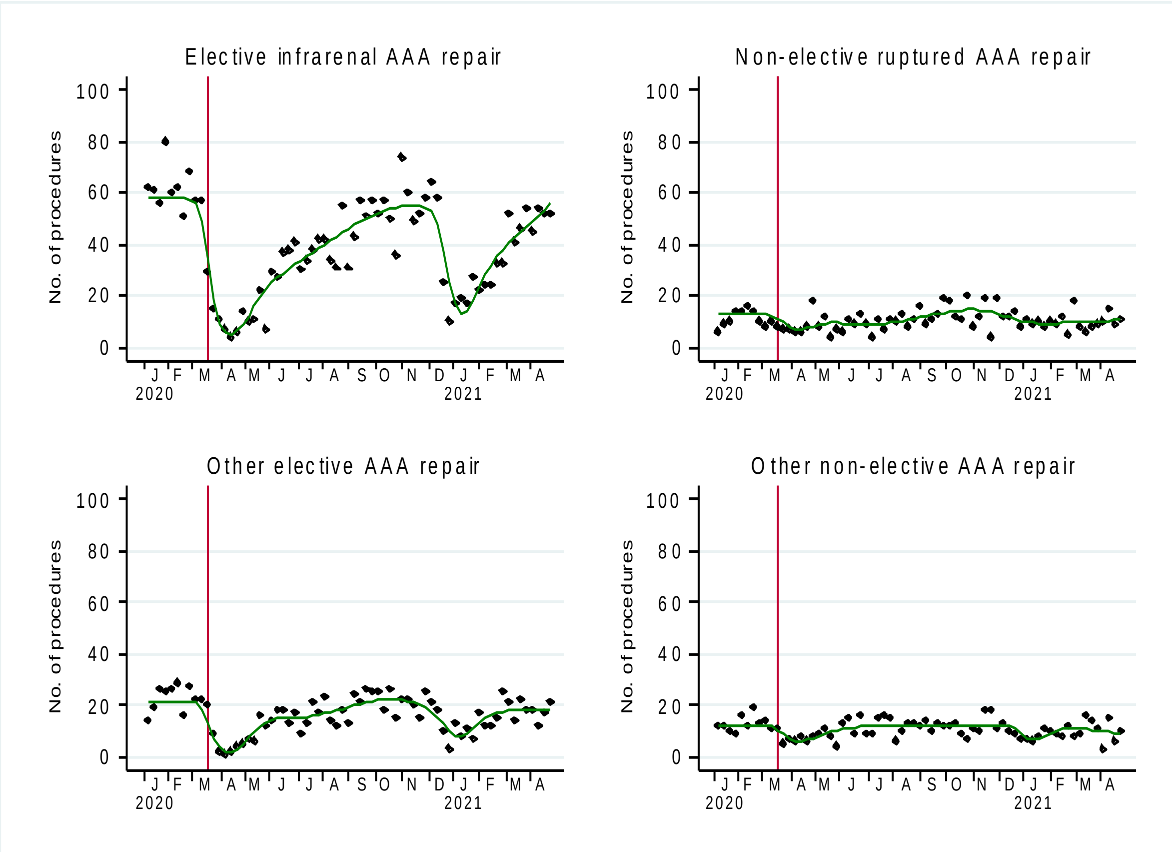
Many NHS vascular services have been submitting data on patients treated in their units since January 2021. We therefore present some preliminary results on the impact that the second wave of the COVID-19 pandemic had on the provision of vascular care in winter 2021.

The results in this section should be regarded as preliminary. Information in the submitted records was not always complete, and a portion of the records had not been locked when the data extract was taken from the NVR data collection system (27 July 2021).

Thus, the results are restricted to the data from 84 NHS vascular units whose activity in the NVR between January and April 2021 was similar to that in the previous period.

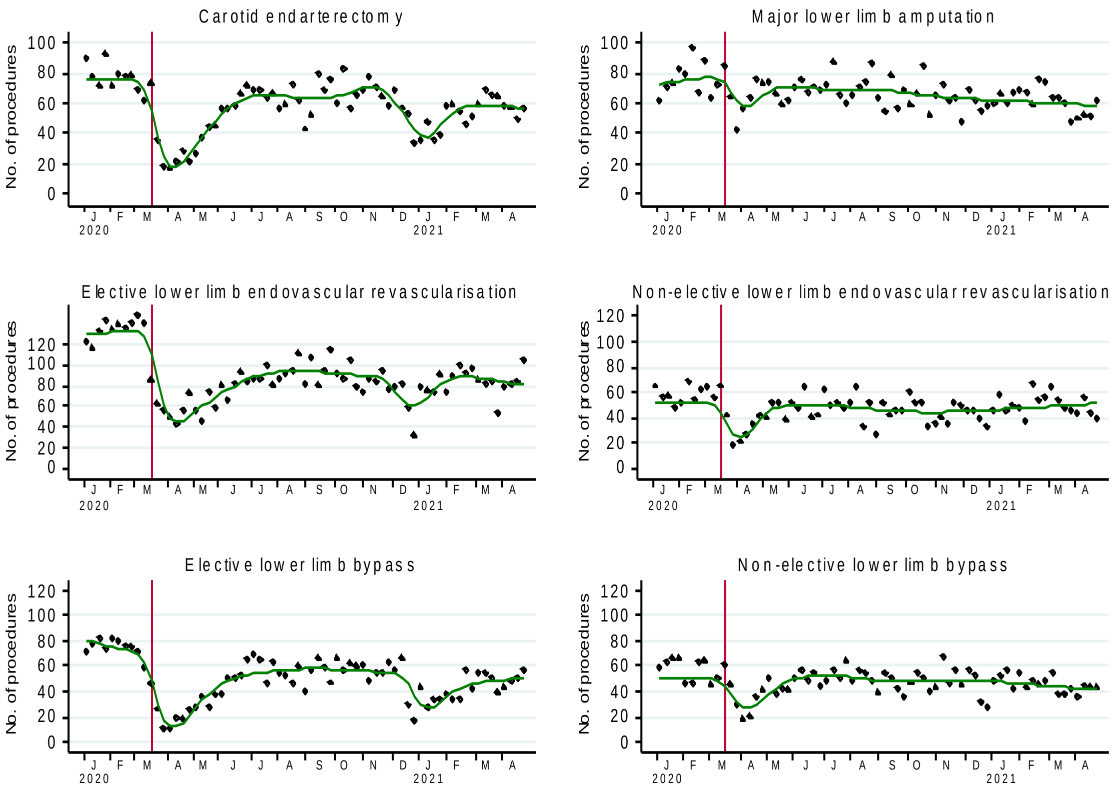
Figures 1.1 and 1.2 show the weekly pattern of activity (Sunday to Saturday) from Sunday 5 January 2020. The red lines denote the week of 15-21 March, which covers the beginning of the government's policy to stop the spread of the virus: on 16 March, social distancing was recommended, and on 23 March, a national lockdown came into force.

Figure 1.1: Weekly number of AAA repairs in 79 NHS vascular units between 5 January 2020 and 1 May 2021, by type of repair



The red lines denote the week of 15-21 March

Figure 1.2: Weekly number of lower limb procedures and carotid endarterectomies in 79 NHS vascular units between 5 January and 1 May 2021



The red lines denote the week of 15-21 March

As we reported in the 2020 Annual Report, there was a large drop in vascular activity after 15 March, particularly among the elective procedures during April 2020.

Activity recovered in the following weeks until the peak of the second COVID-19 wave in January-February 2021. Compared with April 2020, there was less of an impact on non-elective procedures. However, the second COVID-19 wave decreased the number of elective procedures again for a short time with infra-renal AAA repairs being the worst affected.

2. Repair of elective infra-renal abdominal aortic aneurysm

2.1 Background

An abdominal aortic aneurysm is the local expansion of the abdominal aorta. The condition tends not to produce symptoms until the aneurysm ruptures. Most aneurysms occur below the kidneys (i.e., are infra-renal).

The National Abdominal Aortic Aneurysm Screening Programme (NAAASP) was introduced in 2010, to provide a comprehensive preventative service. This invites men for an ultrasound scan of their aorta in the year they turn 65 years old. If an aneurysm is detected, a repair procedure is planned with the patient and typically performed as an elective procedure.

The organisation of vascular services undertaking AAA repair continues to evolve. The number of NHS vascular units performing AAA repairs decreased from 75 in 2018 to 72 in 2020. The number of elective infra-renal AAA repairs being performed also decreased from 3,456 in 2019 to 2,258 procedures recorded in 2020 (Table 2.1), mainly due to the impact of the COVID-19 pandemic. This represented a reduction of 35% compared to 2019, and will have led to a large backlog of patients with an AAA waiting for surgery. The graphs presented in section 1.5 showed that the restoration of vascular services was affected by the second wave of the pandemic into 2021.

In recent years, there has been a decrease in the number of endovascular (EVAR) procedures. The reduction over the last three years has occurred over all age ranges (Table 2.1 and Figure 2.1). The reasons for this change could be a more conservative approach to treatment (particularly in older, sicker patients) and the influence of the draft NICE guidance, which recommended open repair more strongly than an endovascular approach. This reduction slowed slightly following COVID-19, accounting for around 60% of all elective infra-renal AAA repairs in 2019 and 2020 (Table 2.2).

Table 2.1: Estimated case-ascertainment of elective infra-renal AAA repairs*

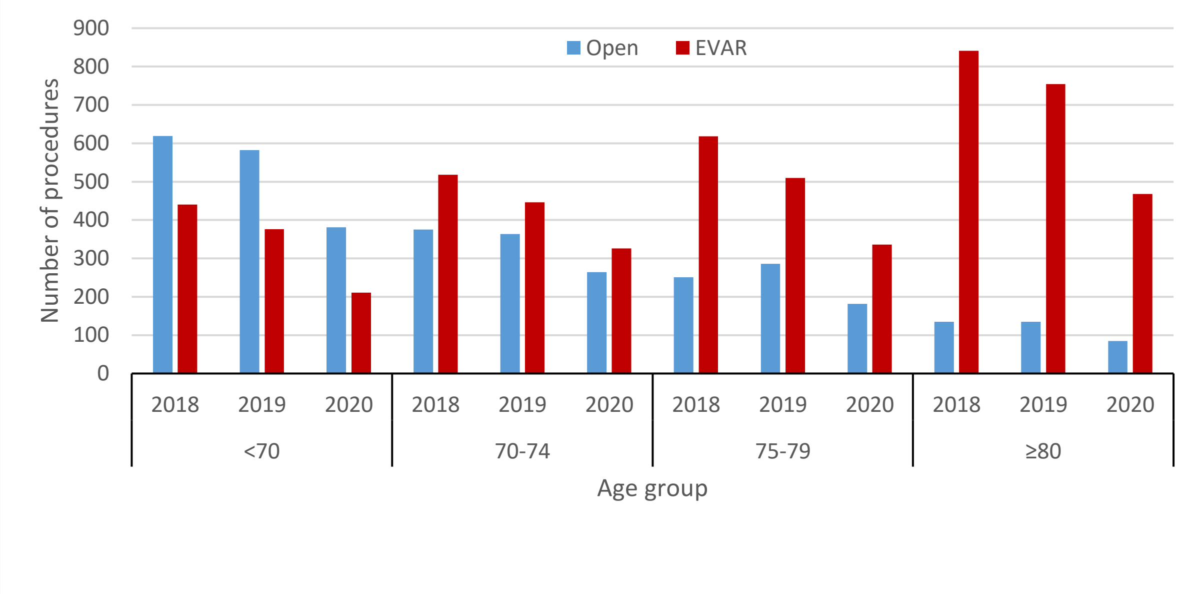
	2018	2019	2020
Audit procedures	3,802	3,456	2,258
Expected procedures	4,032	3,674	2,493
Estimated case-ascertainment	94%	94%	91%

*It is possible that a small number of complex EVAR procedures carried out for infra-renal aneurysms are included in the expected procedures figures due to issues related to their coding.

Table 2.2: Split of open and endovascular elective infra-renal AAA procedures by year

Year	Open	EVAR	Total	% EVAR
2018	1,384	2,418	3,802	63.6
2019	1,368	2,088	3,456	60.4
2020	913	1,345	2,258	59.6
Total	3,665	5,851	9,516	61.5

Figure 2.1: Distribution of elective infra-renal AAA repairs by age group between 2018 and 2020

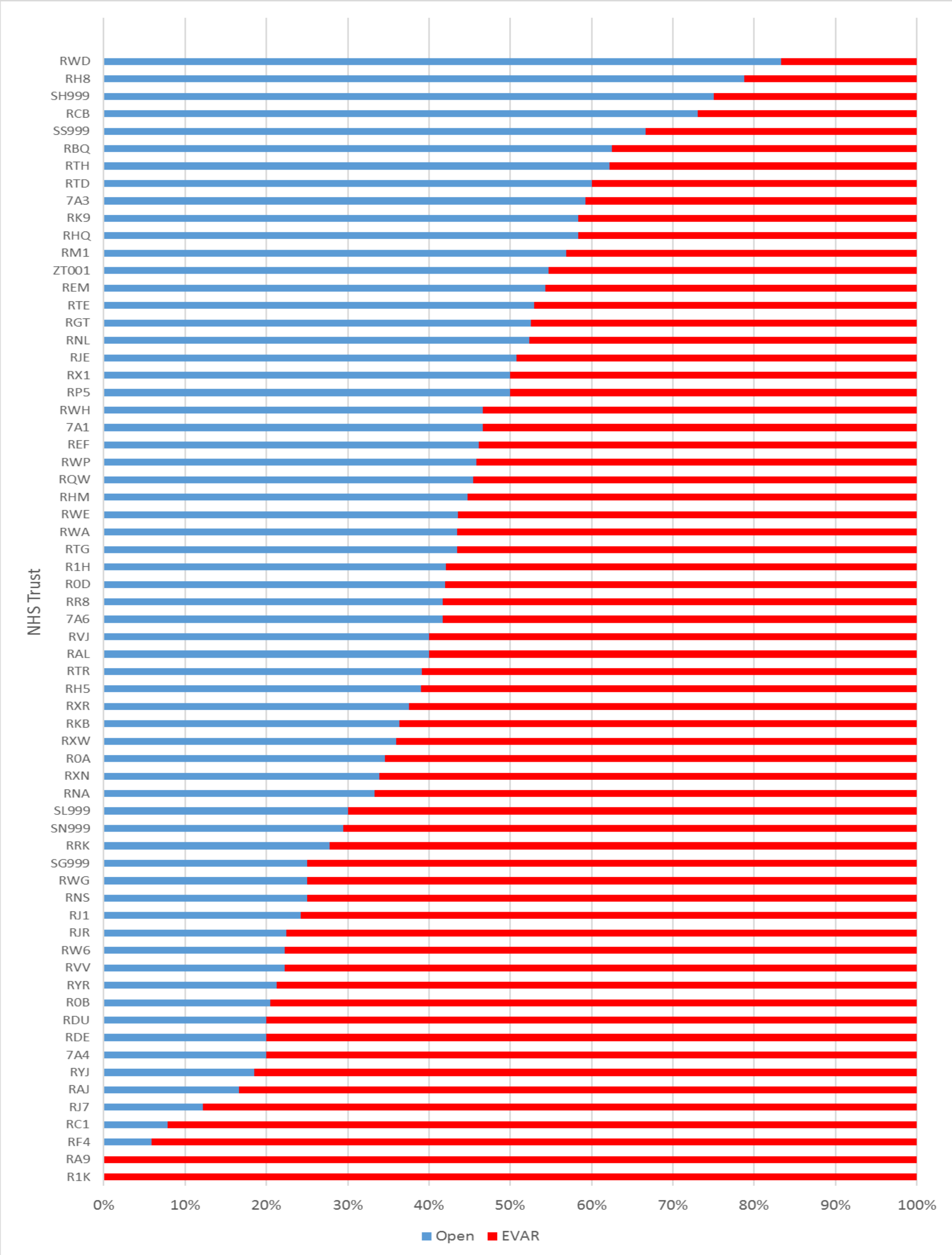


There were differences in the characteristics of patients who had EVAR and those who had open procedures (Appendix 3), with patients undergoing EVARs being, on average, slightly older and having a greater burden of comorbid disease. The majority of procedures were performed for patients with an AAA diameter between 5.5 and 7.4 cm. Figure 2.2 shows the proportion of open and EVARs for 2020 by trust. Presently, 18 of the 65 (28%) trusts shown are performing more open repairs than EVARs (Figure 2.2).

A full description of a vascular network's aortic practice will include patients treated conservatively because it was not clinically appropriate for them to undergo an elective or emergency procedure. The NVR is unable to record the number of these patients, as they are outside of the scope of the NVR.

The National AAA Screening Programme established the 8 week target time from referral to treatment to ensure elective repairs are scheduled sufficiently so as to reduce the risk of a patient's AAA rupturing while waiting for treatment [NAAASP 2009]. In previous NVR Annual Reports, we have used this standard to examine the time from assessment to surgery across NHS vascular units. In light of the COVID-19 pandemic, an evaluation of individual NHS Trusts against this metric was not attempted. The relaxation of this metric was a result of guidance from the VSGBI, BSIR, NHS England Vascular CRG and GIRFT.

Figure 2.2: Percentage of open repairs and EVARs by trust in 2020



2.2 Preoperative care pathway for elective infra-renal AAA

VSGBI AAA QIF

All elective procedures should be reviewed preoperatively in an MDT that includes surgeon(s) and interventional radiologist(s) as a minimum.
All patients should undergo standard preoperative assessment and risk scoring, as well as CT angiography to determine their suitability for EVAR.
All patients should be seen in pre-assessment by an anaesthetist with experience in elective vascular anaesthesia.

Table 2.3 describes the overall performance of NHS vascular units against the VSGBI AAA QIF standards over the past two years. The majority of patients received care consistent with the QIF recommendations but there is potential for increasing the proportion of patients who:

- have preoperative CT/MR angiography, and
- are discussed at an MDT meeting.

The figures in Table 2.3 might be approximate because patients for whom the dates were unknown or contradictory were counted as equivalent to patients who did not receive these elements of care.

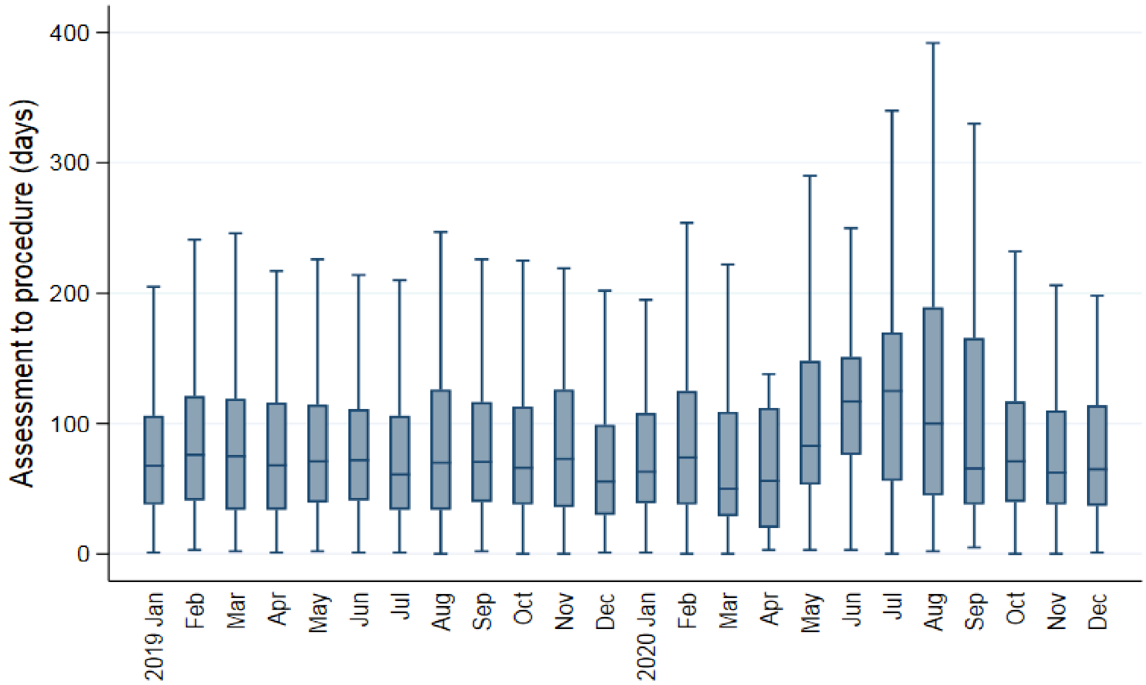
Table 2.3: Overall compliance with standards related to the elective AAA care pathway

	Percentage of patients meeting standard	
	2020	**2019**
Elective patients were discussed at MDT meetings	85.5 1,931/2,258	85.5
Patients with an AAA diameter ≥ 5.5cm deemed suitable for repair had a preoperative CT/MR angiography assessment	91.4 1,878/2,054	90.3
Patients underwent a formal anaesthetic review	97.2 2,194/2,258	94.7
Patients whose anaesthetic review was done by a consultant vascular anaesthetist	92.0 2,018/2,194	91.4
Patients who had their fitness measured	80.0 1,805/2,256	83.1
Most common assessment methods:		
CPET	51.8 935/1,805	59.4
Echocardiogram	42.7 770/1,805	36.2

Figure 2.3 shows the impact of the first wave of the pandemic on the time from vascular assessment to surgery for elective infra-renal procedures. The reduced level of activity led to an increase in the median time to surgery after April 2020. It is currently not clear why the times fell in October to December as the lower levels of activity suggest there is a backlog of patients suitable for elective AAA repair.

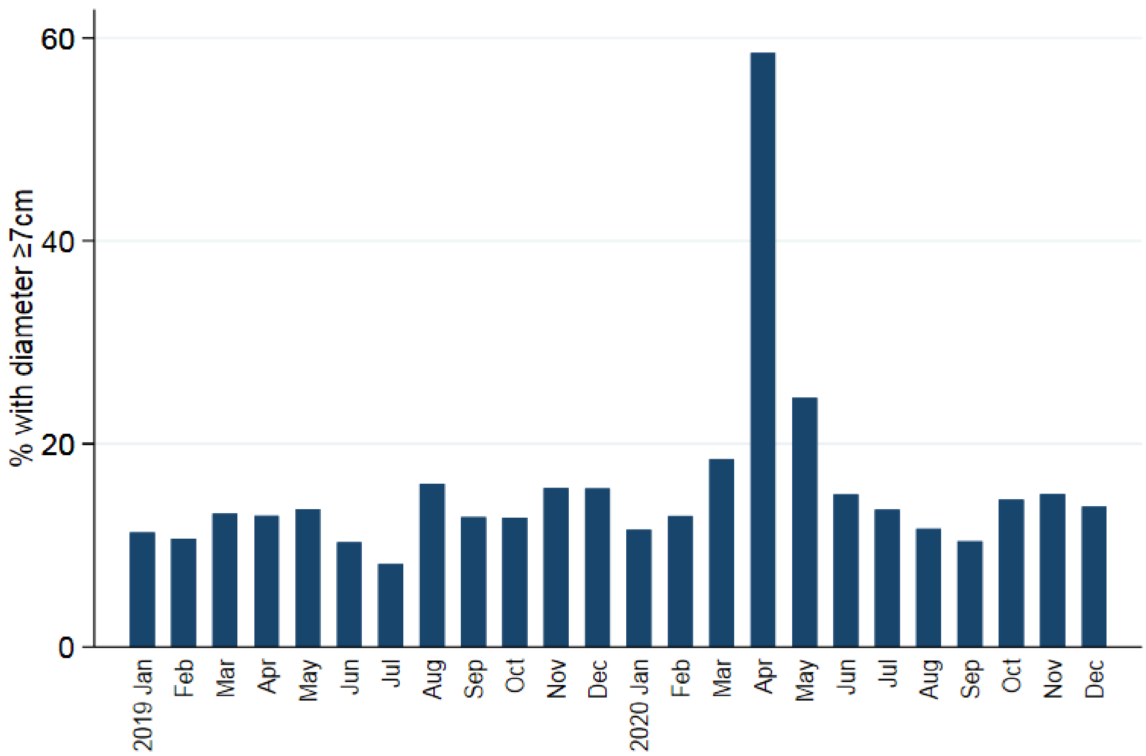
During the first wave of the COVID-19 pandemic, the VSGBI recommended that only patients with infra-renal AAAs with an aortic diameter greater than 7cm should be offered elective surgery. During April 2020, over 50% of patients who had an AAA repair had these large aneurysms; as activity increased after the first COVID-19 wave, the proportion of patients who had a diameter greater than 7cm returned to typical levels, making up around 15% of the monthly activity (Figure 2.4).

Figure 2.3: Boxplot of median (IQR) time from assessment to treatment (days) for patients who had an elective infra-renal AAA repair between January 2019 and December 2020 by month*



*Excludes outside values

Figure 2.4: Bar plot of proportion of patients with a diameter ≥7.0cm by month in 2019 & 2020



2.3 Postoperative outcomes after elective infra-renal AAA repair

Table 2.4 describes various aspects of postoperative care and highlights some notable differences between patients having open and endovascular repairs between 2019 and 2020.

- For EVAR, over 65% of patients went to a normal hospital ward after surgery, and the median length of the postoperative stay was 2 days. The in-hospital mortality rate was around 0.3-0.4%
- For patients undergoing open repair, at least 95% of patients were admitted to a level 2 or level 3 critical care unit after surgery. Patients typically remained in critical care for 2 days and the median total postoperative stay was 7 days. Patients undergoing open repair were more susceptible to cardiac, renal and respiratory complications, and the rate of return to theatre was also higher. The in-hospital mortality rate for open repair in 2020 was 3.3% (95% CI 2.2 to 4.7), compared to 2.3% (95% CI 1.6 to 3.3) in 2019. Furthermore, respiratory complications increased from 9.2% (95% CI 7.7 to 10.9) to 12.3% (95% CI 10.2 to 14.6) from 2019 to 2020.

Table 2.4: Postoperative details of elective infra-renal repairs undertaken between January 2019 and December 2020

		Open repair		EVAR	
		2020 (n=913)	**2019 (n=1,368)**	**2020 (n=1,345)**	**2019 (n=2,088)**
Admitted to	Ward	4.5%	1.8%	68.2%	67.4%
	Level 2	61.0%	62.9%	28.9%	29.6%
	Level 3	34.4%	35.3%	2.9%	3.0%
		Median (IQR)	***Median (IQR)***	***Median (IQR)***	***Median (IQR)***
Days in critical care:	Level 2	2 (2 – 4)	2 (1 – 4)	1 (0 – 1)	1 (0 – 1)
	Level 3	2 (1 – 4)	2 (1 – 4)	2 (1 – 2)	1 (1 – 2)
Post-op length of stay (days)		7 (6 – 10)	7 (6 – 10)	2 (1 – 3)	2 (1 – 3)
		Rate	***Rate***	***Rate***	***Rate***
In-hospital postoperative mortality		3.3	2.3	0.4	0.3
Defined complications					
	Cardiac	3.9	4.2	1.1	0.8
	Respiratory	12.3	9.2	1.5	1.1
	Haemorrhage	0.9	1.0	0.4	0.8
	Limb ischaemia	1.6	2.5	0.5	0.8
	Renal failure	4.5	5.3	1.0	1.1
	Other	11.3	7.5	4.5	3.6
	None of the above	69.7	73.5	90.8	91.7
Return to theatre		6.4	6.9	1.6	2.0
Readmission within 30 days		6.3	4.8	4.9	5.7

Patients undergoing endovascular procedures may experience an endoleak. Of these, type I endoleaks (in which blood leaks around the points of graft attachment) are the most serious and generally require intervention. Among the EVARs performed in 2020:

- 1,080 (82.2%) procedures experienced no endoleak while the patient was in hospital
- 60 (4.6%) procedures experienced a type I endoleak
- 76 endoleaks (of any type) required intervention at the time of the procedure.

Frailty is a syndrome defined as increased vulnerability due to a decline in reserve and function, and covers both cognitive and physical domains. The importance of frailty assessment has already been established in patient selection and postoperative care among older surgical patients, and there is evidence for its use in preoperative optimisation with an elderly care physician review prior to vascular surgery.

For the second time, we explored the influence of frailty in patients undergoing both open and endovascular procedures for elective infra-renal AAA repair. However, in 2020, frailty was recorded in 75% (1,702) of patients, only a slight increase from the 73% found in 2019. Therefore, there was insufficient data to demonstrate a relationship between frailty and in-hospital postoperative mortality. From the available data however, there appears to be a higher prevalence of frailty in those having EVAR (39.6%) compared to open repairs (18.6%).

We encourage vascular units to identify at risk ‘frail’ patients and ensure their degree of frailty is submitted to the NVR.

2.4 Postoperative in-hospital mortality for elective infra-renal AAA repair

The principal performance measure used by the NVR for elective infra-renal AAA repair is the postoperative in-hospital mortality rate. We report this outcome for NHS organisations during the period from 1 January 2018 to 31 December 2020 to give robust outcome estimates.

The comparative, risk-adjusted mortality rates for individual NHS Trusts are shown in a funnel plot in Figure 2.5. The overall in-hospital mortality rate was 1.4%, and all NHS Trusts had a risk-adjusted rate of inpatient mortality that fell within the expected range given the number of procedures they each performed. These were adjusted for gender, cardiac disease, aortic diameter, renal disease and the number of Covid-19 cases.

Figures 2.6A and 2.6B show the risk-adjusted rate of inpatient mortality among NHS Trusts for open repair and EVAR procedures separately. The funnel plots are centred on the national mortality rate for these two procedures. The overall in-hospital mortality rates for open and EVAR procedures for the 3-year period between 2018 and 2020 were 2.9% and 0.4%, respectively.

Figure 2.5: Risk-adjusted in-hospital mortality rates after elective infra-renal AAA repair among NHS vascular units for procedures performed between January 2018 and December 2020. The overall in-hospital mortality rate was 1.4%.

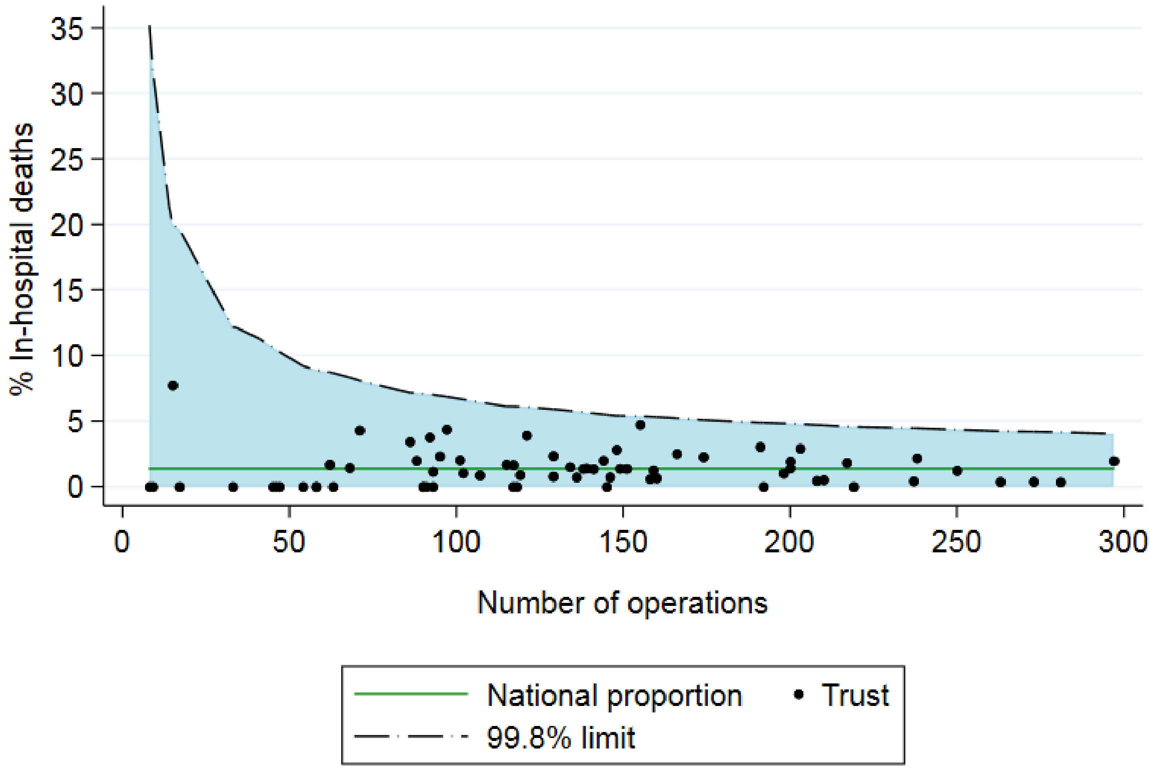
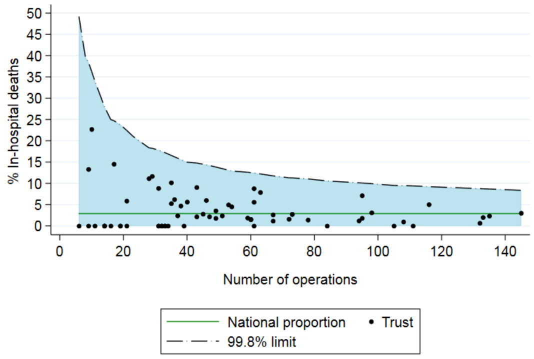
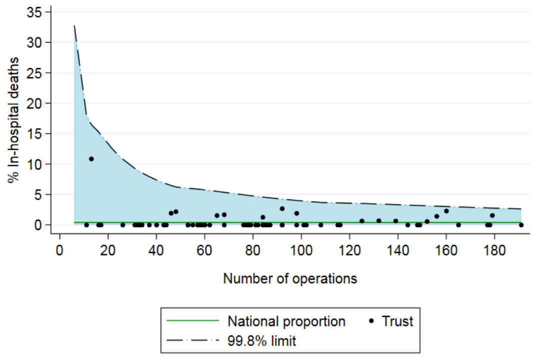


Figure 2.6: Funnel plot of risk-adjusted in-hospital mortality after elective AAA repair for open and EVAR procedures performed between 2018 and 2020.



A: Open repairs

The postoperative in-hospital mortality rate for open repair procedures was 2.9%



B: EVAR procedures

The postoperative in-hospital mortality rate for EVAR procedures was 0.4%

Postoperative in-hospital mortality after open repair has risen; in 2020, the rate was 3.3% compared to 2.3% in 2019 respectively. This outcome is likely to reflect the impact of COVID-19. For EVARs, the rate has remained around 0.3-0.4%.

The very low in-hospital mortality rates following elective EVAR repair raises the question of whether mortality remains the most valuable measure of outcome for infra-renal AAA [Boyle 2019]. Consequently, the NVR introduced a refined aortic dataset in 2020 to capture data on revision surgery and re-interventions following aortic surgery in the expectation that this will become a better measure of quality in time. The first NVR report on aortic devices was published in 2021 and we request that all aortic devices (both open and endovascular) are entered on the NVR.

3. Elective repair of complex aortic conditions

3.1 Background

Aneurysms can occur at various locations along the aorta. In addition to infra-renal aneurysms, a distinction is made between three other types, which collectively are referred to as complex aneurysms:

- juxta-renal (that occur near to the renal arteries)
- supra-renal (that occur above the renal arteries) and
- thoraco-abdominal (more extensive aneurysms involving the thoracic and abdominal aorta).

The repair of these complex aneurysms is often performed using endovascular procedures, the most common of which are:

- fenestrated EVAR (FEVAR) which involves the use of a graft that has holes (fenestrations) to allow the passage of blood vessels from the aorta
- branched EVAR (BEVAR) in which separate grafts are deployed on each blood vessel from the aorta after the main graft has been fitted
- thoracic endovascular aortic/aneurysm repair (TEVAR).

The endovascular approach may also be used when an abdominal aneurysm extends down to the common iliac arteries. Here, an iliac branch device is used to preserve the blood flow to the internal iliac arteries.

3.2 Patterns of complex repairs

This chapter mainly focusses on results for the 2-year period between January 2019 and December 2020. The NVR received 1,424 records related to complex AAA procedures from 60 vascular units. The numbers have fluctuated over recent years; with 799 procedures in 2019 and 625 in 2020. This represented a reduction of around 20% between 2019 and 2020. Over the last two years, 1,280 (90%) were endovascular (Table 3.1), with over half being fenestrated repairs.

The median annual volume amongst operative vascular units in the last two years was 6 in 2019 but has reduced to 4.5 for 2020. Moreover, the level of activity differed markedly between trusts. One unit performed 160 complex repairs between 2019 and 2020 but 38 units performed fewer than 20 procedures.

The changes in the number of trusts providing elective repair of complex AAA is summarised in Figure 3.1. In 2018, 23 of the 71 (32%) trusts were performing at least 10 procedures annually. This remained unchanged in 2020, although there were 18 trusts performing no procedures in 2020 compared to 11 in 2018.

The level of case-ascertainment for these procedures is currently unknown because the coding of complex aortic procedures in the national administrative hospital datasets prevents these procedures from being clearly identified.

Figure 3.1: Number of trusts performing elective complex AAA repair

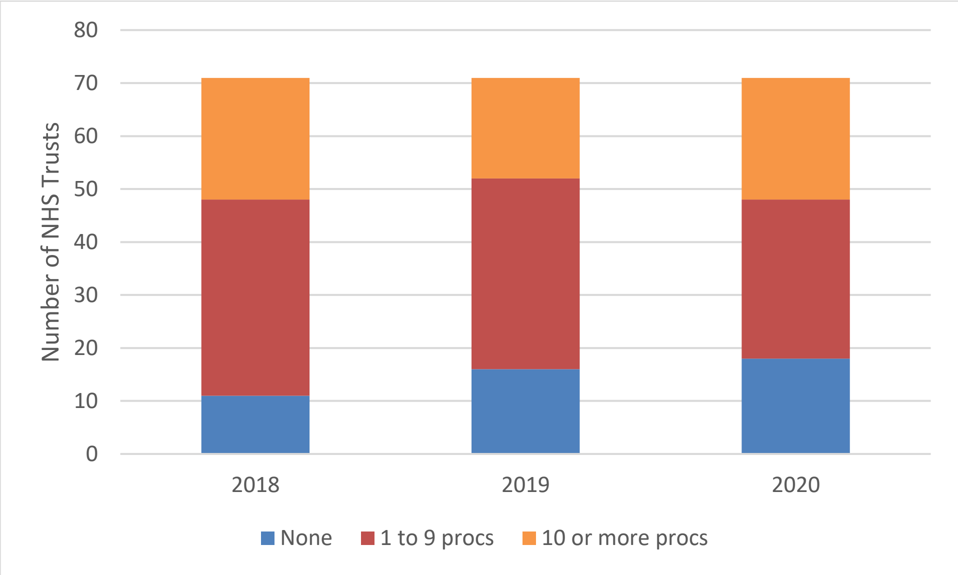


Table 3.1: Characteristics of patients who had an elective repair of complex AAA between January 2019 and December 2020

Open repair		2020	%	2019	%	Total
Total procedures		51		93		144
Age group (years)	Under 66	10	19.6	22	23.7	32
	66 to 75	28	54.9	44	47.3	72
	76 to 85	12	23.5	26	28.0	38
	86 and over	<5	2.0	<5	1.1	<5
Male		41	80.4	79	84.9	120
Female		10	19.6	14	15.1	24
Endovascular		**2020**	**%**	**2019**	**%**	**Total**
Total procedures		574		706		1,280
Age group (years)	Under 66	77	13.5	82	11.6	159
	66 to 75	249	43.7	276	39.1	525
	76 to 85	228	40.0	317	44.9	545
	86 and over	16	2.8	31	4.4	47
Male		475	82.8	579	82.0	1,054
Female		99	17.2	127	18.0	226
Type of procedure	FEVAR	349	60.9	406	57.6	755
	BEVAR	34	5.9	74	10.5	108
	TEVAR	115	20.1	139	19.7	254
	Iliac branch graft	64	11.2	72	10.2	136
	Composite graft	4	0.7	3	0.4	7
	Other (e.g., chimney / snorkel / periscope)	7	1.2	11	1.6	18

Similar to infra-renal AAAs, we have not reported the median assessment to procedure times at trust level due to guidance released in response to the COVID-19 pandemic. Nationally between 2018 and 2020, the median was 132 days (IQR: 75-207).

The 2016 NVR snapshot audit identified a number of reasons why patients having complex repairs typically had a longer delay between vascular assessment and surgery than patients having infra-renal endovascular repair. These included:

1. over a quarter of patients having a complex open repair required a specialist opinion from a physician in cardiology, respiratory medicine or nephrology (renal disease).
2. the time it took for a non-conventional device to be delivered, with the average delivery time being 67 days.

The main concern that arises from significant delays between assessment and surgery is the possibility of aneurysm rupture whilst the patient is waiting. The NVR does not capture this data, but encourages rapid fitness assessment MDT decision making and device procurement to reduce these delays.

Tables 3.2 & 3.3 describe the outcomes of elective complex aortic repairs in 2019 and 2020. As with elective infra-renal AAA repairs, some differences and similarities can be seen between 2019 and 2020:

- For open repairs, around 50% of patients were admitted to a level 3 critical care unit. The median overall postoperative stay was around 9-10 days.
- Mortality showed a decline for open repairs but this coincided with a large reduction in procedures for 2020.
- For endovascular repairs, in both years the majority of patients were admitted to level 2 critical care. The median length of stay was 4 days.

The in-hospital postoperative mortality rates for open and endovascular procedures were greater than the equivalent rates for infra-renal AAA repair, reflecting the complex nature of the disease and surgery. For open repairs, there was also a high risk of returning to theatre (12%). Overall, in the last two years, for endovascular repairs, the rates of in-hospital deaths showed a decline from 3.8% (95%CI 2.5 to 5.5) to 2.4% (95%CI 1.3 to 4.1).

For the two most common complex endovascular procedures, the mortality for TEVAR patients was slightly higher than FEVAR patients (Table 3.4). The mortality for elective FEVAR reduced by a half from 3.9% to 1.7%, although the number of procedures reduced from 406 to 349 from 2019 to 2020.

Table 3.2: Postoperative details of complex open AAA repairs undertaken between January 2019 and December 2020

Open repair		2020 (n=51)		2019 (n=93)	
Admitted to	Ward	2.0%		2.2%	
	Level 2	45.1%		46.2%	
	Level 3	52.9%		48.4%	
	Died in theatre	0.0%		3.2%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	4	3 to 6	3	2 to 5
	Level 3	3	2 to 9	4	3 to 6
Post-op length of stay (days)		9	6 to 17	10	7 to 14
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		7.8	2.2 to 18.9	12.9	6.8 to 21.5
Readmission to critical care		5.9	1.2 to 16.2	4.4	1.2 to 11.0
Return to theatre		11.8	4.4 to 23.9	12.2	6.3 to 20.8
30 day readmission rate		6.4	1.3 to 17.5	5.3	1.5 to 12.9

Table 3.3: Postoperative details of complex endovascular repairs undertaken between January 2019 and December 2020

Endovascular		2020 (n=574)		2019 (n=706)	
Admitted to	Ward	22.0%		20.3%	
	Level 2	63.4%		65.2%	
	Level 3	14.5%		14.4%	
	Died in theatre	0.2%		0.1%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	2	1 to 2	2	1 to 3
	Level 3	2	1 to 3	2	1 to 3
Post-op length of stay (days)		4	2 to 6	4	2 to 7
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		2.4	1.3 to 4.1	3.8	2.5 to 5.5
Readmission to critical care		1.4	0.6 to 2.7	1.4	0.7 to 2.6
Return to theatre		3.7	2.3 to 5.5	5.5	4.0 to 7.5
30 day readmission rate		6.6	4.6 to 9.0	8.3	6.3 to 10.7

Table 3.4: Postoperative details of complex TEVAR and FEVAR undertaken between January 2019 and December 2020

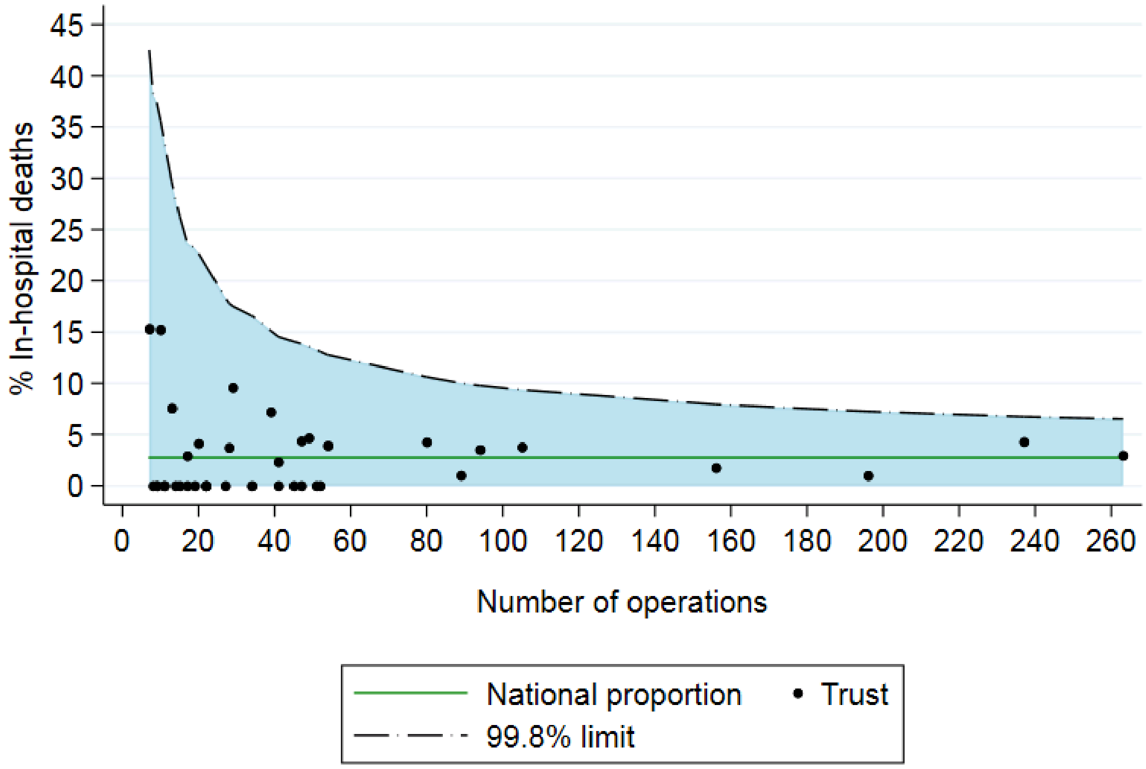
TEVAR		**2020 (n=115)**		**2019 (n=139)**	
Admitted to	Ward	19.1%		21.6%	
	Level 2	53.0%		58.3%	
	Level 3	27.8%		19.4%	
	Died in theatre	0.0%		0.7%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	2	1 to 3	2	1 to 3
	Level 3	1	1 to 2	2	1 to 3
Post-op length of stay (days)		4	2 to 6	4	2 to 7
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		4.3	1.4 to 9.9	4.3	1.6 to 9.2
Readmission to critical care		1.7	0.2 to 6.1	0.0	0.0 to 2.6
Return to theatre		4.3	1.4 to 9.9	4.3	1.6 to 9.2
30 day readmission rate		8.1	3.6 to 15.3	13.2	7.6 to 20.8
FEVAR		**2020 (n=349)**		**2019 (n=406)**	
Admitted to	Ward	16.9%		15.3%	
	Level 2	70.8%		70.7%	
	Level 3	12.3%		14.0%	
	Died in theatre	0.0%		0.0%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	2	1 to 2	2	1 to 2
	Level 3	2	1 to 3	2	1 to 3
Post-op length of stay (days)		4	2 to 6	4	3 to 7
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		1.7	0.6 to 3.7	3.9	2.3 to 6.3
Readmission to critical care		1.1	0.3 to 2.9	2.5	1.2 to 4.5
Return to theatre		3.4	1.8 to 5.9	5.4	3.4 to 8.1
30 day readmission rate		7.6	5.0 to 10.9	7.6	5.2 to 10.8

3.2 Postoperative in-hospital mortality for complex endovascular procedures

This section describes the in-hospital mortality rates for NHS organisations undertaking complex endovascular procedures during the period from 1 January 2018 to 31 December 2020.

The adjusted mortality rates for individual NHS Trusts are shown using a funnel plot in Figure 3.2. All NHS Trusts had an in-hospital mortality that fell within the expected range around the national average of 2.8%, given the number of procedures performed.

Figure 3.2: In-hospital mortality after complex endovascular repairs between January 2018 and December 2020



3.3 Comment

Complex aortic aneurysm repairs account for a relatively small part of the overall vascular surgical workload, but they consume a relatively greater proportion of the health care resources than infra-renal AAA repairs. The relatively high postoperative mortality rate, particularly for open repairs, highlights the need for NHS Trusts and Commissioners to focus on ensuring the care for these patients is delivered safely. It is recommended that complex aortic surgery should only be commissioned from vascular units that submit complete and accurate data on caseload and outcomes of these procedures to the NVR. Furthermore, commissioning of complex AAA intervention should be reviewed if units perform less than 10 procedures annually.

The area of endovascular repair continues to evolve, with new complex endovascular grafts being made available to vascular services.

4. Repair of ruptured abdominal aortic aneurysms

4.1 Surgical activity for ruptured AAA

Although there has been a steady decline in the incidence of ruptured abdominal aneurysms, it remains a common vascular emergency. In this chapter, the outcomes of emergency repairs among patients with a ruptured AAA are described for the period between 1 January 2019 and 31 December 2020. Details of 1,155 procedures were submitted to the NVR. There were 477 procedures recorded on the NVR in 2020, compared to 678 in 2019, representing a reduction of 30%.

Compared to patients who had an elective infra-renal AAA repair, patients who had surgery for a ruptured AAA were older, with over 50% being over 75 years old. The average diameter of the aneurysm was also larger.

While a reduction in ruptured procedures in 2020 is evident following COVID-19, the proportion of patients having an EVAR over the last three years has also seen a change (Figure 4.1). In 2018, around 30% of all procedures were EVARs, however, by 2020 this has increased to over 40%. At trust level over the three years, less than a quarter of all centres performed more EVARs than open repairs (Figure 4.2).

When considering 2019 and 2020, EVARs attributed 37.7% (n=435) of all cases. For patients undergoing EVAR, the basic characteristics of their anatomy were:

- 87.2% had a neck angle between 0-60 degrees; for 7.5%, it was 60-75 degrees
- the median neck diameter was 23mm (IQR: 21 – 26) and the median neck length was 20mm (IQR: 15 – 30)
- the aneurysm was extended into either the left / right iliac artery for 16.2% of procedures and was extended bilaterally for 4.4% of procedures
- the median aortic diameter was 7.1cm (IQR: 6.0 – 8.6).

For patients having open repair, 72.7% underwent tube grafts, 26.6% included a bifurcated graft and 4.9% had a groin incision.

The outcomes of the procedures for ruptured AAA are summarised in Table 4.1. Postoperative details for patients undergoing open and EVAR procedures in 2019 and 2020 were as follows:

- median postoperative length of stay was around 14-15 days for open repair in the last two years compared with 7 days in 2020 and 9 days in 2019 for EVAR patients, among those discharged alive
- Over 80% of patients who had an open procedure required level 3 critical care after the procedure (about 40% for patients undergoing an endovascular procedure), with a median length of stay of 4 days for open repair and 2-3 days for EVAR
- a greater proportion of patients who had open repair suffered from cardiac, renal and respiratory complications.

These differences are likely to reflect the severity of patients’ conditions and the suitability of patients for endovascular repair.

The in-hospital postoperative mortality rates for open procedures were 39.5% (95% CI 34.9 to 44.3) in 2019 but increased to 50.0% (95% CI 44.0 to 56.0) for 2020. For EVARs, the rates were around 20% for both years. This is likely to reflect the selection of more stable patients with better aortic anatomy for EVAR, and should be interpreted as indicating their relative effectiveness. The results of the IMPROVE trial reported 30-day mortality rates of 37.4% for open repair and 35.4% for EVAR among patients with ruptured AAA. The NVR data does not include any information on out-of-hospital care, such as transfers of patients from non-arterial hospitals to arterial hospitals. There could be delays in the pre-hospital pathways that may determine whether a patient is offered a repair of their ruptured AAA or what type of repair they may be suitable for. This may mean that comparisons between patient characteristics and post-op outcomes at different NHS trusts should be interpreted with caution.

Figure 4.1: Number of open repairs and EVARs for ruptured AAAs between January 2018 and December 2020.

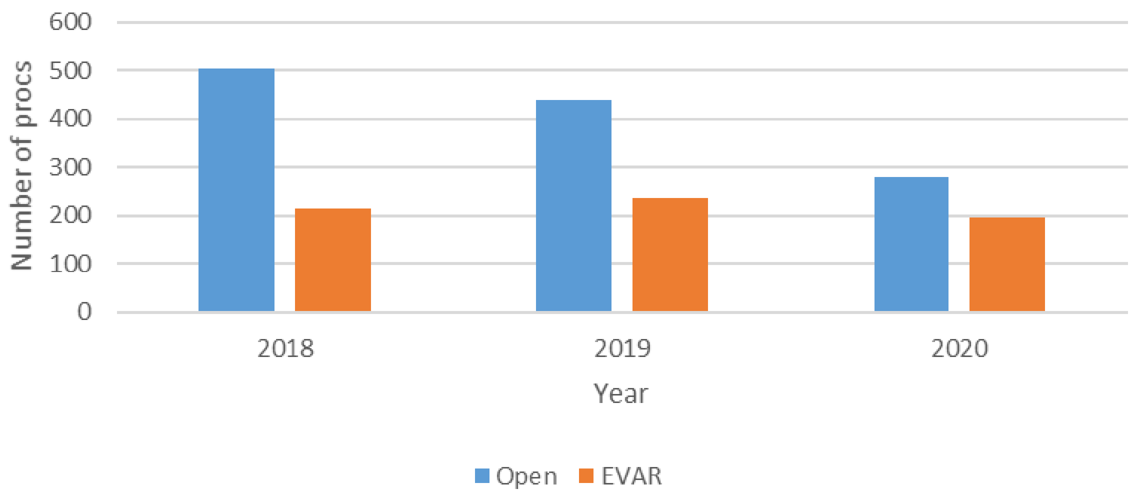


Figure 4.2: Percentage of open repairs and EVARs for ruptured AAAs performed between January 2018 and December 2020 by trust.

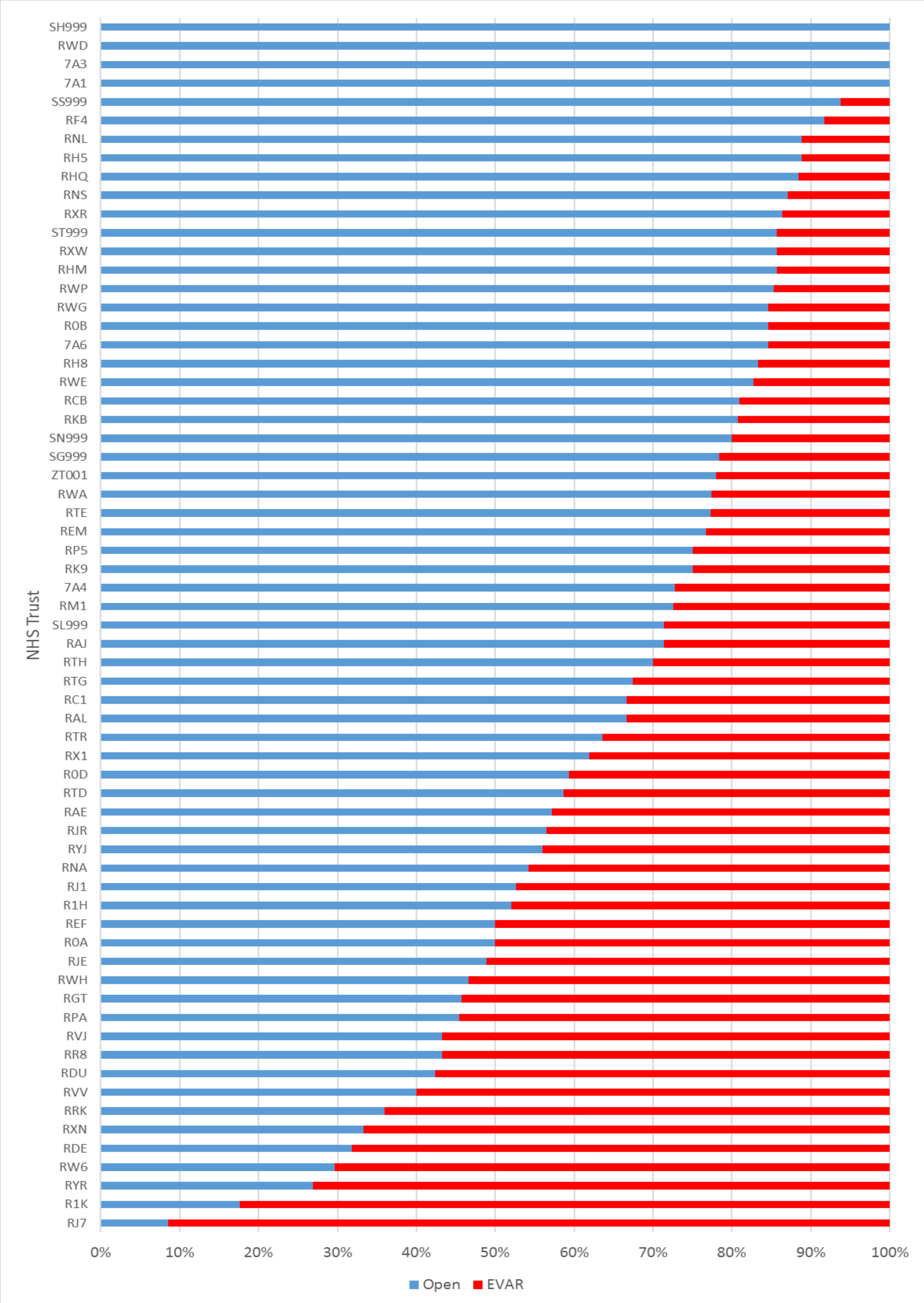


Table 4.1: Postoperative details of emergency repairs for ruptured AAAs undertaken between January 2019 and December 2020

Open		2020 (n=280)		2019 (n=440)	
Admitted to	Ward	0.4%		0.9%	
	Level 2	9.3%		6.8%	
	Level 3	81.7%		85.4%	
	Died in theatre	8.6%		6.8%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	3	2 to 5	5	3 to 11
	Level 3	4	2 to 8	4	2 to 8
Post-op length of stay (days)		9	2 to 18	10	3 to 19
Post-op length of stay for patients discharged alive (days)		14	9 to 26	15	9 to 23
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		50.0	44.0 to 56.0	39.5	34.9 to 44.3
Defined complications					
	Cardiac	21.5	16.6 to 27.0	22.0	18.0 to 26.3
	Respiratory	34.8	28.9 to 40.9	30.5	26.1 to 35.2
	Renal failure	28.9	23.4 to 34.9	30.2	25.8 to 34.9
	None of predefined	29.3	23.8 to 35.3	31.0	26.5 to 35.7
Return to theatre		21.5	16.6 to 27.0	20.0	16.2 to 24.2
Readmission within 30 days		10.7	6.1 to 17.1	8.4	5.3 to 12.4
EVAR		**2020 (n=197)**		**2019 (n=238)**	
Admitted to	Ward	15.2%		13.9%	
	Level 2	41.1%		37.1%	
	Level 3	41.1%		46.8%	
	Died in theatre	2.5%		2.1%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	1	1 to 2	2	1 to 3
	Level 3	2	1 to 3	3	1 to 6
Post-op length of stay (days)		7	3 to 11	8	4 to 16
Post-op length of stay for patients discharged alive (days)		7	4 to 12	9	5 to 16
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		20.3	14.9 to 26.6	19.7	14.9 to 25.4
Defined complications					
	Cardiac	8.3	4.8 to 13.2	9.4	6.0 to 13.9
	Respiratory	16.7	11.7 to 22.7	14.2	10.0 to 19.3
	Renal failure	12.0	7.7 to 17.4	14.6	10.3 to 19.8
	None of predefined	56.8	49.4 to 63.9	58.8	52.2 to 65.2
Return to theatre		11.5	7.3 to 16.8	8.2	5.0 to 12.4
Readmission within 30 days		13.4	8.5 to 19.7	11.6	7.4 to 17.0

4.2 Postoperative in-hospital mortality for ruptured AAA repair

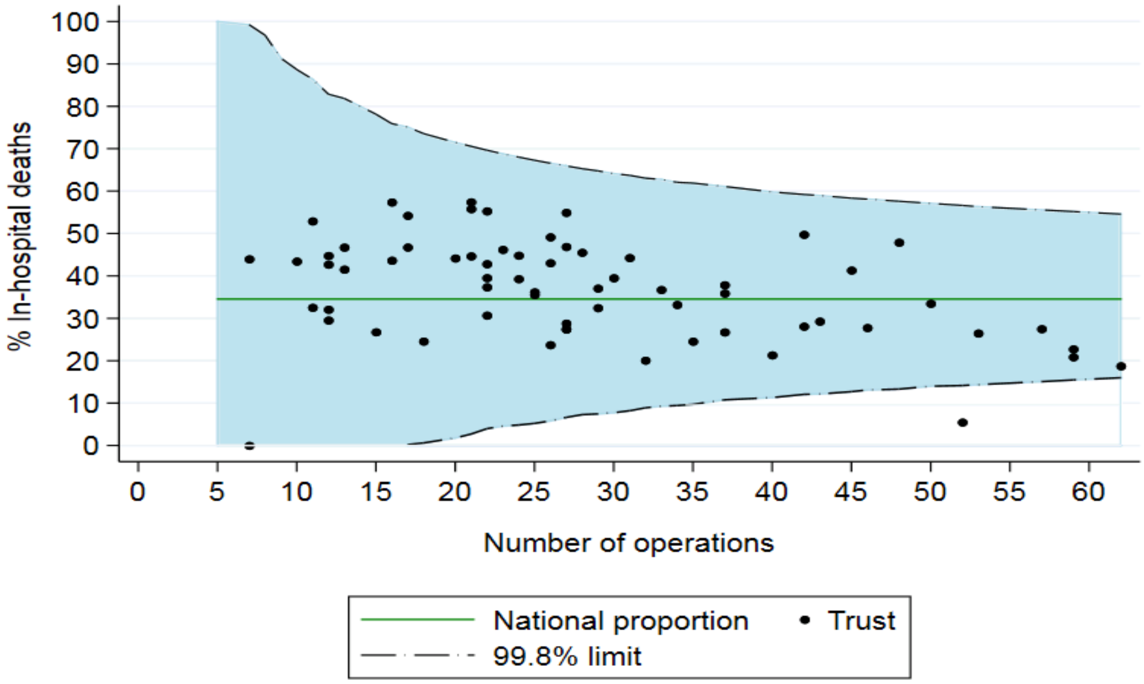
For NHS organisations undertaking repair of a ruptured AAA between 1 January 2018 and 31 December 2020, the risk-adjusted postoperative mortality rates are shown using a funnel plot in Figure 4.3.

All NHS Trusts had a risk-adjusted rate of in-hospital mortality that fell within the expected range around the national average of 34.5%, given the number of procedures performed. There was one NHS Trust that had a mortality rate that was lower than the lower 99.8% control limit. Cases were adjusted for age, sex, ASA grade, COVID-19 admissions, abnormal ECG, serum creatinine, sodium and potassium counts.

The rates among the NHS Trusts typically ranged from 20-60%, which reflects the relatively low volumes used to calculate these rates. The online appendices spreadsheet gives the figures for each NHS Trust*. Vascular units should evaluate how access to endovascular repair can be improved for emergency repair of ruptured aneurysms. This may require:

- network pathways for vascular surgery working in collaboration with interventional radiology and vascular anaesthesia
- 24/7 access to hybrid operating theatres
- developing teams with the required expertise qualified to deliver in and out of hours care including nursing staff and radiographers
- addressing workforce for both vascular surgery and interventional radiology.

Figure 4.3: Risk-adjusted in-hospital mortality for emergency repairs of ruptured AAAs between January 2018 and December 2020 by NHS Trust. The overall mortality rate was 34.5%.



* The online appendices spreadsheet can be found at https://www.vsqip.org.uk/reports/2021-annual-report/

5. Lower limb revascularisation for PAD

5.1 Introduction

This chapter describes the processes and outcomes of care for patients who have a lower limb revascularisation – performed as an endovascular procedure, open bypass procedure or a combination of both (called a hybrid procedure). The NVR has collected data on endovascular and hybrid procedures since 2014, to complement the information collected on lower limb bypass. All are treatment options for patients suffering from peripheral arterial disease.

In this chapter, we report on:

- 15,126 (15,072 in active centres) endovascular procedures,
- 2,421 hybrid procedures, and
- 11,371 bypass procedures

performed between January 2019 and December 2020 that were the index procedure within an admission. In other words, the analysis focuses on the first procedure undergone by a patient during an admission; subsequent procedures are considered to be re-operations.

Case-ascertainment has risen over time for all procedures. Nonetheless, overall data submission for lower limb angioplasty remains comparatively low and there was considerable variation between NHS Trusts (Figure 5.1). The number of submitted cases dropped in 2020 due to the COVID-19 pandemic.

The 2018 GIRFT report on vascular services recommended that case-ascertainment rates for lower limb endovascular procedures should exceed 85% [Horrocks 2018]. NHS hospitals should ensure there are sufficient resources (including administrative support) for vascular services to meet this target level of participation in the NVR.

Table 5.1: Estimated case-ascertainment for lower limb bypass procedures, by year

	2018	2019	2020
NVR procedures	6,148	6,300	5,071
Expected procedures	7,905	7,616	6,323
Estimated case-ascertainment	78%	83%	80%

Table 5.2: Estimated case-ascertainment for lower limb endovascular procedures, by year

	2018	2019	2020
NVR procedures	7,731	8,736	6,390
Expected procedures	17,928	16,851	13,853
Estimated case-ascertainment	43%	52%	46%

Figure 5.1: Number of lower limb angioplasties submitted to the NVR in 2019-2020 by NHS Trust

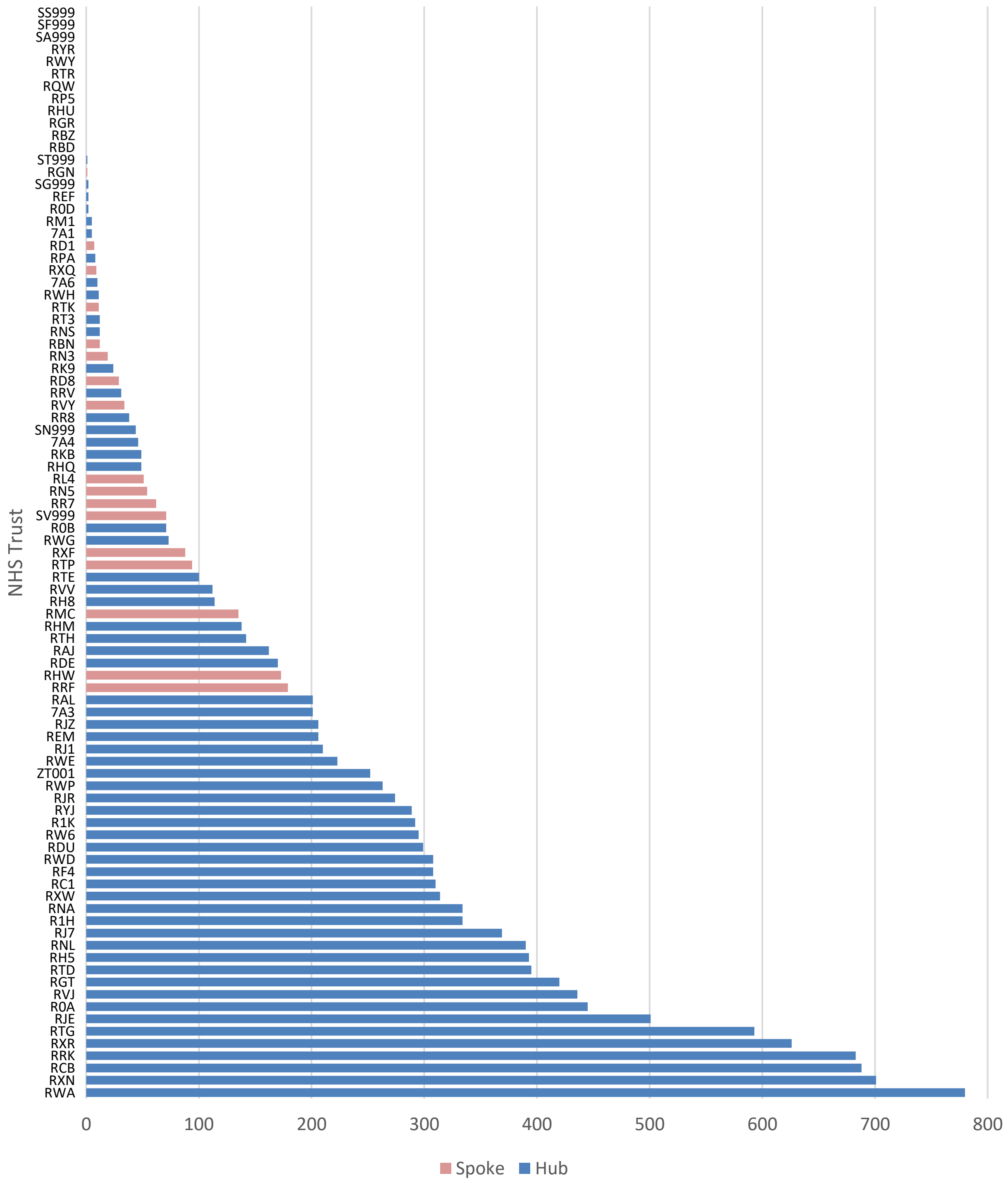
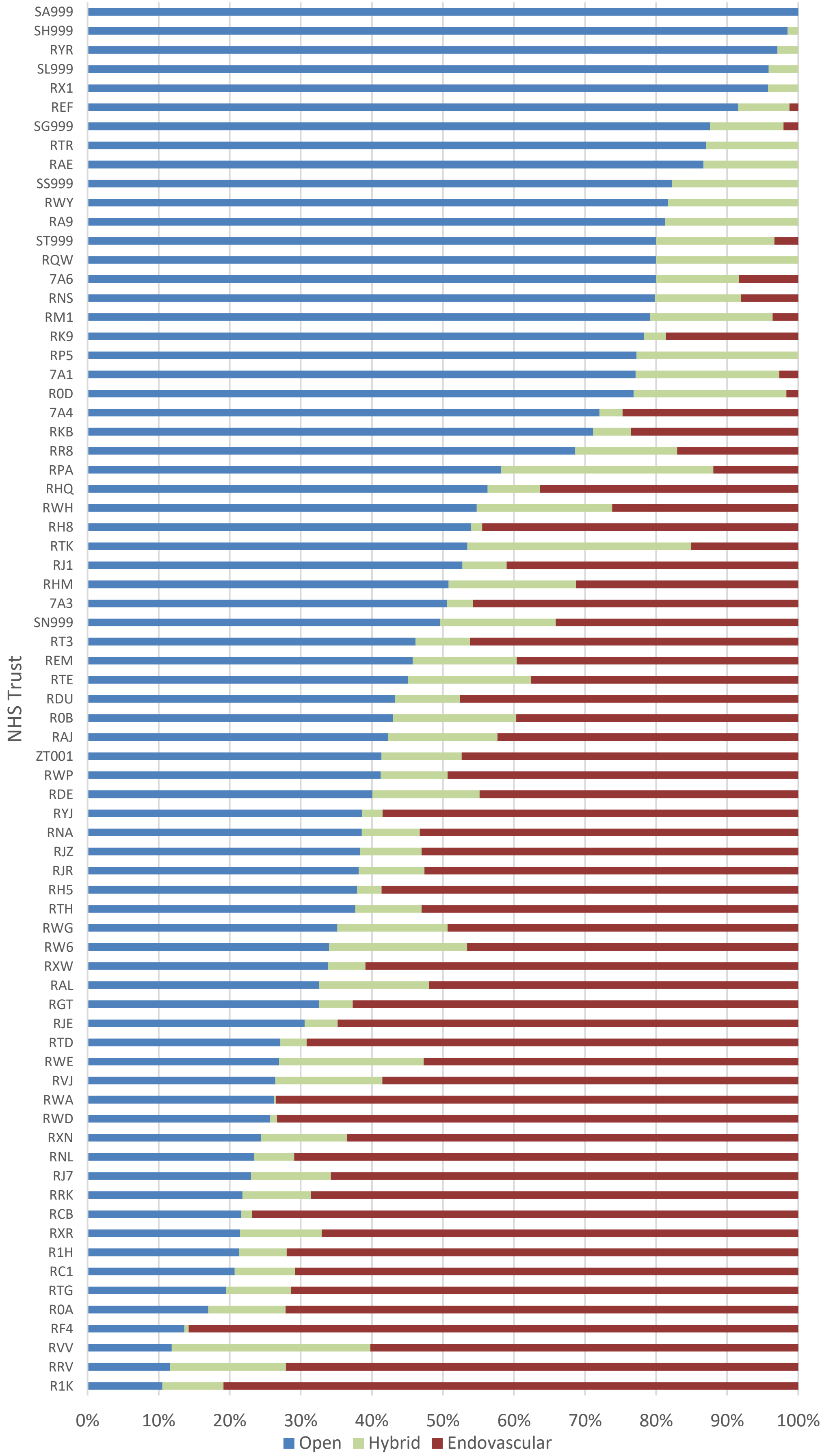


Figure 5.2 Types of revascularisation procedures by NHS Trust for 2019 and 2020



5.2 Patient and procedure characteristics

Most patients (91%) underwent the procedure for chronic limb ischaemia. Of the patients undergoing endovascular revascularisation for chronic ischaemia, in 2019 35% presented with intermittent claudication and 46% with gangrene, whereas in 2020 24% presented with intermittent claudication and 55% with gangrene.

Two-thirds of patients undergoing endovascular procedures were men (68%), and about a quarter of patients were aged 80 years or older (23%). The prevalence of ischaemic heart disease, hypertension and diabetes was high and most patients were on antihypertensive, antiplatelet medication and a statin (see Appendix 3 for details). A third had undergone a previous procedure on the same limb (36%).

Table 5.3: Characteristics of lower limb endovascular procedures undertaken between January 2019 and December 2020 by anatomical location

	Vessels treated		Stent insertion		Stenosis/ aneurysm[1]		Procedure success[2]	
	n	%	n	%	n	%	n	%
Aorta	214	0.9	116	54.2	-	-	-	-
Common iliac	3834	15.4	2,447	63.8	2,761	72.1	3,644	95.1
External iliac	2885	11.6	1,246	43.2	2,226	77.2	2,760	95.7
Superficial femoral	7454	30.0	1,272	17.1	4,261	57.2	6,886	92.4
CFA, PFA	881	3.6	122	13.8	686	77.9	773	87.7
Popliteal	4528	18.2	599	13.2	2,729	60.4	4,142	91.5
Tibial/pedal	4221	17.0	115	2.7	2,171	51.4	3,498	82.9
Within graft	808	3.3	46	5.7	707	87.5	741	91.7

[1] The other indication for intervention was occlusion. 15 vessels and aorta missing lesion codes.
[2] The other outcomes were residual stenosis and failure. 4 vessels and aorta missing outcome codes.

Characteristics of the lower-limb endovascular procedures are summarised in Table 5.3. The procedures involved interventions in 24,825 vessels. There were similar numbers of right (44%) and left-sided (46%) interventions, and 10% of the procedures were bilateral.

Half of the endovascular procedures involved treatment of a single vessel (53%), with 33% treating two, 11% treating 3 and 3% treating 4 or more vessels. The most common site was the superficial femoral artery, followed by the popliteal, tibial/pedal and common iliac arteries (Table 5.3). Balloon angioplasty alone was the most common type of intervention (18,862 vessels, 76%) while 5,963 (24%) were a combination of angioplasty and stenting. The success rate of the procedures (defined as successful by the operator) was high overall, although the rate decreased slightly for anatomical locations further down the leg.

Lower limb revascularisation procedures can be performed via open surgery, endovascular techniques or a combination of both (hybrid). Figure 5.2 depicts the proportion of each type of procedure by NHS Trust, for Trusts that perform all three types. For Trusts that have lower case ascertainment for angioplasty compared to bypass in the NVR, the figure does not depict the true distribution of procedures and should be interpreted with caution.

Table 5.4: Characteristics of lower limb bypass procedures undertaken between January 2019 and December 2020

	Elective procedures (n=6,504)				Non-elective procedures (n=4,867)			
Fontaine score	**2020**	**%**	**2019**	**%**	**2020**	**%**	**2019**	**%**
1 Asymptomatic	16	0.7	22	0.7	16	0.9	16	0.9
2 Intermittent claudication	620	27.6	1,240	37.5	41	2.4	55	3.2
3 Nocturnal &/or resting pain	862	38.4	1,077	32.6	438	25.6	421	24.7
4 Necrosis &/or gangrene	746	33.2	968	29.3	1,216	71.1	1,212	71.1

VSGBI: PAD QIF

Trusts should aim to perform at least 75% of lower limb revascularisations on planned operating lists.

Among the index endovascular procedures, in 2019 2,537 (29.2%) were non-elective and 6,148 (70.8%) were elective, while in 2020 the proportion of non-elective procedures increased (4,220 [66.1%] and 2,167 [33.9%] respectively). Overall, 97.1% (n=8,429) of the endovascular revascularisations in 2019 and 97.3% (n=6,216) in 2020 were recorded as being performed between 8am and 6pm, which were taken as indicating they had been on planned operating lists.

The percentage of procedures performed between 8am and 6pm was more than 83% for all NHS Trusts that submitted more than 10 procedures in the NVR, suggesting that most Trusts met the QIF target during the 2019-20 audit period.

There were 3,862 (61.3%) elective bypass procedures in 2019 and 2,642 (52.1%) in 2020, which is a drop of over 30%. This included a reduction of around 600 procedures for patients with intermittent claudication (Table 5.4). For non-electives, there were 2,438 (38.7%) in 2019 and 2,429 (47.9%) procedures in 2020.

There were 11,000 (96.7%) bypasses undertaken in 2019 and 2020 that were performed between 8am and 6pm. This was 99.4% for elective procedures in 2019 and 99.0% in 2020. For non-electives it was 93.3% and 93.5% respectively.

Most endovascular procedures (90.5%) were performed under local anaesthetic, 1.9% under regional and 7.6% under general anaesthetic. For bypasses, 86.9% were under general anaesthetic and 8.7% had some local infiltration.

VSGBI: PAD QIF

Patients admitted non-electively with chronic limb-threatening ischaemia (CLTI) should have a revascularisation procedure within five days.

Endovascular

There were 8,949 (65.3%) patients presenting with CLTI, 3,798 of whom were admitted non-electively, that underwent endovascular revascularisation during the 2019-20 audit period (2,022 in 2019 vs 1,776 in 2020). Among the non-elective patients, in 2019 51.8% were revascularised within 5 days and the median time from admission to intervention was 5 days (IQR: 2-9 days).

In 2020 there was an improvement in endovascular revascularisation times for patients with CLTI admitted non-electively, with 57.8% of these patients revascularised within 5 days and the median time from admission to intervention was 4 days (IQR: 2-8 days). This indicates that patients being admitted with CLTI during the COVID-19 pandemic may have been better served that other vascular patients.

Figure 5.4 depicts the percentage of non-elective endovascular procedures for CLTI performed within 5 days in 2019 and 2020 for the 30 active NHS Trusts with at least 10 non-elective CLTI cases each year. The figure shows considerable variation between NHS Trusts in proportion of patients with timely revascularisation for the 2019-20 audit period.

Bypass

There were 3,283 patients admitted non-electively with CLTI that underwent open revascularisation during the 2019-20 audit period (1,632 in 2019 vs 1,651 in 2020 indicating that COVID-19 had less of an impact on non-elective admissions). Among these, in 2019 47% were revascularised within 5 days and the median time from admission to intervention was 6 days (IQR: 3-9 days). In 2020 there was a significant improvement in open revascularisation times, with 58.8% of these patients revascularised within 5 days and median time from admission to intervention of 4 days (IQR: 2-8 days).

Figure 5.5 summarises the proportion of non-elective patients with CLTI undergoing bypass within 5 days from admission in 2019 and 2020.

All revascularisation procedures

Overall, 7,203 patients were admitted non-electively with CLTI and underwent revascularisation during the 2019-20 audit period (3,705 in 2019 vs 3,498 in 2020). The proportion of patients revascularised within 5 days from admission was 50% for 2019 and 58.4% for 2020. The median time from admission to intervention was 6 days (IQR: 2-9 days) in 2019 and 4 days (IQR: 2-8) in 2020. This suggests that NHS Trusts have begun to successfully implement the PAD QIF. Figure 5.3 depicts the proportion of patients revascularised within 5 days from admission for 2019 (hollow circle) and 2020 (solid green circle) across 59 NHS Trusts that performed 10 or more revascularisation procedures for non-elective CLTI admissions each year.

Figure 5.3: Proportion of non-elective patients with CLTI who had revascularisation (open, endovascular or hybrid) within 5 days from admission by active NHS Trust with a volume of ≥10 non-elective CLTI cases per year in 2019 (hollow circle) and 2020 (solid green circle). The early adopter centres of the Peripheral Arterial Disease Quality Improvement Programme are depicted with hollow square for 2019 and solid blue square for 2020.

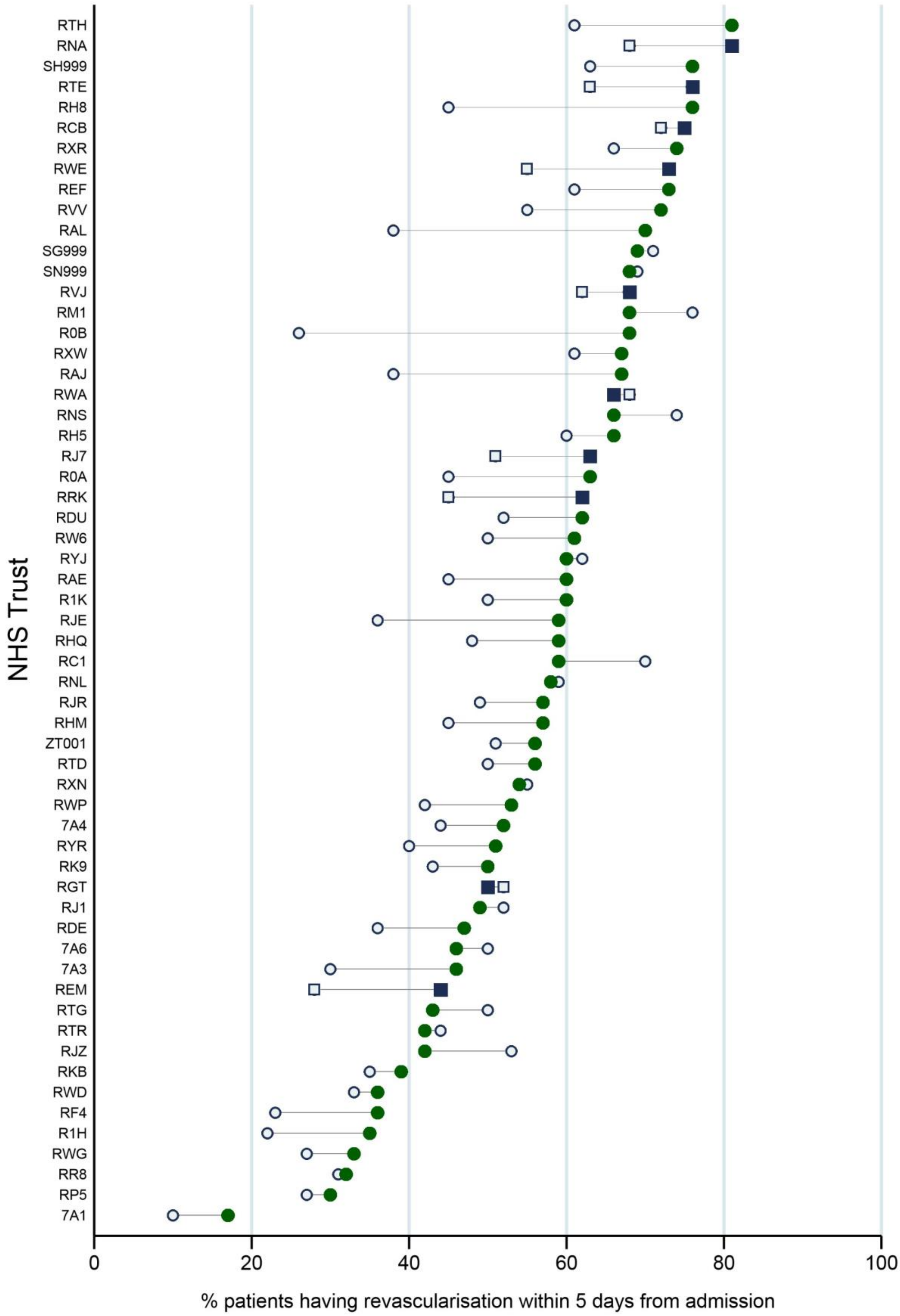


Figure 5.4: Proportion of non-elective patients with CLTI who had endovascular revascularisation within 5 days from admission by active NHS Trust with a volume of ≥10 non-elective CLTI cases per year in 2019 (hollow circle) and 2020 (solid green circle). The early adopter centres of the Peripheral Arterial Disease Quality Improvement Programme are depicted with hollow square for 2019 and solid blue square for 2020.

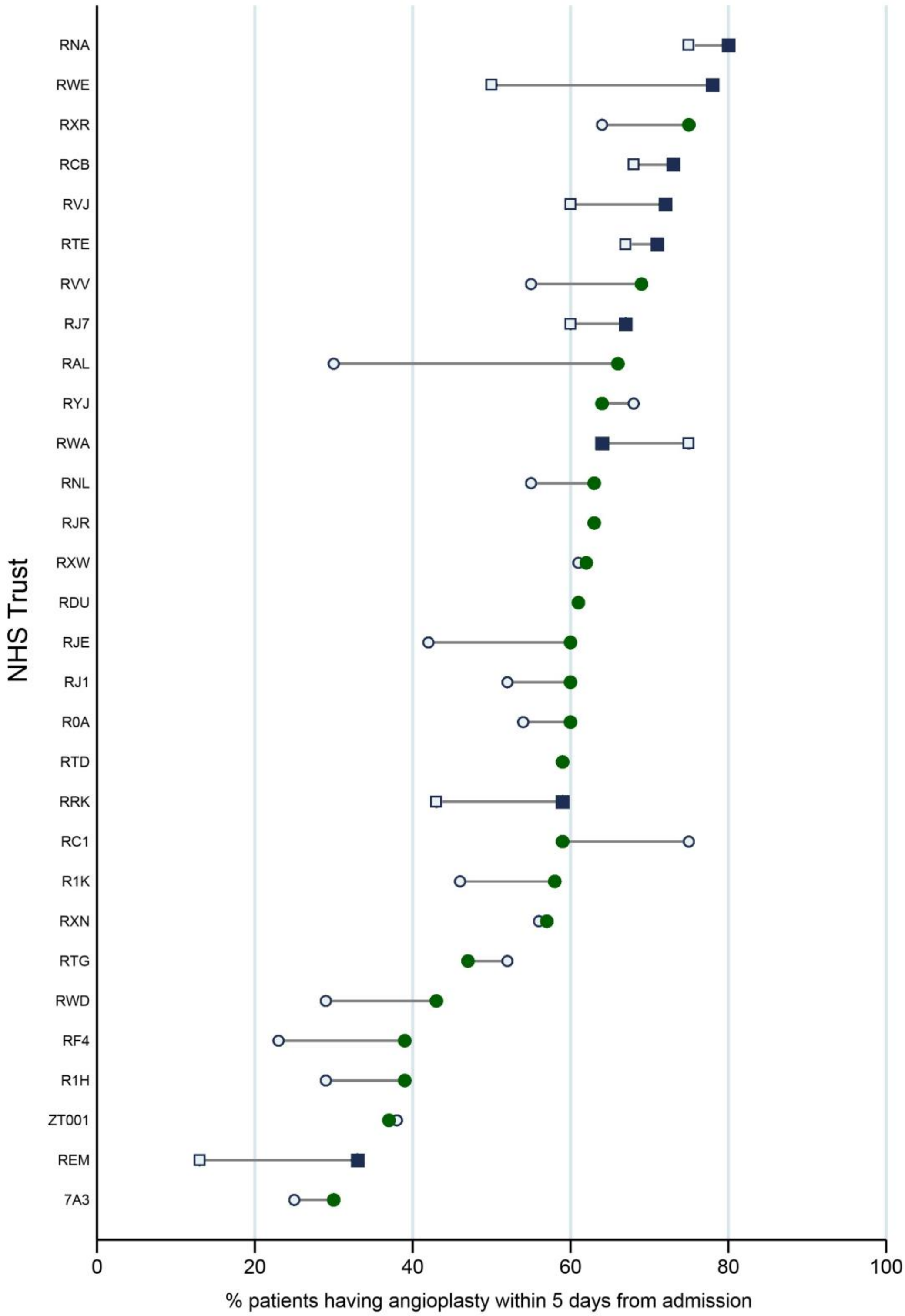
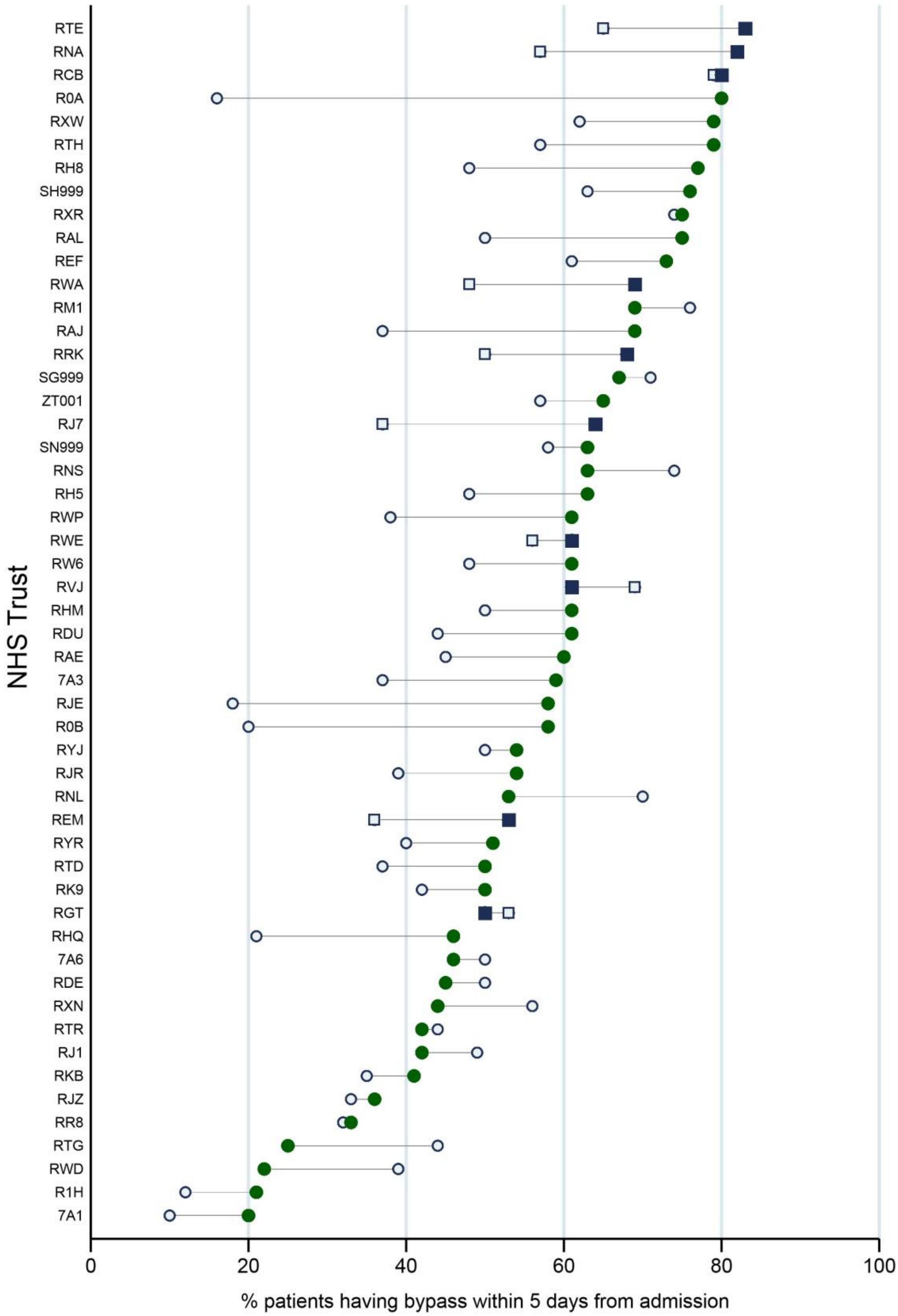
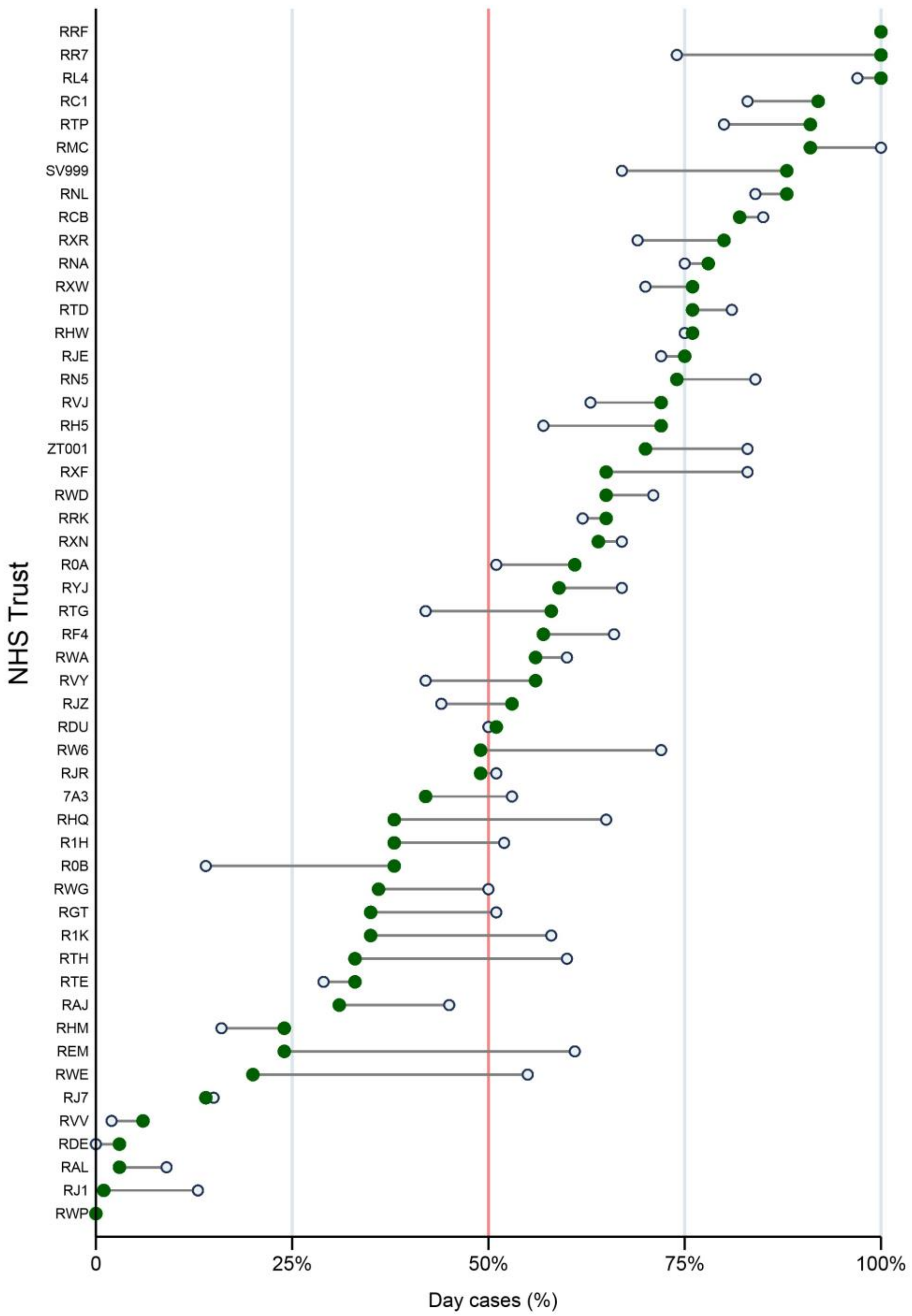


Figure 5.5: Proportion of non-elective patients with CLTI who had surgical revascularisation within 5 days from admission by active NHS Trust with a volume of ≥10 non-elective CLTI cases per year in 2019 (hollow circle) and 2020 (solid green circle). The early adopter centres of the Peripheral Arterial Disease Quality Improvement Programme are depicted with hollow square for 2019 and solid blue square for 2020.



The 2018 GIRFT report on vascular services emphasised the potential gains in efficiency that could stem from a greater number of endovascular revascularisation procedures being performed on a same-day basis [Horrocks 2018]. The NVR data for the audit period 2019-20 reveal wide variation in the proportion of elective procedures done as day cases (Figure 5.6), with some units experiencing a decrease in the proportion of day case procedures in 2020 compared to 2019. Overall, 60.2% of elective endovascular procedures were performed as day-cases in 2019 compared to 57.8% in 2020. While the low levels of case-ascertainment limit the interpretation of these figures, they may indicate loss of day-case beds due to the COVID-19 pandemic, and highlight the importance of day-case facilities or ring-fenced beds for interventional radiology revascularisation procedures

Figure 5.6: Proportion of elective endovascular procedures performed as day cases, by active NHS Trust with a volume of ≥10 elective cases per year in 2019 (hollow circle) and 2020 (green).



5.3 Outcomes of lower limb revascularisation procedures

Tables 5.5a and 5.5b describe specific outcomes for lower limb endovascular and bypass procedures, by mode of admission. As expected, patients undergoing procedures as non-elective admissions generally had worse outcomes than those undergoing elective procedures. Patients undergoing endovascular procedures for acute limb ischaemia also had worse outcomes than CLTI, with an in-hospital mortality rate of 1.0 (95%CI 0.4-2.1) for elective and 6.1 (95%CI 4.3-8.4) for non-elective admissions.

We report the 30-day major amputation rate for the first time in the 2021 Annual Report. This is calculated using data on any major amputations with a procedure date within 30 days of the revascularisation procedure (either within the same admission or in a subsequent admission).

Table 5.5a: Postoperative outcomes after lower limb revascularisation, by year of procedure for elective admissions

	Endovascular		**Bypass**	
	2020	**2019**	**2020**	**2019**
Elective				
Total Procedures	4,221	6,188	2,642	3,862
Post-op destination				
Ward	1931 (45.7%)	2659 (43%)	1922 (72.7%)	2755 (71.4%)
Level 2 (HDU/PACU)	51 (1.2%)	106 (1.7%)	594 (22.5%)	885 (22.9%)
Level 3 (ICU)	8 (0.2%)	9 (0.1%)	126 (4.8%)	221 (5.7%)
Died in theatre	<5 (<0.1%)	<5 (<0.1%)	0.0%	0.0%
Day-case unit	2231 (52.9%)	3414 (55.2%)	0.0%	0.0%
Defined complications	**Rate**	**Rate**	**Rate**	**Rate**
None	94.4	94.9	81.5	82.2
Cardiac	0.4	0.2	2.2	2.2
Respiratory	0.3	0.2	2.9	2.8
Limb ischaemia	0.6	0.4	3.4	3.1
Renal failure	0.1	0.2	1.1	1.3
Further unplanned procedures				
None	96.2	96.4	91.9	93.1
Angioplasty/stent	1.2	1.0	1.1	0.9
Bypass	0.4	0.5	2.0	1.2
Minor amputation	1.0	0.7	1.6	0.9
Major amputation	0.5	0.4	1.1	1.0
30-day major amputation	1.2	1.1	1.3	1.4
In-hospital mortality	0.8	0.5	1.6	1.1
Re-admission to higher level care	0.5	0.8	1.6	2.0
Re-admission within 30 days	8.8	6.7	10.7	10.4
	Median (IQR)	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Overall length of stay (days)	0 (0 - 1)	0 (0 - 1)	5 (3 - 8)	5 (3 - 8)
Admission-to-procedure (days)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	0 (0 - 1)
Post-op length of stay (days)	0 (0 - 1)	0 (0 - 1)	4 (3 - 7)	5 (3 - 7)

Table 5.5b: Postoperative outcomes after lower limb revascularisation, by year of procedure for non-elective admissions

	Endovascular		Bypass	
	2020	**2019**	**2020**	**2019**
Non-elective				
Total Procedures	2,169	2,548	2,429	2,438
Post-op destination				
Ward	2011 (92.7%)	2364 (92.8%)	1729 (71.2%)	1640 (67.3%)
Level 2 (HDU/PACU)	70 (3.2%)	88 (3.5%)	526 (21.7%)	578 (23.7%)
Level 3 (ICU)	25 (1.2%)	22 (0.9%)	173 (7.1%)	215 (8.8%)
Died in theatre	<5 (<0.1%)	<5 (<0.1%)	<5 (0.0%)	<5 (0.1%)
Day-case unit	63 (2.9%)	73 (2.9%)	0.0%	0.0%
Defined complications	**Rate**	**Rate**	**Rate**	**Rate**
None	84.1	86.7	69.4	71.1
Cardiac	1.4	1.3	3.8	4.8
Respiratory	3.0	2.4	5.6	4.6
Limb ischaemia	4.6	2.7	8.6	9.3
Renal failure	1.1	1.2	2.1	2.5
Further unplanned procedures				
None	83.2	82.9	81.5	80.0
Angioplasty/stent	3.5	3.1	1.4	1.6
Bypass	1.8	2.3	2.7	2.8
Minor amputation	6.0	6.6	4.0	5.1
Major amputation	5.0	4.4	6.0	6.6
30-day major amputation	9.5	7.4	7.5	7.5
In-hospital mortality	4.8	4.4	4.9	4.4
Re-admission to higher level care	2.6	2.4	2.8	3.4
Re-admission within 30 days	17.5	17.6	13.7	14.6
	Median (IQR)	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Overall length of stay (days)	11 (6 - 22)	12 (6 - 25)	13 (8 - 22)	16 (9 - 26)
Admission-to-procedure (days)	4 (2 - 8)	5 (2 - 8)	3 (1 - 7)	4 (1 - 8)
Post-op length of stay (days)	5 (1 - 13)	5 (2 - 15)	8 (4 - 15)	9 (5 - 18)

Thus, the 30-day major amputation metric gives a more complete description of the risk of major amputation. This is most clearly demonstrated in Table 5.5b; for patients who had an endovascular revascularisation in 2020, the rate of unplanned major amputation within a single admission was 5.0%; the rate of 30-day major amputation after revascularisation was 9.5%.

The analysis also highlighted that some subsequent major amputations performed within the same admission were being entered as separate records and were not linked to the initial revascularisation. Vascular units should ensure that the further unplanned lower limb procedure question is entered accurately.

Hybrid revascularisation procedures (where there is an open surgical procedure carried out in conjunction with an endovascular procedure) were investigated and their outcomes are presented in table 5.6 by mode of admission. These were further split into whether the endovascular element was proximal (above) or distal (below) to the surgical element. There were 1,530 hybrid procedures with proximal angioplasties (1,011 elective, 519 non-elective) and 411 hybrid procedures with distal angioplasties (250 elective, 161 non-elective) in the 2019-2020 audit period, while the rest were not possible to categorise. Hybrid procedures with proximal and distal angioplasties had similar mortality rates for elective (1.4% vs 1.6%) and non-elective (5% for both) procedures. The rate of any complication was 15.9% for proximal and 12.4% for distal elective cases and 25.4% for proximal and 26.1% for distal non-elective cases. The rates of unplanned procedures after proximal and distal angioplasties were also comparable for both elective (7.3 vs 7.2%) and non-elective procedures (17.5 vs 19.9%).

Table 5.6: Outcomes of hybrid revascularisation procedures

	Elective		Non-elective	
	2020	**2019**	**2020**	**2019**
Total Procedures	682	851	464	424
Post-op destination				
Ward	75.8%	77.4%	71.8%	69.1%
Level 2 (HDU/PACU)	21.0%	18.2%	21.3%	21.2%
Level 3 (ICU)	2.3%	3.1%	6.3%	9.7%
Died in theatre	0.0%	0.0%	0.0%	0.0%
Day-case unit	0.9%	1.3%	<0.1%	0.0%
Defined complications	**Rate**	**Rate**	**Rate**	**Rate**
None	84.6	85.4	75.0	73.3
Cardiac	1.9	2.7	3.7	5.4
Respiratory	1.9	1.8	5.2	3.5
Limb ischaemia	2.6	2.7	5.0	8.5
Renal failure	0.4	1.1	2.6	2.6
Further unplanned procedures				
None	92.1	93.2	82.5	81.4
Angioplasty/stent	2.1	2.2	2.8	1.7
Bypass	2.2	1.6	3.4	4.5
Minor amputation	1.2	1.1	2.8	4.7
Major amputation	1.2	0.5	5.2	6.1
30-day major amputation	1.2	0.9	4.7	7.1
In-hospital mortality	2.2	1.1	4.5	5.4
Re-admission to higher level care	1.9	1.6	2.8	4.5
Re-admission within 30 days	9.5	10.7	14.7	17.2
	Median (IQR)	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Overall length of stay (days)	4 (2 - 7)	4 (2 - 7)	12 (7 - 22)	14 (8 - 24.5)
Admission-to-procedure (days)	0 (0 - 1)	0 (0 - 0)	3.5 (1 - 7)	5 (2 - 8)
Post-op length of stay (days)	3 (2 - 6)	3 (2 - 6)	7 (3 - 15)	7 (4 - 16.5)

Table 5.7: Postoperative outcomes following endovascular lower limb revascularisation, for patients with CLTI undergoing non-elective revascularisation[1], by admission-to-procedure time in days

Endovascular	**Admission-to-procedure ≤5 days**		**Admission-to-procedure >5 days**	
	2020	**2019**	**2020**	**2019**
Procedures	1,026 (58.2%)	1,048 (52.2%)	738 (41.8%)	961 (47.8%)
	Median (IQR)	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Overall length of stay (LOS)	7 (3 - 15)	7 (4 - 15)	20 (12 - 31)	20 (13 - 36)
Post-op LOS	4 (1 - 12)	4 (1 - 13)	7 (2 - 16)	8 (3 - 21)
Complications	**Rate**	**Rate**	**Rate**	**Rate**
None	87.0	89.4	80.8	84.0
Cardiac	1.0	1.0	1.8	1.7
Respiratory	2.4	1.0	3.7	3.9
Limb ischaemia	3.7	2.0	4.2	3.3
Renal	0.5	1.0	1.6	1.7
Haematoma	1.4	1.7	0.7	1.5
Distal embolus	1.3	1.2	0.7	1.1
Further unplanned procedures				
None	83.0	84.5	83.9	80.6
Angioplasty/stent	3.1	2.9	3.1	3.9
Bypass	1.9	2.1	1.1	2.2
Minor amputation	5.8	7.0	8.3	7.9
Major amputation	5.7	3.5	3.3	4.8
In-hospital mortality	3.0	3.3	6.5	5.0
Re-admission to higher level care	2.8	1.6	2.7	2.7
Re-admission within 30 days	17.7	16.3	17.9	20.5

[1] Fontaine score 3 or 4

Table 5.8: Postoperative outcomes following lower limb bypasses, for patients with CLTI undergoing non-elective revascularisation[1], by admission-to-procedure time in days

Bypass	**Admission-to-procedure ≤5 days**		**Admission-to-procedure >5 days**	
	2020	**2019**	**2020**	**2019**
Procedures	970	767	681	865
	Median IQR	**Median IQR**	**Median IQR**	**Median IQR**
Days in critical care				
Level 2	1(1-3)	2(1-3)	2(0-3)	1.5 (0-3)
Level 3	2(1-4)	2(1-3)	3(2-6)	2(1-3)
Overall LOS	9(6-15)	11 (7-18)	21(14-33)	22(16-35)
Post-op LOS	7(4-12)	8 (5-16)	10(6-21)	10(6-20)
	Rate	**Rate**	**Rate**	**Rate**
In-hospital mortality	3.3	2.9	6.6	4.3
No predefined complication	75.4	76.6	64.2	70.9
Cardiac	2.8	4.4	4.8	5.3
Respiratory	4.4	3.3	6.9	4.6
Limb ischaemia	6.4	7.2	8.4	8.1
Renal	1.5	1.4	1.9	2.8
Haematoma	1.0	1.7	2.1	2.0
Unplanned lower limb procedure				
None	84.7	80.8	79.0	80.1
Angioplasty/stent	1.1	1.4	2.6	2.4
Bypass	2.6	2.7	2.5	2.2
Minor amputation	4.4	7.2	5.7	5.9
Major amputation	4.1	5.2	5.9	5.7
Re-admission to higher level care	1.9	3.0	3.4	2.9
Re-admission within 30 days	13.7	15.1	13.5	14.9

[1] Fontaine score 3 or 4

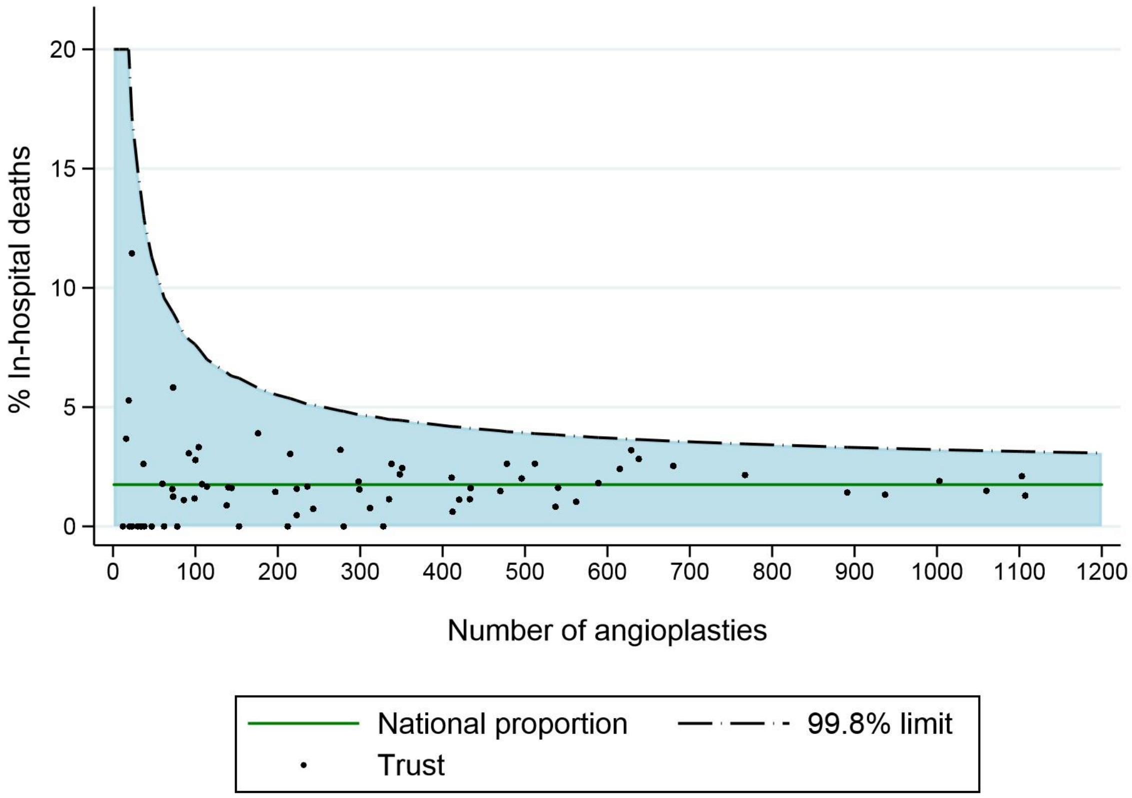
5.4 Risk-adjusted in-hospital deaths

The risk-adjusted mortality rates for each NHS Trust that performed an adequate number of endovascular revascularisations between January 2018 and December 2020 are shown in Figure 5.7. This was defined as the NHS Trusts having more than 10 procedures. All NHS Trusts had a risk-adjusted rate of postoperative in-hospital mortality that fell within the expected range of the overall national average of 1.8% (95% CI: 1.6 to 1.9).

The rates of in-hospital mortality after endovascular revascularisation were adjusted to take account of the differences in patient populations within each organisation. The model included admission mode, presenting problem, Fontaine score, patient age, chronic lung disease, chronic renal disease, chronic heart failure, smoking status and national COVID admission rates.

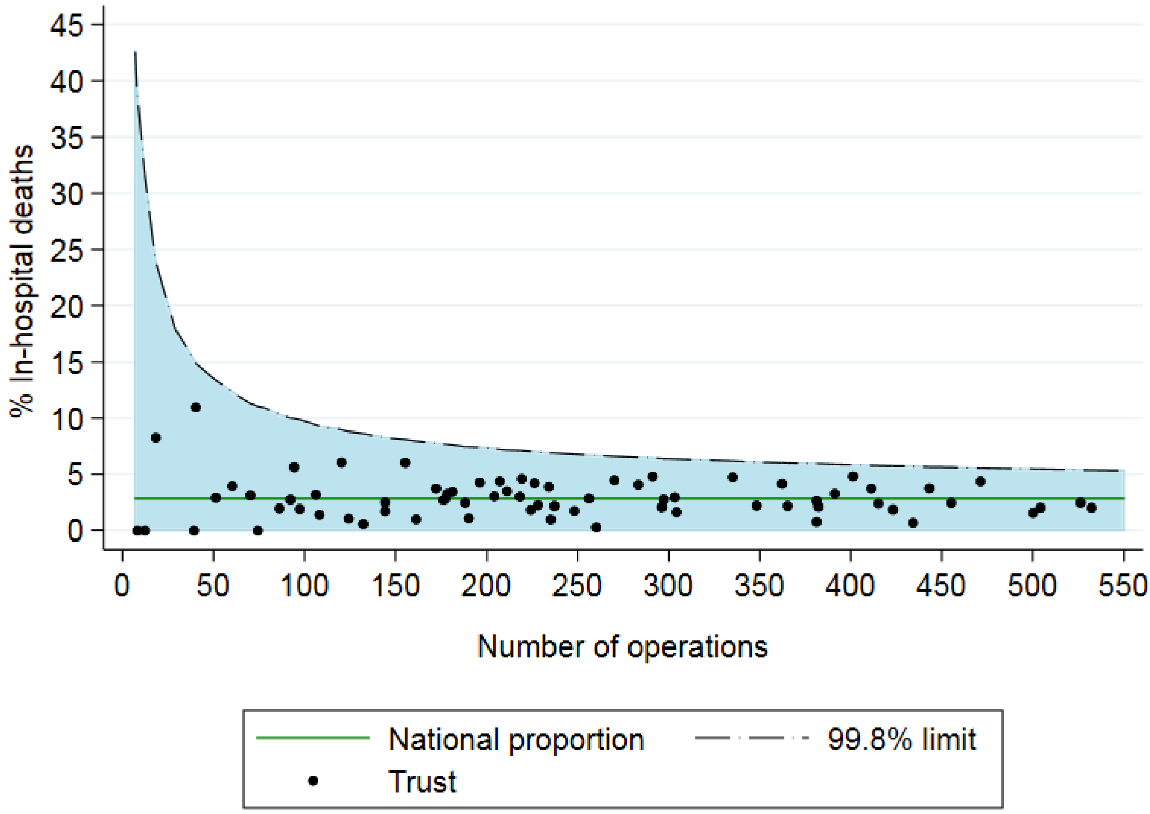
For bypasses (Figure 5.8), all NHS Trusts were within the expected range of 2.8% (95% CI: 2.6 to 3.1). The risk adjustment model accounted for age, sex, procedure type, ASA grade, Fontaine score, mode of admission, COVID admission rates, renal disease and chronic lung disease.

Figure 5.7: Funnel plot of risk-adjusted in-hospital deaths after lower limb endovascular revascularisation for NHS Trusts between January 2018 and December 2020.



Note: This figure is based on data from NHS Trusts that continue to offer endovacsular revascularisation, with more than 10 procedures in the NVR.

Figure 5.8: Funnel plot of risk-adjusted in-hospital deaths from lower limb bypass for NHS Trusts, shown for procedures performed between January 2018 and December 2020.



6. Major lower limb amputation

6.1 Introduction

This chapter describes the patterns of care and outcomes for patients undergoing unilateral major lower limb amputations due to vascular disease during the audit period from January 2019 to December 2020.

During this period, 6,429 primary major unilateral amputations were recorded in the NVR, which consisted of 3,226 (50.2%) below the knee amputations (BKAs) and 3,203 (49.8%) above the knee amputations (AKAs). Through knee amputations (TKAs) have been analysed as part of the BKA group. TKAs accounted for 3.2% of all major amputations recorded on the NVR during the two-year analysis period.

In addition, NHS hospitals submitted information on 2,033 (21.3%) minor amputations, 114 (1.5%) bilateral amputations, 71 (1.0%) amputations due to trauma and 883 (11.8%) associated with a revascularisation performed within 30 days prior to the amputation. As this chapter focuses on major unilateral lower limb amputations that were primary procedures, these records were not included in the analysis.

There was a slight reduction in major amputations in 2020 compared to 2019, however not to the same levels as seen in other procedures.

Table 6.1: Estimated case-ascertainment for major lower limb vascular amputations by year

Case-ascertainment	2018	2019	2020
Audit procedures	3,641	3,701	3,594
Expected procedures	4,376	4,204	4,141
Estimated case-ascertainment	83%	88%	87%

6.2 Care pathways

Overall, lower limb major amputations undertaken in 2020 shared similar patient and clinical characteristics to those in 2019. Tissue loss was the most common presenting problem for both below knee and above knee procedures (45% and 39%, respectively). More than half of patients had a previous ipsilateral lower limb procedure (63% BKA and 54% AKA). About 80% of patients were non-elective admissions (78% BKA and 84% AKA).

Most patients were male and over 90% of patients had one or more comorbidities – mainly hypertension, diabetes and ischaemic heart disease.

VSGBI: Amputation QIF

All patients undergoing major amputation should be admitted in a timely fashion to a recognised arterial centre with agreed protocols and timeframes for transfer from spoke sites and non-vascular units.

NHS vascular units have to balance the urgency of surgery with the need to optimise the patients' condition before their operation. For patients admitted non-electively for an amputation, the median time from vascular assessment to surgery was 7 days (IQR: 3 to 17 days). For patients undergoing amputations as elective procedures, the median time was 25 days (IQR: 8 to 74 days), probably reflecting the less severe nature of their condition. Overall, the median delay was 8 days (IQR: 3 to 24 days).

Figure 6.1 describes the median and interquartile range (IQR) of time to amputation from vascular assessment for patients admitted non-electively over 2019 and 2020. Patients undergoing major amputation in April 2020 overall had the shortest waiting time.

Figure 6.1: Monthly median and interquartile range (IQR) of time in days from vascular assessment to non-elective amputations between January 2019 and December 2020. Red line indicates the overall median time of 7 days

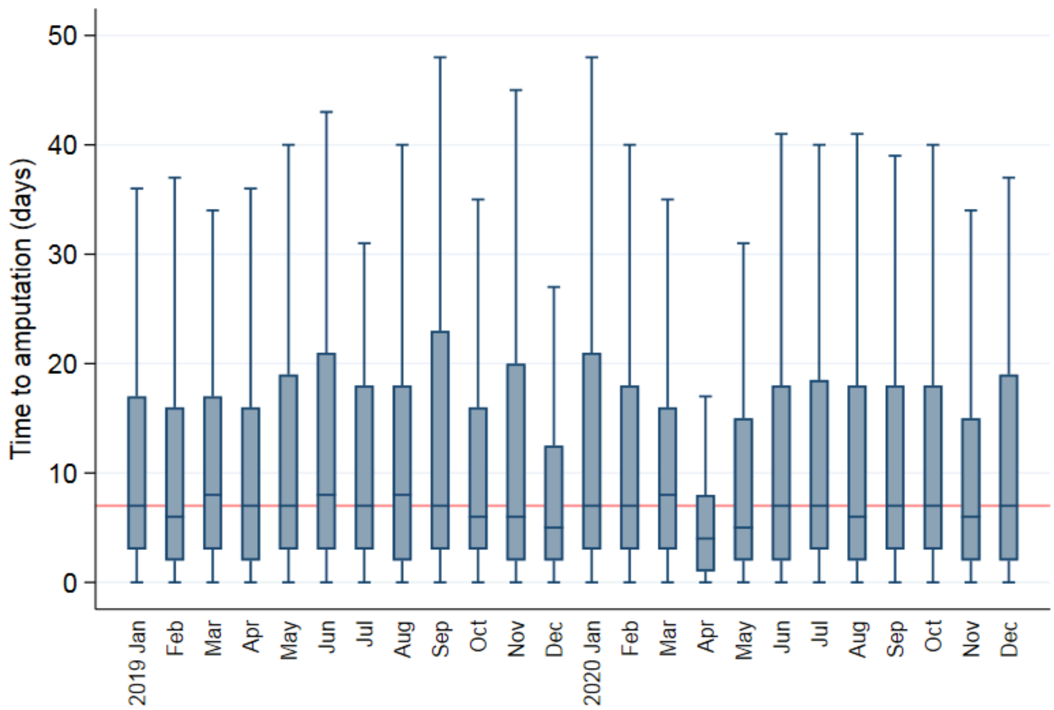


Figure 6.2 describes the times from vascular assessment to amputation by NHS Trust for patients admitted non-electively in 2020 and 2019. The graph shows some variation across the NHS Trusts in the median wait, but among the 25% of patients who have the longest waits, there was considerably greater variation in the delay across NHS Trusts. At 9 NHS Trusts in 2019 and 6 in 2020, more than 25% of patients had a wait that exceeded 30 days. Compared to 2019, there was less variation in the delay across NHS Trusts among the 25% of patients who had the longest waits.

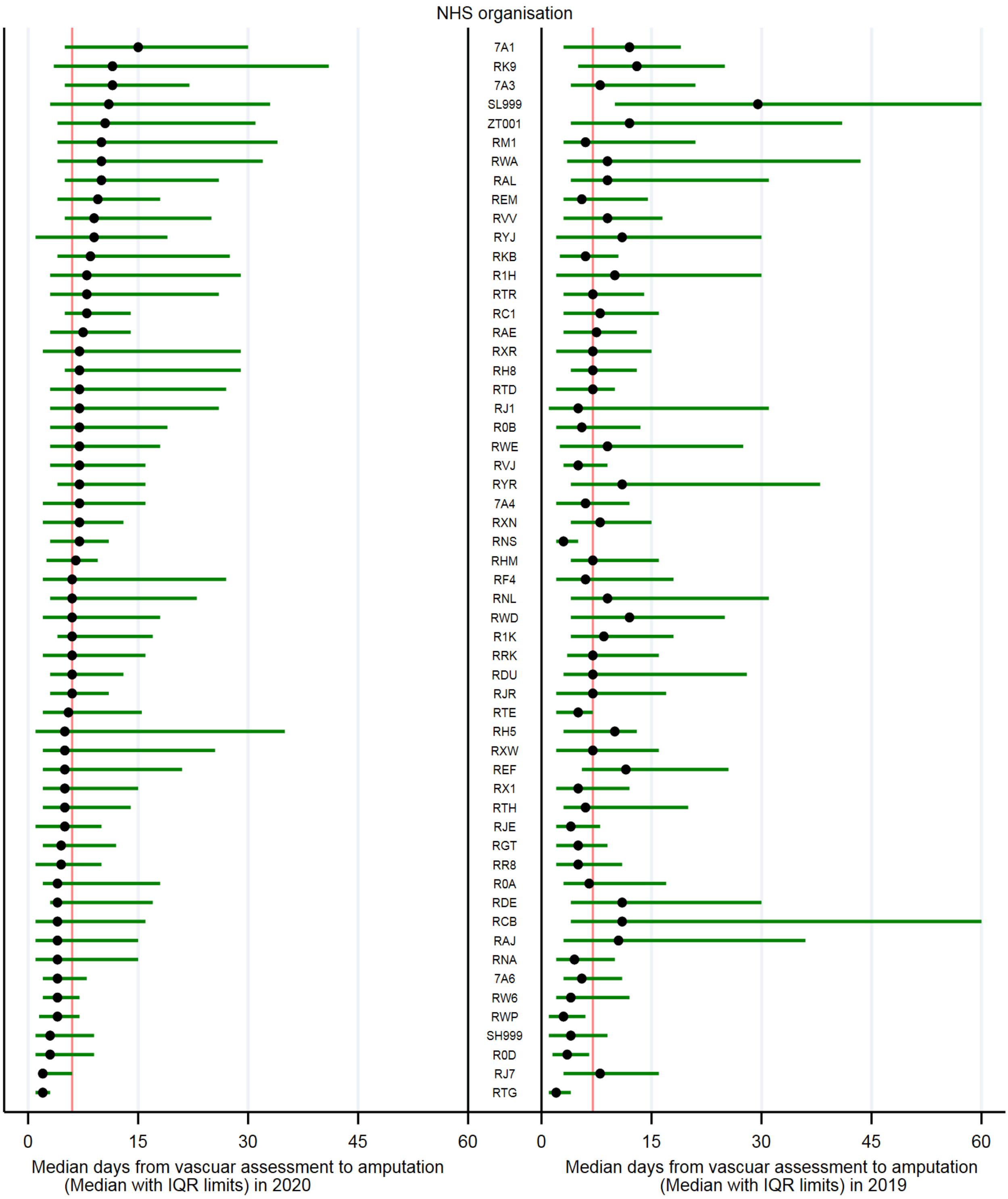
There are various reasons for patients to wait different times for an amputation, such as revascularisation attempts, however this is unlikely to explain the variation in 2019 shown in Figure 6.2. Vascular units should investigate the cause of this and attempt to reduce the longer times as much as possible.

VSGBI: Amputation QIF

Below knee amputation should be undertaken whenever appropriate. Vascular units should aim to have an above knee to below knee ratio below one.

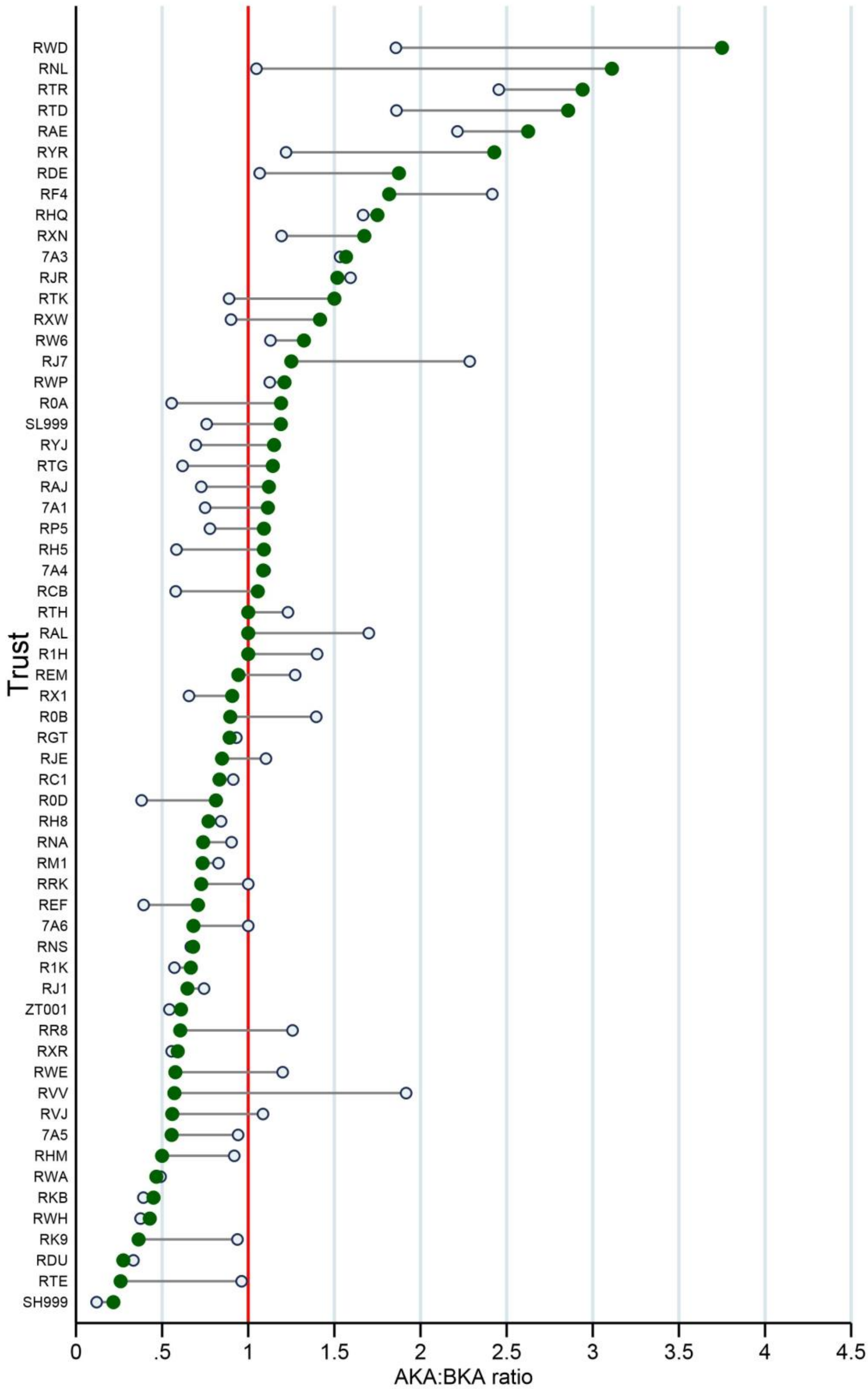
Figure 6.3 describes the movement of AKA:BKA ratio from 2019 to 2020, by NHS Trust. Nationally, the AKA:BKA ratio was 0.98 (95% CI: 0.92 to 1.05) in 2020, and 1.00 (95% CI: 0.94 to 1.07) in 2019. In 2020, half of the NHS Trusts had a ratio of less than one, and 27 had ratios that were above 1.0. Twelve organisations had a ratio of more than 1.5. It is possible that the high ratios relate to some trusts treating more severely ill patients, although it is not possible to confirm this with the data collected in the NVR.

Figure 6.2: Median (IQR) time from vascular assessment to non-elective amputation for procedures undertaken in 2019 and 2020, by NHS Trust[1]. Red lines indicate the overall median times of 6 days and 7 days in 2020 and 2019 respectively



[1]Figure presents NHS Trusts reporting ≥10 non-elective major amputations in both 2020 and 2019.

Figure 6.3: Movement of the ratio of above knee to below knee amputations for procedures undertaken in 2019 (hollow circles) to ratio in 2020 (green circles), by NHS Trust[1]



[1]Figure presents NHS Trusts reporting ≥10 major amputations in both 2019 and 2020.

VSGBI: Amputation QIF and NCEPOD: Recommendations

Major amputations should be undertaken on a planned operating list during normal working hours.
A consultant surgeon should operate or at least be present in the theatre to supervise a senior trainee (ST4 or above) undertaking the amputation.
The patient should have routine antibiotic and DVT prophylaxis according to local policy.

Table 6.2 summarises some key aspects of perioperative care for BKA and AKA patients. Performance against these standards was generally reasonable in 2019 and 2020, but the figures suggest there is potential for improvement:

- over 85% of major amputations (BKAs and AKAs) were performed during the day
- a consultant surgeon was present for just about three-quarters of the procedures. The consultant presence rate was lower in 2020, in particular for above knee procedures.
- prophylactic antibiotics and DVT medication were recorded for just over 60% of patients.

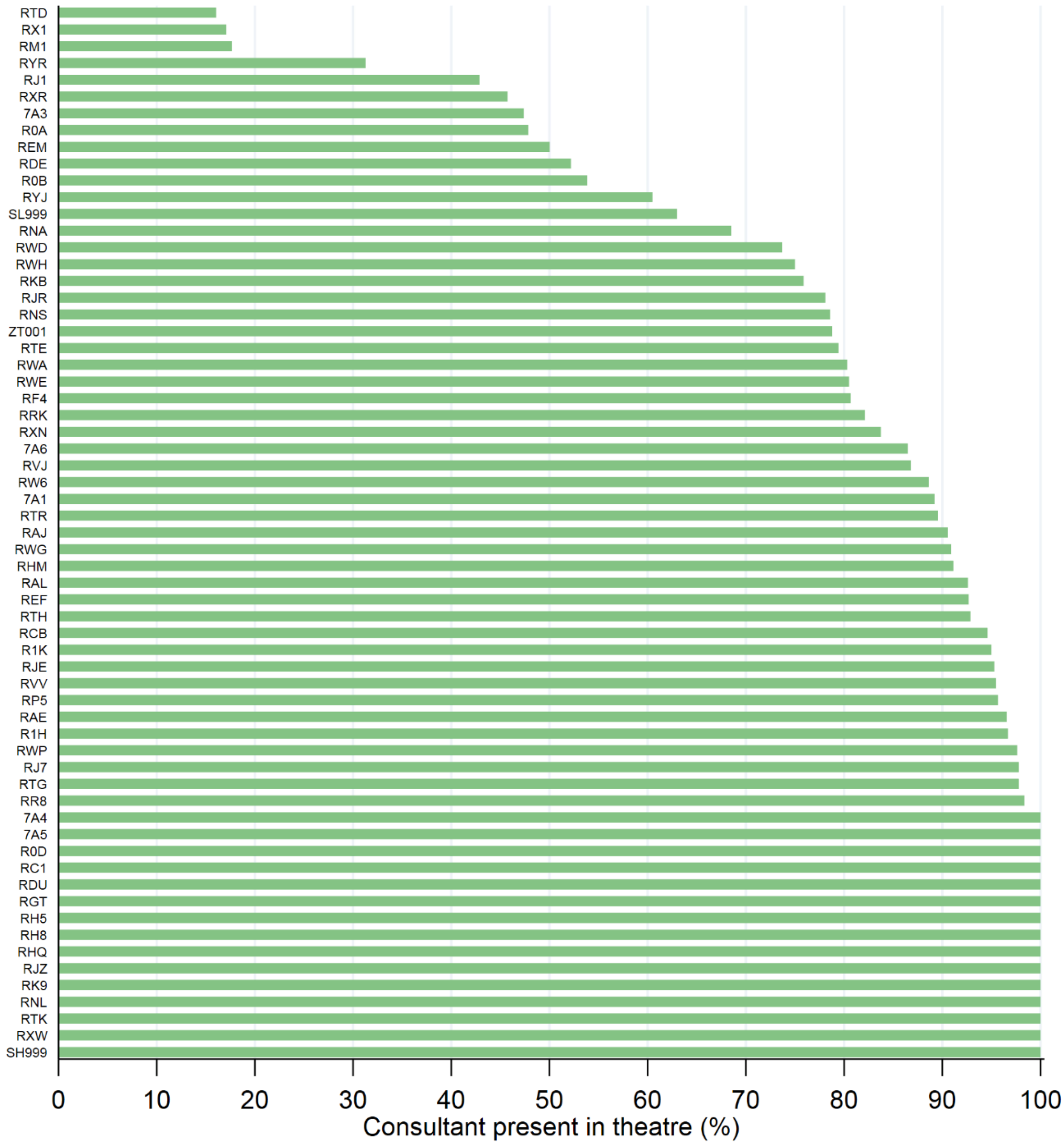
Whilst many NHS Trusts followed the recommendation that a consultant should be present in theatre during the audit period, there is some variation in practice across NHS organisations (Figure 6.4). In particular those trusts that had low rate of consultant presence presented in 2019 had an even lower rate of consultant presence in 2020. Vascular units should investigate the reasons for this variation.

The observed levels of prophylactic antibiotics and DVT medication are low in comparison with expected levels. It appears that these figures reflect data completeness rather than actual clinical practice and we recommend that units ensure this information is submitted to the NVR. The updates made to the NVR datasets in July 2021 should improve the reporting of this in future years.

Table 6.2: Perioperative care of patients undergoing lower limb major amputation between January 2019 and December 2020

	Below knee		Above knee	
	2020	**2019**	**2020**	**2019**
Procedures	1,598	1,628	1,571	1,632
Mode of admission	**%**	**%**	**%**	**%**
Elective	19.8	23.5	15.0	16.5
Non-elective	80.2	76.5	85.0	83.5
Time procedure started				
8am to 6pm	87.2	88.9	85.4	85.2
6pm to midnight	9.9	9.5	11.8	12.4
Midnight to 8am	2.9	1.6	2.8	2.5
Consultant present in theatre	77.3	79.9	73.6	78.9
Prophylactic medication				
Antibiotic prophylaxis	68.5	71.7	68.6	68.3
DVT prophylaxis	66.3	65.0	66.5	64.8

Figure 6.4: Percentage of major amputations where a consultant surgeon was present in theatre in 2020, by NHS Trust[1]



[1]Figure presents NHS Trusts reporting ≥10 lower limb major amputations performed in 2020

6.3 In-hospital outcomes following major amputation

Patient outcomes immediately following major lower limb amputation are summarised in Table 6.3.

The overall median length of hospital stay associated with major lower limb amputations was 19 days (IQR: 11 to 32 days) in 2020, whilst 22 days (IQR: 13 to 37) in 2019. Most patients were returned to the ward following amputation, although approximately 11% of BKA patients and 18% of AKA patients were admitted to critical care (level 2 or level 3) in 2020, compared to 13% and 23% in 2019.

Most patients were discharged alive, but around 6% of BKA patients and 10% of AKA patients died in hospital. Over 25% of patients suffered more than one reported complication following major amputation:

- respiratory problems occurred in 7.9% of BKAs and 11.4% of AKAs for procedures performed in 2020, compared with 6.8% of BKAs and 10.2% of AKAs in 2019
- proportion of cardiac complications were smaller in 2020 than in year 2019, in particular among patients undergoing above knee procedures.
- In 2020, 6.4% had surgical site infection for BKAs, compared with 4.5% in 2019. It was statistically significantly higher in 2020.
- In 2020, 2.5% of BKAs and 3.8% of AKAs resulted in postoperative confusion, which was slightly higher than in 2019 although the increases were not statistically significant.

Rate of return to theatre within the admission was 5.5% for AKA patients undergoing lower limb amputations in 2020, which was statistically significantly lower than that of 7.4% in 2019.

Table 6.3: Patient outcomes following major lower limb amputation, by amputation level

	Below knee		Above knee	
	2020	**2019**	**2020**	**2019**
Procedures	1,598	1,628	1,571	1,632
Post-op destination				
Ward	1,408 (88.4)	1,419 (87.2)	1,288 (82.0)	1,256 (77.0)
Level 2 (HDU/PACU)	127 (8.0)	147 (9.0)	164 (10.4)	240 (14.7)
Level 3 (ICU)	55 (3.5)	61 (3.7)	118 (7.5)	135 (8.3)
	Median (IQR)	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Days in level 2 critical care	2 (1 – 3)	2 (1 - 3)	2 (1 – 4)	2 (1 – 4)
Days in level 3 critical care	4 (2 – 7)	2 (1 – 3)	4 (2 – 6)	4 (2 - 8)
Overall length of stay (days)	20 (12 – 33)	22 (13 – 36)	18 (11 – 30)	22 (13 – 38)
Postoperative length of stay (days)	12 (8 – 22)	14 (9 – 25)	12 (7 – 20)	15 (8 – 27)
	Rate	**Rate**	**Rate**	**Rate**
Overall in-hospital mortality	6.1	5.6	10.7	10.4
30-day in-hospital mortality	4.8	4.2	9.3	8.6
Procedure complications	**Rate**	**Rate**	**Rate**	**Rate**
Respiratory	7.9	6.8	11.4	10.2
Cardiac	3.9	4.5	4.3	6.0
Limb ischaemia	3.1	2.6	2.0	3.6
Renal failure	2.4	2.6	2.9	4.0
Surgical site infection	6.4	4.5	3.9	3.7
Postoperative confusion	2.5	2.0	3.8	3.3
Haemorrhage	0.4	0.6	0.3	0.4
Cerebral	0.4	0.4	0.7	0.8
No defined complications	71.3	74.7	71.9	70.6
Return to theatre	10.7	9.7	5.5	7.4
Re-admission to higher level care	2.3	2.0	2.0	2.2

Outcomes for patients undergoing major amputations, by preoperative length of stay, are summarised in Table 6.4. Over half of the patients (57% in 2019 vs. 61% in 2020) underwent amputation within 5 days of being admitted. In comparison with the results for lower limb bypass and endovascular revascularisation, the differences in outcomes were small between patients with comparatively short and long times from admission to surgery.

Table 6.4: Patient outcomes following major lower limb amputation, by time to surgery

	Admission-to-procedure ≤ 5 days		**Admission-to-procedure >5 days**	
	2020	**2019**	**2020**	**2019**
Procedures	1,936 (61.1)	1,856 (56.9)	1,233 (38.9)	1,404 (43.1)
Days in critical care	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Level 2	2 (1 – 3)	2 (1 – 4)	2 (1 – 4)	2 (1 – 4)
Level 3	4 (2 – 6)	3 (1 – 6)	3.5 (2 – 7)	3 (2 – 7)
Overall length of stay (days)	13 (9 – 22)	15 (10 – 26)	29 (20 – 45)	32 (21 – 50)
Post-op length of stay (days)	11 (7 – 20)	13 (8 – 23)	14 (8 -23)	16 (10 – 28)
	Rate	**Rate**	**Rate**	**Rate**
Overall in-hospital mortality	8.1	7.4	8.8	8.8
30-day in-hospital mortality	6.8	6.1	7.4	6.8
No defined complications	73.0	73.4	69.5	71.7
Return to theatre	8.6	7.9	7.3	9.4
Re-admission to higher level care	2.2	2.3	2.2	1.9

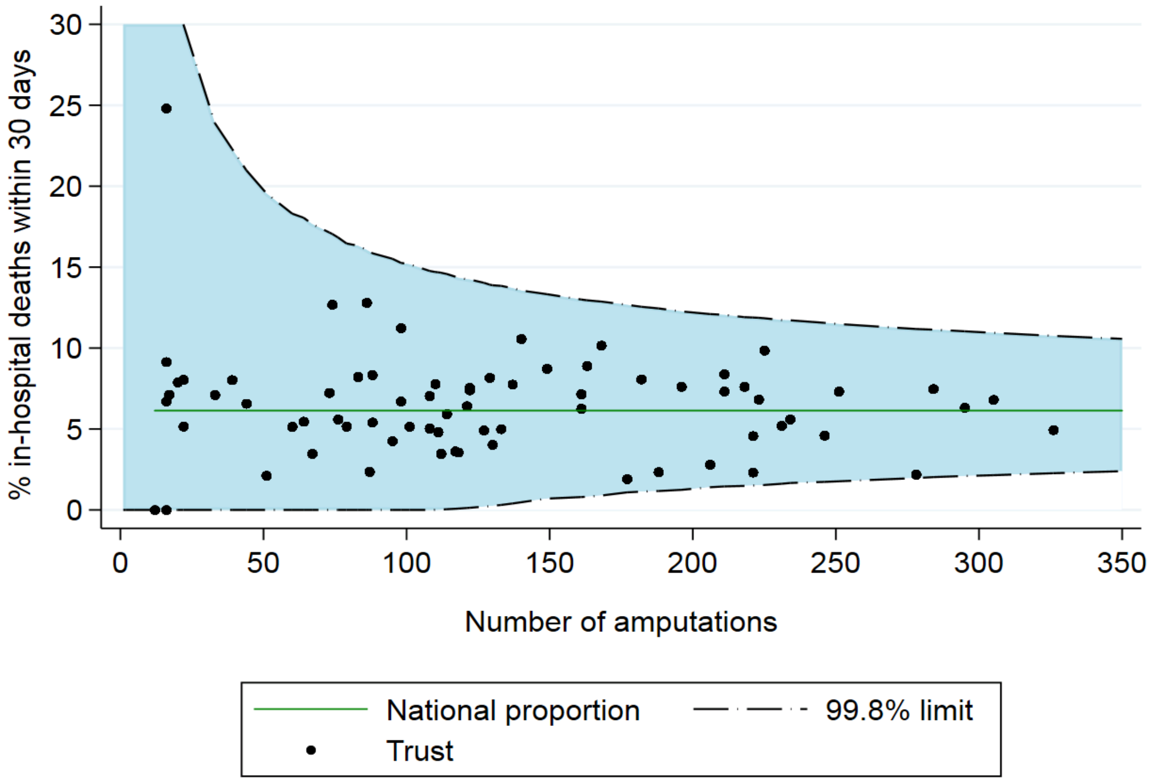
Adjusted 30-day in-hospital mortality figures following major unilateral lower limb amputation for NHS Trusts are shown in Figure 6.5. All NHS Trusts had an adjusted rate that fell within the 99.8% control limits.

For elective cases, the rates were adjusted for age, ASA grade (1-3 vs 4-5), comorbid chronic renal disease, and the daily case number of coronavirus in UK NHS hospitals. For non-elective cases, the rates were further adjusted for level of amputation (below or above the knee).

The overall rate of in-hospital death in 2020 was 8.4% (95% CI: 7.4% to 9.4%), and the 30-day in-hospital mortality was 7.0% (95% CI: 6.2% to 8.0%). This was 8.0% (95% CI: 7.1% to 9.0%) and 6.4% (95% CI: 5.6% to 7.3%), for procedures undertaken in 2019.

Amongst those patients who had unilateral major lower limb amputations undertaken in 2019 and 2020, as well as a revascularisation within 30 days prior to the amputations, the overall rate of in-hospital death in AKA and BKA patients was 8.5% (95% CI: 6.7% to 10.6%), and the 30-day in-hospital mortality was 6.9% (95% CI: 5.3% to 8.8%).

Figure 6.5: Risk-adjusted 30-day in-hospital death rate following major amputation for procedures undertaken during January 2018 and December 2020[1], shown in comparison to the three-year overall national average of 6.1%



[1]Figure presents NHS Trusts reporting ≥10 major lower limb amputations between January 2018 and December 2020.

6.4 Discharge and follow-up

Discharge and follow-up of patients undergoing lower limb amputations, among patients discharged alive, are summarised in Table 6.5. Most patients' wounds had healed by 30 days. Over 80% of patients undergoing BKAs were referred to rehabilitation units or limb fitting centres, compared with 65% and 71% of patients who had undergone AKAs in 2019 and 2020, respectively. Approximately 1 in 10 patients were readmitted to hospital within 30 days of the amputations and after discharge from hospital.

Table 6.5: Discharge and follow-up of patients undergoing lower limb amputations, among patients discharged alive

	Below knee		**Above knee**	
	2020	**2019**	**2020**	**2019**
Alive at discharge	1,451 (93.8)	1,487 (94.6)	1,392 (89.5)	1,449 (89.6)
	%	**%**	**%**	**%**
Wound healed at 30 days[1]	78.6	80.8	89.2	86.0
Referred to rehabilitation/limb fitting[2]	83.0	81.4	71.1	65.4
Re-admission within 30 days[1,2]	10.1	9.8	9.1	10.1

[1]based on patients with available follow-up data; [2]based on patients alive at discharge

7. Carotid Endarterectomy

7.1 Background

In the UK, around 3,000-4,000 patients undergo a carotid endarterectomy (CEA) each year to remove plaque that has built up within the carotid arteries (the main vessels that supply blood to the brain, head and neck). Most procedures are performed in patients who have experienced transient symptoms or a stroke. A minority of procedures are performed in patients found to have reduced blood flow to the brain but who are asymptomatic. A few vascular units also perform carotid stenting but this equates to only around 250 procedures annually.

The information in this report focuses primarily on carotid procedures performed within NHS hospitals between 1 January 2019 and 31 December 2020.

The number of procedures reported to the NVR in 2020 shows a reduction compared to the previous year and a sharp decline around April 2020 following the impact of COVID-19. This is in line with the guidance published in March 2020 by the VSGBI, BSIR, NHS England Vascular CRG and GIRFT. Overall there was a 28% reduction in the number of CEAs carried out in 2020 compared to 2019. The NVR are unable to determine if this has resulted in an increase in the incidence of stroke during the pandemic. The decreasing number of carotid interventions should prompt consideration into the relevance of the numbers of carotid procedures undertaken by vascular networks in the guidance provided by the VSGBI.

Table 7.1: Estimated case-ascertainment of carotid endarterectomy in the UK

	2018	2019	2020
Audit procedures	4,284	4,156	2,991
Expected procedures	4,359	4,279	3,206
Estimated case-ascertainment	98%	97%	93%

7.2 Treatment pathways

Patients may be referred for carotid endarterectomy from various medical practitioners. In 2020, the most common source of referral was the stroke physician (86.3%), followed by vascular surgeons (3.5%), neurologists (3.2%), and general practitioners (1.8%).

The characteristics of the patients having carotid procedures have remained stable over time (see appendix 3). The mean age at surgery was 72 years, and there was no obvious change in the proportion of older or more comorbid patients being treated. Similarly, the distribution of symptoms and degree of stenosis was relatively unchanged:

- There were 2,862 patients (95.7%) with symptomatic disease. TIA was the most common symptom (44.3%) followed by stroke (39.3%)
- Nearly three-quarters of patients had at least 70% stenosis in their ipsilateral carotid artery at the time of operation

- Only 0.7% of patients had a previous ipsilateral treatment

Medication for cardiovascular conditions was common among patients prior to surgery. Overall, 92.9% were on antiplatelet medication (54.4% on single and 38.5% on dual therapy), while 83.2% were taking statins.

NICE guideline (NG128)

The target time from symptom to operation is 14 days in order to minimise the chance of a high-risk patient developing a stroke.

In the years from 2009 to 2012, the proportion of patients who were treated within the 14 day target rose from 37% to 56%. This figure has been relatively stable since then, with 62% of patients in 2020 being treated within 14 days.

The median time from symptom onset to surgery for symptomatic patients in 2020 was 12 days (IQR 7-21). For the three distinct phases within this pathway, the median time delays were:

- 4 days (IQR 1-8) from symptom to first medical referral
- 1 day (IQR 0-3) from first medical referral to being seen by the vascular team, and
- 5 days (IQR 2-8) from being seen by the vascular team to undergoing CEA.

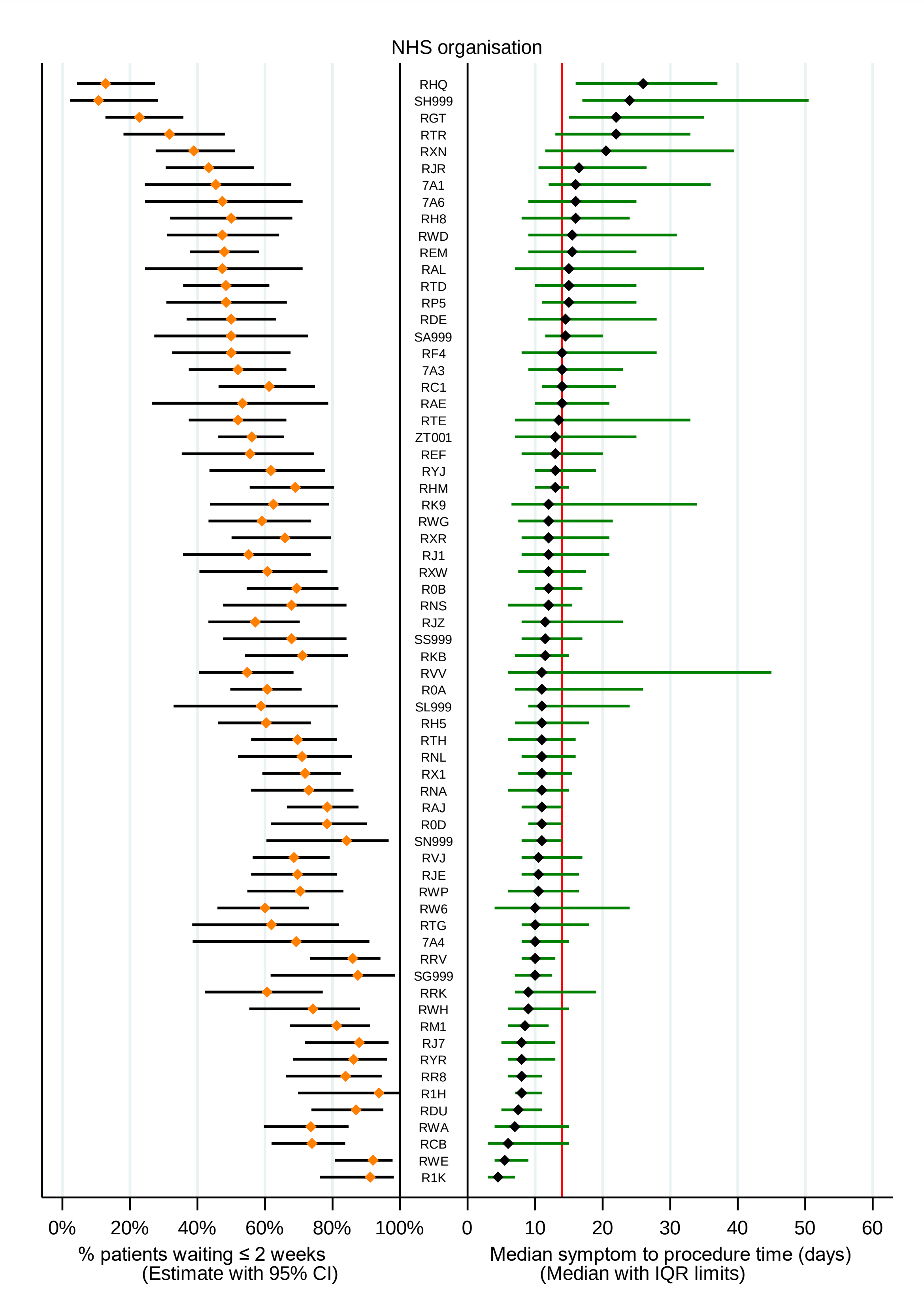
The distribution of symptom to operation times (right panel) and the proportion operated on within 14 days (left panel) for all NHS Trusts is summarised in Figure 7.1. The grey horizontal bars represent their 95% confidence intervals. The graph contains figures for all organisations that performed 10 or more procedures for symptomatic cases with known symptom and procedure dates. The NICE guidance standard of 14 days is included on the graph as a vertical red line.

There was considerable variation among NHS Trusts in the median time to surgery during 2020 (right panel, Figure 7.1):

- 50 of the 66 NHS organisations had a median time of 14 days or less
- the median exceeded 20 days for just 5 vascular units, a considerable improvement from the 16 found in 2016
- 13 trusts had less than half of their patients operated on within 14 days.

The values for the individual organisations can be found in the Annual Report results spreadsheet available at www.vsqip.org.uk.

Figure 7.1: Median time (and interquartile range) from symptom to procedure by NHS Trust for procedures performed between January and December 2020 (black diamonds) and proportion waiting less than 2 weeks following symptoms (orange diamonds)



7.3 Outcomes after carotid endarterectomy

Patients may experience various complications following carotid endarterectomy. The rate of postoperative stroke is of primary concern, but other complications include: bleeding, cardiac complications such as myocardial infarction, and cranial nerve injury (CNI), which describes damage to one of the nerves to the face and neck.

The complication rates for the 7,000 procedures performed in NHS hospitals between 2019 and 2020 are summarised in Table 7.2. The rates of the different complications tended to be around 1-2% and have remained fairly consistent over the last few NVR Annual Reports.

Over this 2-year period:

- the median length of stay was 2 days (IQR: 1 to 5 days)
- rate of return to theatre was 2.6% (95% CI 2.3 to 3.0), and
- the rate of readmission within 30 days was 4.5% (95% CI 4.0 to 5.0).

Table 7.2: Postoperative outcomes following carotid endarterectomy in 2019 and 2020

Procedures	**2,991**	**4,156**
Complication	**Complication rate (%) 2020**	**Complication rate (%) 2019**
Death and/or stroke within 30 days	2.6 (2.1-3.3)	2.2 (1.7-2.7)
Stroke within 30 days	1.9 (1.5-2.5)	1.9 (1.5-2.3)
Deaths within 30 days	1.0 (0.7-1.4)	0.7 (0.5-1.0)
Bleeding within admission	1.9 (1.5-2.5)	1.9 (1.5-2.4)
Myocardial infarct within admission	1.3 (0.9-1.8)	1.1 (0.8-1.4)
Cranial nerve injury within admission	1.7 (1.3-2.3)	2.2 (1.7-2.7)

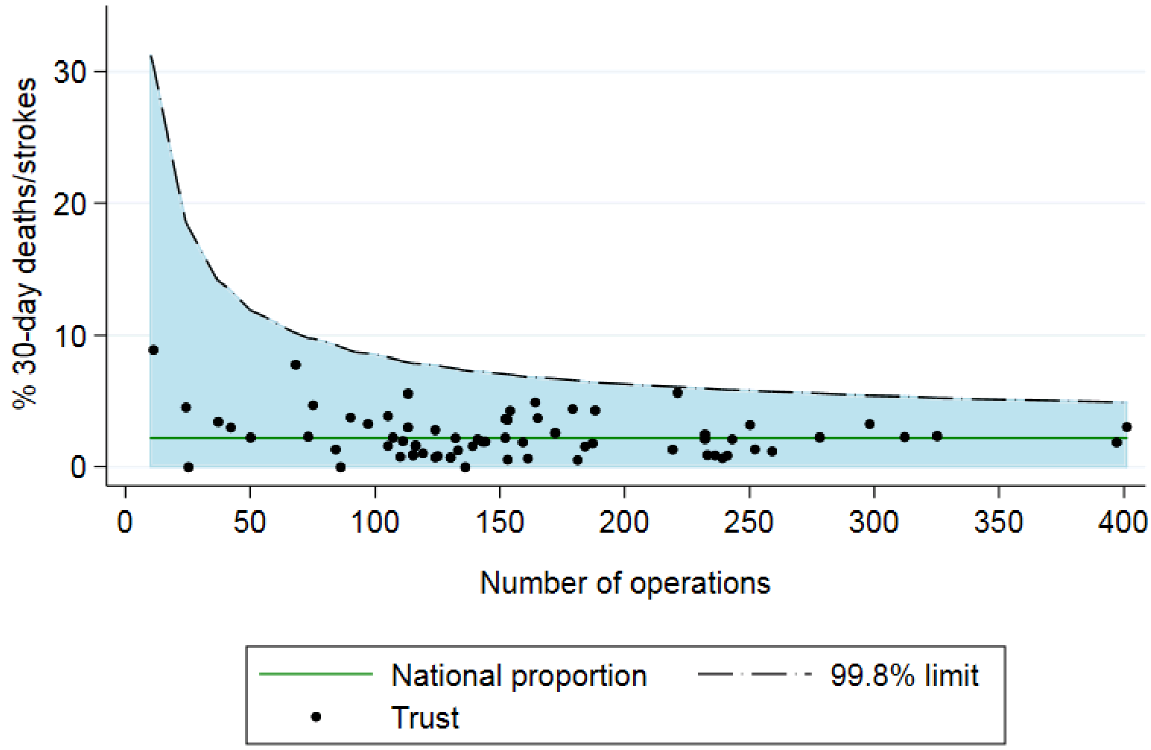
7.4 Rates of stroke/death within 30 days among NHS Trusts

The primary measure of safety after carotid endarterectomy is the rate of death or stroke within 30 days of the procedure. The risk-adjusted values for each NHS Trust for this outcome indicator are shown in the funnel plot in Figure 7.2.

All NHS organisations were within the expected distance of the overall national average rate of 2.2% (i.e., they were within the 99.8% control limits).

The online appendices spreadsheet gives the figures for each organisation. The 30-day death/stroke rates were risk adjusted to account for differences in the characteristics of patients treated at the various organisations by age, gender, diabetes, Rankin score, ASA grade, serum creatinine and number of Covid-19 cases.

Figure 7.2: Funnel plot of risk-adjusted rates of stroke/death within 30 days for NHS Trusts, for carotid endarterectomies between January 2018 and December 2020



The overall national average rate of stroke/death within 30 days = 2.2%

Appendix 1: NVR Governance structure

The NVR is assisted by the Audit and Quality Improvement Committee of the Vascular Society and overseen by a Project Board, which has senior representatives from the participating organisations and the commissioning organisation.

Members of Audit and Quality Improvement Committee of the Vascular Society

Mr A Pherwani	Chair	VSGBI
Mr D Adam		VSGBI
Ms K Kaji Sritharan		VSGBI
Ms L Wales		VSGBI
Mrs S Ward		Society for Vascular Nursing
Mr A Nasim		National AAA Screening Programme
Dr R O'Neill		British Society of Interventional Radiology
Dr R Williams		British Society of Interventional Radiology
Dr D Taylor		Vascular Anaesthesia Society of GB & I
Mr A McLaren		Medicines and Healthcare products Regulatory Agency
Mr D Dunphy		Association of British HealthTech Industries

plus members of the CEU involved in the NVR: Ms Panagiota Birmpili, Prof David Cromwell, Dr Amundeep Johal, Dr Qiuju Li, and Mr Sam Waton

Members of Project Board

Prof I Loftus, Chair	VSGBI
Miss S Renton	VSGBI
Ms E Skipper	HQIP
Ms S Harper	HQIP
Mr P Palmer	NEC Software Solutions UK
Mr R Armstrong	NEC Software Solutions UK

plus members of the project / delivery team: Mr Arun Pherwani (Surgical Leads), Dr Richard O'Neill, D R Williams (IR Leads), Ms Panagiota Birmpili, Prof David Cromwell, Dr Amundeep Johal, Dr Qiuju Li, and Mr Sam Waton

Appendix 2: NHS organisations that perform vascular procedures

Code	Organisation Name	CEA	AAA	Bypass	Angio	Amp
7A1	Betsi Cadwaladr University Health Board	Yes	Yes	Yes	Yes	Yes
7A3	Swansea Bay University Health Board	Yes	Yes	Yes	Yes	Yes
7A4	Cardiff and Vale University Health Board	Yes	Yes	Yes	Yes	Yes
7A6	Aneurin Bevan University Health Board	Yes	Yes	Yes	Yes	Yes
R0A	Manchester University NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
R0B	South Tyneside and Sunderland NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
R0D	University Hospitals Dorset NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
R1H	Barts Health NHS Trust	Yes	Yes	Yes	Yes	Yes
R1K	London North West University Healthcare NHS Trust	Yes	Yes	Yes	Yes	Yes
RA7	University Hospitals Bristol and Weston NHS Foundation Trust	No	No	Yes	No	No
RA9	Torbay and South Devon NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RAE	Bradford Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RAJ	Mid and South Essex NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RAL	Royal Free London NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RBD	Dorset County Hospital NHS Foundation Trust	No	No	Yes	No	No
RBN	St Helens & Knowsley Teaching Hospitals NHS Trust	No	No	Yes	No	No
RBQ	Liverpool Heart And Chest NHS Foundation Trust	Yes	No	No	No	No
RBZ	Northern Devon Healthcare NHS Trust	No	No	Yes	Yes	Yes
RC1	Bedford Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RCB	York Teaching Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RD1	Royal United Hospital Bath NHS Trust	No	No	Yes	No	No
RD8	Milton Keynes Hospital NHS Foundation Trust	No	No	Yes	No	No
RDE	East Suffolk and North Essex NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RDU	Frimley Health NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
REF	Royal Cornwall Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
REM	Liverpool University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RF4	Barking, Havering and Redbridge University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RGN	North West Anglia NHS Foundation Trust	No	No	Yes	No	No
RGR	West Suffolk NHS Foundation Trust	No	No	Yes	No	No
RGT	Cambridge University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RH5	Somerset NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RH8	Royal Devon and Exeter NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RHM	University Hospital Southampton NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RHQ	Sheffield Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RHU	Portsmouth Hospitals NHS Trust	No	No	Yes	No	No
RHW	Royal Berkshire NHS Foundation Trust	No	No	Yes	No	No
RJ1	Guy's and St Thomas' NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes

Code	Organisation Name	CEA	AAA	Bypass	Angio	Amp
RJ7	St George's University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RJE	University Hospital of North Midlands NHS Trust	Yes	Yes	Yes	Yes	Yes
RJR	Countess of Chester Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RJZ	King's College Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RK9	University Hospitals Plymouth NHS Trust	Yes	Yes	Yes	Yes	Yes
RKB	University Hospitals Coventry and Warwickshire NHS Trust	Yes	Yes	Yes	Yes	Yes
RL4	Royal Wolverhampton Hospitals NHS Trust	No	No	No	Yes	No
RM1	Norfolk and Norwich University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RMC	Bolton NHS Foundation Trust	No	No	No	Yes	No
RN3	Great Western Hospitals NHS Foundation Trust	No	No	No	Yes	No
RN5	Hampshire Hospitals NHS Foundation Trust	No	No	No	Yes	No
RNA	The Dudley Group NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RNL	North Cumbria Integrated Care NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RNS	Northampton General Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RP5	Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RPA	Medway NHS Foundation Trust	No	Yes	Yes	Yes	Yes
RQW	Princess Alexandra Hospital NHS Trust	Yes	No	Yes	Yes	Yes
RR7	Gateshead Health NHS Foundation Trust	No	No	No	Yes	No
RR8	Leeds Teaching Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RRF	Wrightington, Wigan And Leigh NHS Foundation Trust	No	No	No	Yes	No
RRK	University Hospitals Birmingham NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RRV	University College London Hospitals NHS Foundation Trust	No	Yes	Yes	Yes	No
RT3	Royal Brompton & Harefield NHS Foundation Trust	Yes	Yes	Yes	Yes	No
RTD	Newcastle upon Tyne Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RTE	Gloucestershire Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RTG	University Hospitals of Derby and Burton NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RTH	Oxford University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RTK	Ashford and St Peter's Hospitals NHS Foundation Trust	No	No	No	Yes	No
RTP	Surrey and Sussex Healthcare NHS Trust	No	No	No	Yes	No
RTR	South Tees Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RVJ	North Bristol NHS Trust	Yes	Yes	Yes	Yes	Yes
RVV	East Kent Hospitals University NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RVY	Southport and Ormskirk Hospital NHS Trust	No	No	No	Yes	No
RW6	Pennine Acute Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWA	Hull University Teaching Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWD	United Lincolnshire Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWE	University Hospitals of Leicester NHS Trust	Yes	Yes	Yes	Yes	Yes

Code	Organisation Name	CEA	AAA	Bypass	Angio	Amp
RWG	West Hertfordshire Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWH	East and North Hertfordshire NHS Trust	Yes	Yes	Yes	Yes	Yes
RWP	Worcestershire Acute Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWY	Calderdale and Huddersfield NHS Foundation Trust	No	No	No	Yes	No
RX1	Nottingham University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RXF	Mid Yorkshire Hospitals NHS Trust	No	No	No	Yes	No
RXL	Blackpool Teaching Hospitals NHS Foundation Trust	No	No	No	Yes	No
RXN	Lancashire Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RXP	County Durham and Darlington NHS Foundation Trust	No	No	No	Yes	No
RXQ	Buckinghamshire Healthcare NHS Trust	No	No	No	Yes	No
RXR	East Lancashire Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RXW	Shrewsbury and Telford Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RYJ	Imperial College Healthcare NHS Trust	Yes	Yes	Yes	Yes	Yes
RYR	University Hospital Sussex NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
SA999	NHS Ayrshire & Arran	Yes	Yes	Yes	Yes	Yes
SF999	NHS Fife	No	No	No	Yes	No
SG999	NHS Greater Glasgow and Clyde	Yes	Yes	Yes	Yes	Yes
SH999	NHS Highland	Yes	Yes	Yes	Yes	Yes
SL999	NHS Lanarkshire	Yes	Yes	Yes	Yes	Yes
SN999	NHS Grampian	Yes	Yes	Yes	Yes	Yes
SS999	NHS Lothian	Yes	Yes	Yes	Yes	Yes
ST999	NHS Tayside	Yes	Yes	Yes	Yes	Yes
SV999	NHS Forth Valley	No	No	No	Yes	No
SY999	NHS Dumfries and Galloway	No	Yes	Yes	Yes	Yes
ZT001	Belfast Health and Social Care Trust	Yes	Yes	Yes	Yes	Yes

Key
CEA – Performs carotid endarterectomy
AAA – Perform AAA repair
Bypass – Performs lower limb bypass
Angio – Performs lower limb angioplasty/stent
Amp – Performs major lower limb amputation

Figure A2.1: Map of vascular units in NHS Trusts that currently perform elective AAA repair

For interactive version, please visit:
https://batchgeo.com/map/a2c308a40d92fe18328d092431cff6b4

Appendix 3: Summary of procedures and patient characteristics

Elective repair of infra-renal AAAs

The characteristics of patients who underwent an elective repair of an infra-renal AAA during 2020 are summarised in Table A3.1.

Table A3.1: Characteristics of patients who had elective infra-renal AAA repair between January and December 2020

		Open repair	%	EVAR	%	Total
Total procedures		913		1,345		2,258
Age group (years)	Under 66	190	20.8	79	5.9	269
	66 to 75	492	53.9	522	38.9	1,014
	76 to 85	221	24.2	631	47.1	852
	86 and over	9	1.0	109	8.1	118
Male		841	92.1	1,207	89.7	2,048
Female		72	7.9	138	10.3	210
Current smoker		236	25.9	244	18.1	480
Previous AAA surgery		41	4.5	100	7.4	141
Indication	Screen detected	460	51.3	529	41.4	989
	Non-screen	340	37.9	594	46.4	934
	Other	97	10.8	156	12.2	253
AAA diameter (cm)	Under 4.5	24	2.6	68	5.1	92
	4.5 to 5.4	44	4.8	64	4.8	108
	5.5 to 6.4	627	68.8	869	64.7	1,496
	6.5 to 7.4	143	15.7	216	16.1	359
	7.5 and over	73	8.0	126	9.4	199
ASA fitness grade	1,2	255	27.9	256	19.0	511
	3	627	68.7	1,011	75.2	1,638
	4,5	31	3.4	77	5.7	108
Comorbidities	Hypertension	610	66.8	937	69.7	1,547
	Ischemic heart disease	247	27.1	472	35.1	719
	Chronic heart failure	17	1.9	108	8.0	125
	Stroke	43	4.7	104	7.7	147
	Diabetes	108	11.8	247	18.4	355
	Chronic renal failure	88	9.6	193	14.3	281
	Chronic lung disease	180	19.7	432	32.1	612

Repair of ruptured abdominal aortic aneurysms

Compared to patients who had an elective repair of an infra-renal AAA, the patients who had surgery for a ruptured AAA were older on average, with most aged over 76 years at the time of surgery and tended to have a larger diameter of the aneurysm (Table A3.2). In comparison to patients undergoing an open repair, patients having EVAR had a smaller AAA diameter, on average, and a greater proportion had also undergone AAA surgery previously.

Table A3.2: Characteristics of patients who had a repair of a ruptured AAA between January 2019 and December 2020

		Open repair	%	EVAR	%	Total
Total procedures		720		435		1,155
Age group (years)	Under 66	107	14.9	41	9.4	148
	66 to 75	246	34.2	127	29.2	373
	76 to 85	315	43.8	201	46.2	516
	86 and over	51	7.1	66	15.2	117
Male		580	80.6	364	83.7	944
Female		140	19.4	71	16.3	211
Previous AAA surgery		63	8.8	83	19.1	146
AAA diameter (cm)	<4.5	6	0.8	28	6.5	34
	4.5 to 5.4	36	5.0	38	8.8	74
	5.5 to 6.4	105	14.7	78	18.1	183
	6.5 to 7.4	132	18.5	93	21.6	225
	7.5 and over	436	61.0	193	44.9	629
ASA fitness grade	1 or 2	26	3.6	21	4.8	47
	3	52	7.2	66	15.2	118
	4	446	61.9	285	65.5	731
	5	196	27.2	63	14.5	259

Lower limb angioplasty / stenting

Table A3.3 Characteristics of patients undergoing endovascular lower limb revascularisation

	Elective				Non-elective			
	2020		2019		2019		2020	
	No.	%	No.	%	No.	%	No.	%
Total procedures	4,221	66.1	6,188	70.8	2,169	33.9	2,548	29.2
Age group (years)								
Under 60	679	16.1	1,057	17.1	355	16.4	395	15.5
60 to 69	1,137	27.0	1,738	28.2	540	24.9	639	25.1
70 to 79	1,453	34.5	2,044	33.1	699	32.3	822	32.3
80 and over	943	22.4	1,335	21.6	571	26.4	690	27.1
Men	2,860	67.8	4,172	67.4	1,471	67.8	1,730	67.9
Women	1,361	32.2	2,016	32.6	698	32.2	818	32.1
Smoking								
Current smoker	1,123	26.7	1,642	26.6	510	23.7	626	24.7
Ex-smoker	2,328	55.4	3,454	55.9	1,139	52.9	1,259	49.6
Never smoked	753	17.9	1,082	17.5	503	23.4	652	25.7
Fontaine score*								
No symptoms	189	4.9	282	4.9	18	0.9	58	2.7
Intermittent claudication	1,298	33.4	2,711	47.2	101	5.3	94	4.3
Nocturnal and/or resting pain	748	19.3	851	14.8	229	12.1	300	13.8
Necrosis and/or gangrene	1,647	42.4	1,905	33.1	1,547	81.6	1,722	79.2
Presenting problem								
Acute limb ischaemia	284	6.7	333	5.4	238	11.0	333	13.1
Chronic limb ischaemia	3,882	92.0	5,749	92.9	1,895	87.4	2,174	85.3
Aneurysm	48	1.1	95	1.5	31	1.4	30	1.2
Trauma	7	0.2	11	0.2	5	0.2	11	0.4
Comorbidities								
None	463	11.0	900	14.5	129	5.9	180	7.1
Diabetes	2,075	49.2	2,720	44.0	1,425	65.7	1,604	63.0
Hypertension	2,755	65.3	3,932	63.5	1,400	64.5	1,616	63.4
Chronic lung disease	781	18.5	1,020	16.5	408	18.8	498	19.5
Ischaemic heart disease	1,343	31.8	1,854	30.0	693	32.0	896	35.2
Chronic heart failure	343	8.1	390	6.3	270	12.4	305	12.0
Chronic renal disease	647	15.3	791	12.8	569	26.2	581	22.8
Stroke	441	10.4	542	8.8	211	9.7	263	10.3
Medication								
None	209	5.0	359	5.8	100	4.6	116	4.6
Anti-platelet	3,235	76.8	4,870	78.7	1,566	72.3	1,887	74.1
Statin	3,025	71.8	4,440	71.8	1,461	67.4	1,790	70.3
Beta-blocker	1,103	26.2	1,602	25.9	678	31.3	812	31.9
ACE inhibitor/ARB	1,525	36.2	2,164	35.0	739	34.1	895	35.1

*Fontaine score is calculated for patients with chronic limb ischaemia and non-missing values (n=13,700).
29 missing values for age, 55 missing values for smoking (angioplasty)

Lower limb bypass

Table A3.4: Characteristics of patients undergoing lower limb bypass between January 2019 and December 2020

	Bypass			
	Elective		Non-elective	
	No. of procs	%	No. of procs	%
Total procedures	6,504		4,867	
Age group (years)				
Under 60	1,314	20.2	956	19.7
60 to 64	936	14.4	660	13.6
65 to 69	1,086	16.7	740	15.2
70 to 74	1,307	20.1	904	18.6
75 to 79	988	15.2	742	15.3
80 and over	864	13.3	855	17.6
Men	4,871	74.9	3,503	72.0
Women	1,633	25.1	1,364	28.0
Smoking				
Current smoker	2,140	32.9	2,048	42,1
Ex-smoker	3,710	57.1	2,231	45.9
Never smoked	650	10.0	580	11.9
Comorbidities				
None	747	11.5	555	11.4
Hypertension	4,583	70.5	3,277	67.3
Ischaemic heart disease	2,248	34.6	1,701	34.9
Diabetes	2,242	34.5	1,942	39.9
Stroke	467	7.2	443	9.1
Chronic lung disease	1,625	25.0	1,274	26.2
Chronic renal disease	618	9.5	581	11.9
Chronic heart failure	385	5.9	388	8.0
Medication				
None	57	0.9	142	2.9
Anti-platelet	5,539	85.2	3,589	73.8
Statin	5,304	81.6	3,561	73.2
Beta blocker	1,760	27.1	1,321	27.2
ACE inhibitor/ARB	2,620	40.3	1,794	36.9

Lower limb major amputation

Characteristics of patients undergoing major unilateral amputations are summarised in Table A3.5, separately for above knee amputations (AKAs) and below knee amputations (BKAs) in 2019 and 2020. Overall, BKAs were more common in patients under 60 years and AKAs more common in patients older than 80 years. Most patients in both amputation groups were men and many were either current or ex-smokers.

The most common presenting problem for BKAs as well as AKAs was tissue loss. Among the BKA patients, the second most common presenting problem was uncontrolled infection. For AKA patients, acute or chronic limb-threatening ischaemia were also common. Over a half of the patients had undergone a previous ipsilateral limb procedure. This may be because with the frailest, older patients, angioplasty (as a less invasive procedure) has been attempted prior to amputation.

Table A3.5: Characteristics of patients undergoing major unilateral lower limb amputation

	Below knee		**Above knee**	
	2020	**2019**	**2020**	**2019**
Total procedures	1,598	1,628	1,571	1,632
Age group (years)	**%**	**%**	**%**	**%**
Under 60	31.3	29.9	18.7	18.0
60 to 64	15.2	14.3	12.0	11.4
65 to 69	13.7	13.5	13.7	13.9
70 to 74	14.5	14.6	17.2	15.9
75 to 79	10.1	12.1	15.0	17.2
80 and over	15.3	15.6	23.4	23.6
Sex				
Men	76.2	77.1	71.0	68.8
Women	23.8	22.9	29.0	31.3
Smoking				
Current smoker	28.8	27.8	38.1	36.1
Ex-smoker	47.6	51.8	46.1	48.2
Never smoked	23.7	20.4	15.8	15.8
Presenting problem				
Acute limb ischemia	8.4	7.7	20.9	20.3
Chronic limb ischemia	19.0	17.5	22.0	20.5
Neuropathy	1.2	1.8	1.0	1.5
Tissue loss	44.0	45.9	38.6	40.3
Uncontrolled infection	27.4	26.9	15.5	16.6
Aneurysm	0.1	0.3	1.9	0.8
Previous ipsilateral limb procedure	62.6	62.9	53.9	53.6
Type of previous ipsilateral limb procedure				
Minor amputation only	18.6	21.3	4.5	5.6
Angioplasty/stent	45.8	41.8	24.6	26.7
Surgical revascularisation	31.5	32.5	48.8	48.5
Major amputation	4.2	4.4	22.1	19.3

Preoperative risk factors are summarised in Table A3.6. The majority of patients had one or more defined comorbid conditions. The most common comorbidities in both BKA and AKA groups were hypertension, diabetes and ischaemic heart disease. A large majority of patients in both groups were taking antiplatelet medication or statins, and about a quarter to a third of the patients were on beta blockers, ACE inhibitors or Angiotensin II receptor blockers (ARBs).

Table A3.6: Preoperative risk factors among patients undergoing lower limb amputation

	Below knee		Above knee	
	2020	**2019**	**2020**	**2019**
Total procedures	1,598	1,628	1,571	1,632
Pre-op ASA grade	**%**	**%**	**%**	**%**
Normal	0.6	0.7	0.6	0.6
Mild disease	6.2	6.1	3.8	3.7
Severe, not life-threatening disease	71.3	70.3	59.3	55.3
Severe, life-threatening disease, or moribund patient	21.9	22.9	36.3	40.5
Comorbidities				
None	6.9	6.9	9.9	9.6
Diabetes	69.1	69.7	44.2	43.4
Hypertension	63.4	62.6	64.7	63.4
Chronic lung disease	18.7	18.9	27.2	27.6
Ischaemic heart disease	36.1	37.0	39.6	42.6
Chronic heart failure	11.8	10.1	12.9	15.0
Chronic renal disease	24.2	22.4	18.1	20.8
Stroke	8.8	9.3	12.4	12.4
Active/managed cancer	5.1	4.2	9.0	7.4
Medication				
None	2.6	2.7	4.3	2.2
Anti-platelet	69.6	66.4	63.4	65.0
Statin	73.7	70.3	66.7	63.2
Beta-blocker	30.0	29.3	30.6	32.8
ACE inhibitor/ARB	34.8	38.0	32.0	33.5
Antibiotic prophylaxis	68.5	71.7	68.6	68.3
DVT prophylaxis	66.3	65.0	66.5	64.8
Oral anticoagulant	19.5	17.9	19.7	17.6

Carotid endarterectomy

Table A3.7: Characteristics of patients who had carotid endarterectomy in 2020, compared with characteristics from 2019

Patient characteristics	No. of procedures	2020 %	2019 %
Total procedures	2,991		
Age (years), (n=2,982)			
Under 66	831	27.9	26.8
66 to 75	1,065	35.7	35.8
76 to 85	938	31.5	32.4
86 and over	148	5.0	5.0
Male	2,073	69.3	69.3
Female	918	30.7	30.7
Asymptomatic	129	4.3	6.9
Patients symptomatic for carotid disease			
Index symptom if symptomatic: (n=2,862)			
Stroke	1,126	39.3	38.5
TIA	1,267	44.3	44.4
Amaurosis fugax	435	15.2	15.6
None of the three above	34	1.2	1.5
Grade of ipsilateral carotid stenosis* (n=2,990)			
<50%	31	1.0	0.9
50-69%	775	25.9	26.1
70-89%	1,258	42.1	41.1
90-99%	920	30.8	31.9
Occluded	6	0.2	0.1
Rankin score prior to surgery			
0-2	2,740	91.6	91.9
3	226	7.6	7.0
4-5	25	0.8	1.2
Co-morbidities			
Diabetes	698	23.3	24.0
Cardiac disease	838	28.0	28.7

* level of stenosis recorded at the time of initial imaging.

Table A3.8: Operative details of carotid endarterectomies performed during 2019 and 2020

Operation details		Procedures (n=2,991)	2020 %	2019 %
Anaesthetic	General	1,920	64.2	63.6
	GA + Block	269	9.0	8.2
	Block or regional	542	18.1	16.4
	Local	258	8.6	11.8
Type of Endarterectomy	Standard	222	7.4	8.2
	Standard + patch	2,628	87.9	85.9
	Eversion	141	4.7	5.9
Carotid shunt used		1,873	62.6	59.2
Ipsilateral patency check		2,080	70.8	68.1

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Glossary

Abdominal Aortic Aneurysm (AAA)	This is an abnormal expansion of the aorta. If left untreated, it may enlarge and rupture causing fatal internal bleeding.
Amaurosis fugax	Transient loss of vision in one eye due to an interruption of blood flow to the retina.
ACE inhibitors	Angiotensin-converting enzyme inhibitors are medications designed to decrease blood pressure.
ARBs	Angiotensin-receptor blockers are drugs designed to decrease blood pressure. They are similar to ACE inhibitors but work in a different way.
Angiography	Angiography is a type of imaging technique used to examine blood vessels. It may be carried out non-invasively using computerised tomography (CT) and magnetic resonance imaging (MRI).
Asymptomatic Patient	A patient who does not yet show any outward signs or symptoms of plaque.
Cardiopulmonary Exercise Testing (CPET)	Cardiopulmonary Exercise Testing is a non-invasive method of assessing the function of the heart and lungs at rest and during exercise.
Carotid Endarterectomy (CEA)	Carotid Endarterectomy is a surgical procedure in which plaque build-up is removed from the carotid artery in the neck.
Carotid Stenosis	Abnormal narrowing of the neck artery to the brain.
Complex AAA	A term used to describe aortic aneurysms that are not located below the arteries that branch off to the kidneys. These are categorised into three types: juxta-renal (that occur near the kidney arteries), supra-renal (that occur above the renal arteries) and thoraco-abdominal (more extensive aneurysms involving the thoracic and abdominal aorta).
Cranial Nerve Injury (CNI)	Damage to one of the 12 nerves supplying the head and neck.
Chronic Limb-Threatening Ischaemia (CLTI)	The most severe form of peripheral arterial disease, where the blood flow to the legs becomes severely restricted, to such an extent that these parts of the limb are at risk of developing gangrene. CLTI is associated with severe pain at rest, which is often worse at night, and there may also be ulcers on the leg and foot.

Confidence Interval (CI)	A statistical term used to describe the range of values that we are confident the metric lies within.
Endovascular Aneurysm Repair (EVAR)	A method of repairing an abdominal aortic aneurysm by placing a graft within the aneurysm from a small cut in the groin.
Fontaine Score	An internationally recognised scoring system or classification of the severity of peripheral arterial disease.
Hospital Episode Statistics (HES)	HES is the national statistical data warehouse for England regarding the care provided by NHS hospitals and for NHS hospital patients treated elsewhere. There are equivalent agencies in Northern Ireland, Scotland and Wales but in this report, the term HES is used generically to describe data that are collected by any of these national agencies.
Index case	The first procedure a patient underwent in their hospital admission.
Infra-renal AAA	An abdominal aneurysm that is located below the point where the arteries branch off the aorta to the kidneys.
Interquartile range (IQR)	Once the data are arranged in ascending order, this is the central 50% of all values and is otherwise known as the ‘middle fifty’ or IQR.
Hybrid operating theatre	An operating theatre with built-in radiological imaging capabilities. The imaging equipment is able to move and rotate around a patient and multiple monitors provide good visibility around the operating table.
Median	The median is the middle value in the data set; 50% of the values are below this point and 50% are above this point.
Myocardial Infarct (MI)	Otherwise known as a Heart Attack, MI involves the interruption of the blood supply to part of the heart muscle.
Occluded artery	An artery that has become blocked and stops blood flow.
National Abdominal Aortic Aneurysm Screening Programme (NAAASP)	A programme funded by the Department of Health to screen men over the age of 65 years for AAA.
OPCS	Office of Population and Censuses Surveys. A procedural classification list for describing procedures undertaken during episodes of care in the NHS.

Peripheral arterial disease (PAD)	Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower-limb arteries. The disease can affect various sites in the legs, and produces symptoms that vary in their severity from pain in the legs during exercise to persistent ulcers or gangrene.
Plaque	Scale in an artery made of fat, cholesterol and other substances. This hard material builds up on the artery wall and can cause narrowing or blockage of an artery or a piece may break off causing a blockage in another part of the arterial circulation.
Stroke	A brain injury caused by a sudden interruption of blood flow with symptoms that last for more than 24 hours.
Symptomatic	A patient showing symptoms is known to be symptomatic.
Transient ischaemic attack (TIA)	A “mini-stroke” where the blood supply to the brain is briefly interrupted and recovers after a short time (e.g., within 24 hours).
Trust or Health Board	A public sector corporation that contains a number of hospitals, clinics and health provisions. For example, there were 4 hospitals in the trust and 3 trusts in the region.
Vascular Society of Great Britain and Ireland (VSGBI)	The VSGBI is a registered charity founded to relieve sickness and to preserve, promote and protect the health of the public by advancing excellence and innovation in vascular health, through education, audit and research. The VSGBI represents and provides professional support for over 600 members and focuses on non-cardiac vascular disease.

The Royal College of Surgeons of England is dedicated to enabling surgeons achieve and maintain the highest standards of surgical practice and patient care. To achieve this, the College is committed to making information on surgical care accessible to the public, patients, health professionals, regulators and policy makers.

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