National Vascular Registry

Supplementary Materials for the 2023 Report

November 2023

Royal College of Surgeons of England
ADVANCING SURGICAL CARE

VASCULAR SOCIETY
OF GREAT BRITAIN AND IRELAND

British Society of Interventional Radiology
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The National Vascular Registry is commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP). HQIP is led by a consortium of the Academy of Medical Royal Colleges, the Royal College of Nursing, and National Voices. Its aim is to promote quality improvement, and in particular to increase the impact that clinical audit has on healthcare quality in England and Wales. HQIP holds the contract to commission, manage and develop the NCAPOP, comprising more than 40 clinical audits and clinical outcome review programmes that cover care provided to people with a wide range of medical, surgical, and mental health conditions. The programme is funded by NHS England, the Welsh Government and, with some individual audits, also funded by the Health Department of the Scottish government and the Northern Ireland Department of Health.

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

We would also like to thank:

- VSGBI Audit and Quality Improvement Committee
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Foreword

As President of the Vascular Society of Great Britain & Ireland, it is a pleasure to provide a foreword for the 2023 National Vascular Registry Annual Report.

Good decision making in vascular and endovascular surgery is crucial, and information and data from the NVR underpins all our working practice. This annual report has highlighted that activity continues to recover post COVID-19 pandemic and activity and is almost back to levels seen in 2019. Nationally we have seen an increase in procedures performed for revascularisation of the lower limbs (>14,000 in 2022 compared with 13,065 in 2021) and whilst in part may be because of better case ascertainment for angioplasty it does feel like a true representation of the clinical workload. However, the numbers of patients having carotid surgery and abdominal aortic aneurysm repair are decreasing.

Vascular surgery is feeling the stretch of a health service under pressure, as times from assessment to treatment have increased for carotid endarterectomy and elective infrarenal aneurysm repair. Whilst the emphasis on decreasing the overall surgical waiting list backlog made 2022 a challenging year it is important to note that only 32% of patients for abdominal aortic aneurysm repair were treated with 8 weeks and only 52% of patients with symptomatic carotid disease had their carotid surgery within the 14-day target.

We continued to make good progress with the quality improvement around the '5-day' target for emergency treatment for patients admitted with critical limb threatening ischaemia. This report shows that we managed to achieve that target in 51% in 2022 compared to 55% in 2021. I am hopeful that the Peripheral Arterial Disease Quality Improvement Framework (PAD-QIF) will continue to help us to highlight this important group of patients, pushing clinicians to expediate their treatment so that we can improve on these numbers. It has also helped that in England, this became a CQUIN target for 2022-2023 and has been adopted again for 2023-2024. For the future we should also consider highlighting the targets for the ambulatory/outpatient CLTI patients, as for many units this is now the main pathway of care.

There has been a rise in major limb amputations from 3,260 in 2019 to 3,430 in 2022. This is a concerning metric but may indicate an increasing prevalence of disease in the population or delayed presentation of diabetic foot infection or PAD. As the Vascular Society and BSIR we must ensure that patients have equity of access to comprehensive revascularisation services regardless of geography.

This NVR report has also included data on complex abdominal aortic aneurysm repair for juxta- and suprarenal aneurysms, which has highlighted that we have good outcomes for complex endovascular repairs with fenestrated/branched devices and that postoperative mortality for open repair is significantly higher. Going forward the quality standard should be compulsory submission of all complex visceral aortic procedures (FEVAR, BEVAR & open) and thoracic endografting (TEVAR) cases to the NVR. Better case ascertainment for TEVAR performed for aortic dissection will allow teams involved in the Acute Aortic Dissection Toolkit to have outcome data to inform practice nationwide.

Next year the NVR data collection system will become integrated with the NHS England system for collecting data on implanted medical devices, the Medical Device Outcome Registry platform (MDOR). The NVR has already been collecting data on devices implanted during AAA repair and this facility will be extended to other procedures in the coming year. It is important that we maintain our excellent case ascertainment rates as this will provide valuable insight into durability and potentially allow identification of failing devices the earliest stage.

It is important to recognise that this report would not exist without the immense commitment from vascular and IR teams across the country in meticulously entering their individual and departmental data – thank you as we know how busy you all are. Huge thanks must also go to Sam Waton, Professor David Cromwell, Dr Robin Williams, our fellows and the audit team based at the Royal College of Surgeons of England for contributing so much to allow the completion this report. It goes without saying that Arun Pherwani deserves a huge vote of thanks for his incredible commitment and dedication as Audit Committee Chair over the last three years. I would also like to take this opportunity to welcome Professor Denis Harkin to the audit team and wish him much success for the next 3 years.

Miss Rachel Bell
President of the Vascular Society of Great Britain & Ireland

I am delighted to add to Miss Rachel Bell's foreword to the NVR. Interventional Radiology plays a key role in the diagnosis and endovascular management of aortic and peripheral vascular disease. We work closely with our vascular surgical colleagues to provide the best possible outcomes for our patients.

Registries such as the NVR are vital to gather outcome data, but finding time for data entry is challenging and administrative support to do this is essential. Input of our own data can now give us individual consultant and unit level outcomes essential to good medical practice. The addition of device specific data will hugely add to the value of this registry.

I would like to thank Arun Pherwani and colleagues at the Vascular Society, and the Circulation Foundation for their proposal and part funding of an IR NVR research Fellowship. This Fellowship in partnership with the BSIR and the Royal College of Radiologists should give excellent research opportunities for the successful candidate whom we will be recruiting shortly.

Dr Phil Haslam
President of the British Society of Interventional Radiology

1. Introduction

Hospital-based vascular services provide care for a variety of conditions that affect blood circulation (conditions that are part of the broad spectrum of cardiovascular disease). Treatments are typically aimed at reducing the risk of cardiovascular events such as a heart attack, stroke or rupture of an artery, and the appropriate therapeutic options will depend upon the severity of a patient's condition as well as the extent of other coexisting conditions.

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.

This document provides supplementary materials for our 2023 State of the Nation Report (available at: https://www.vsqip.org.uk/reports/2023-nvr-state-of-the-nation-report/)

Information is presented on clinical practice in the calendar year of 2022, and on surgical outcomes for the previous three-year period (2020-22). The NVR publishes information on emergency and elective procedures for the following patient groups:

1. **patients with peripheral arterial disease (PAD)** who undergo either (a) lower limb angioplasty/stent, (b) lower limb bypass surgery, or (c) lower limb amputation
2. patients who have a repair procedure for **(abdominal) aortic aneurysm (AAA) or dissection**
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, so that it continues to support the work of the Vascular Society of Great Britain and Ireland (VSGBI) and British Society of Interventional Radiologists (BSIR) 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. The information patterns of practice and patient outcomes also play a crucial role in the commissioning of NHS vascular services.

1.1 The 2023 NVR Report Supplementary Materials

The aim of this Supplementary Materials document is to give a description of the care provided by NHS vascular units, and outcomes delivered to patients.

It 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 benchmark their performance 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, waiting times for treatment and the complications that may occur as part of treatment.

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 a 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 People with Vascular Disease" published by the Vascular Society [VSGBI 2021]. Standards of care specific to the various vascular conditions procedures are described within the documents listed below. In addition, in response to the COVID-19 pandemic, the VSGBI and other organisations made a number of recommendations for the delivery of care to vascular patients. 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 2022]
- 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 additional resources that accompany this document available on the NVR website at: https://www.vsqip.org.uk/reports/2023-nvr-state-of-the-nation-report/

These include the main state of the nation report document, appendices (data tables) containing individual NHS trust results, and an organisational data viewer.

The website also provides access to:

- all previous Annual Reports
- information on how to access your NVR data
- 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 healthcare 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 document

The results in this document are based primarily on vascular interventions that took place within the UK between 1 January 2020 and 31 December 2022. As noted above, the scope of the NVR extends only to patients who underwent a procedure. The NVR does not collect the details of patients who were admitted to hospital with a vascular condition (e.g. a ruptured AAA) but did not undergo an operation.

The data used in this document was extracted from the NVR IT system in June 2023. This was to enable 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. The analysis of the 2020-22 audit period only included records on the NVR IT system that were "locked" by NHS staff (i.e. this mechanism indicates that data entry is complete).

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.

Appendix 1 provides a list of NHS vascular units for which results are published.

Unless stated otherwise, results are presented for all four UK nations (England, Wales, Scotland and Northern Ireland). Where case ascertainment is mentioned, the number of records in the NVR were compared to the number of procedures recorded in the administrative hospital databases used in each nation: HES in England, PEDW in Wales, SMR01 in Scotland and HIS in Northern Ireland.

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 NHS 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 plots is that they show 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.

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 represents the current national average or the national target.

In some chapters, the change in distribution of patient waiting times by month is shown using a graph that uses a sequence of box plots. Each box plot summarises five points in the distribution. The bottom and top lines of the blue rectangles indicate the lower (Q1) and upper quartiles (Q3). The horizontal line inside the rectangle represents the median time. The lower and upper whiskers show the minimum or maximum values (or the distance that is 1.5 times the inter-quartile range (Q3 - Q1) if this is closer to the median).

2. Lower limb revascularisation for PAD

2.1 Introduction

This chapter describes the processes and outcomes of care for patients who have a lower limb revascularisation. Lower limb revascularisation procedures can be performed using open surgery (bypass), endovascular techniques or a combination of both (hybrid).

In this chapter, we report on procedures performed between January 2022 and December 2022 and which cover:

- 8,031 endovascular procedures,
- 6,432 open surgical procedures, of which 4,429 were bypass procedures and 2,003 hybrid procedures.

The analysis focuses on the first procedure undergone by a patient during an admission; subsequent procedures are considered to be re-operations. Hybrid procedures are analysed with the open surgical (bypass/endarterectomy) procedures.

Figure 2.1 shows the frequency of each type of procedure by NHS trust, for those 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.

Case ascertainment has improved slightly over the three years for all procedures (Table 2.1). 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 .

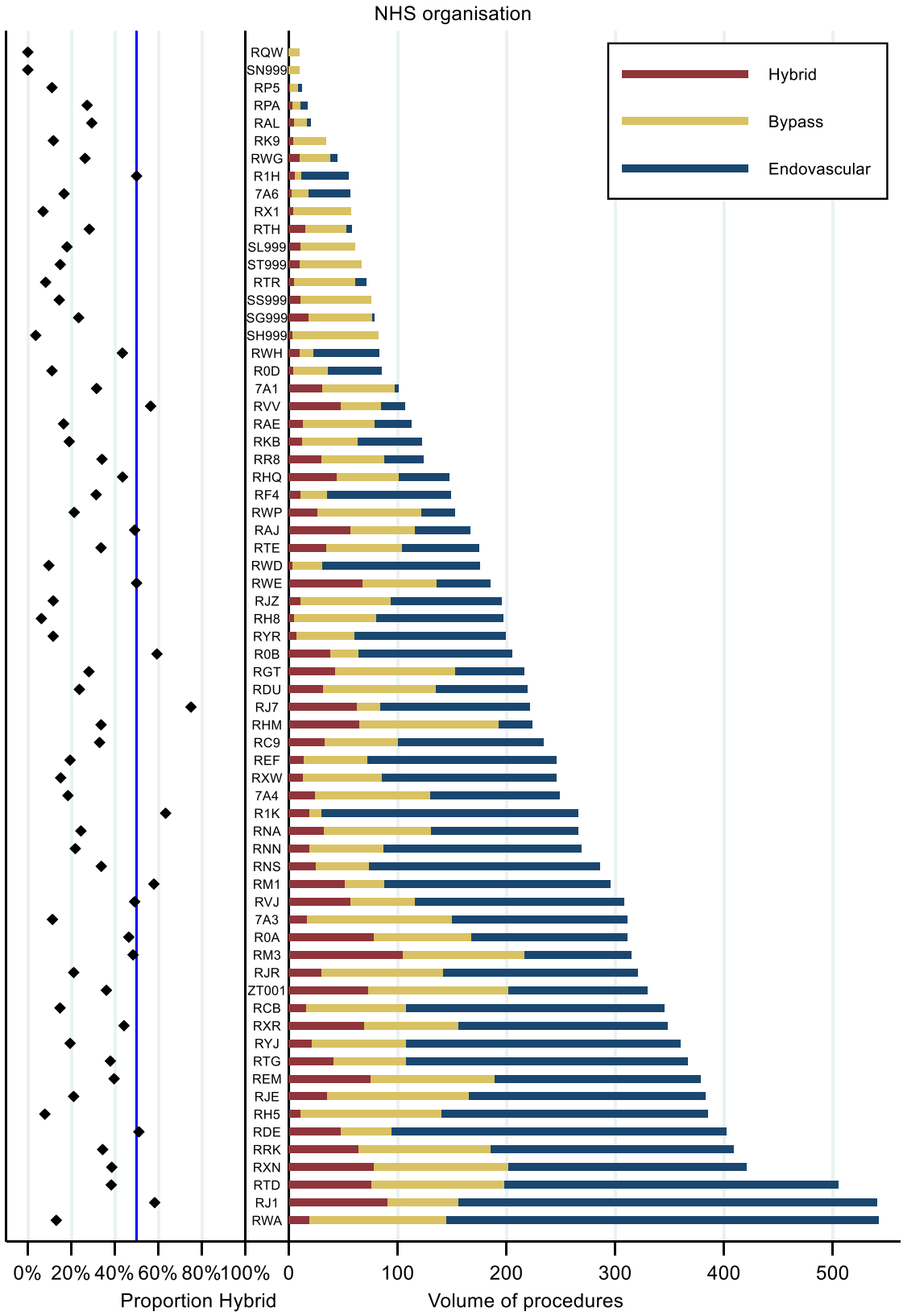
Table 2.1: Estimated case ascertainment for lower limb revascularisation procedures, by year

	Open surgical procedures				Endovascular procedures			
	2019	2020	2021	2022	2019	2020	2021	2022
NVR procedures	6,550	5,445	6,090	6,432	8,710	6,710	7,078	8,031
Expected procedures	7,881	6,578	7,236	7,226	17,480	14,324	14,982	14,871
Estimated case ascertainment	83%	86%	84%	89%	50%	47%	47%	54%

Table 2.2: Estimated case ascertainment rates in 2022 by UK country

	Open surgical procedures	Endovascular procedures
England	92%	60%
Wales	100%	69%
Scotland	41%	6%
Northern Ireland	100%	47%

Figure 2.1 Frequency of each type of revascularisation procedure by NHS trust for 2022



2.2 Patient characteristics

Table 2.3: Characteristics of patients undergoing lower limb revascularisation in 2022

	Elective				Non-elective			
	Endovascular		Open surgical		Endovascular		Open surgical	
	No.	%	No.	%	No.	%	No.	%
Total procedures	5,265	65.6	3,565	55.4	2,766	34.4	2,867	44.6
Age group (years)								
Under 60	806	15.4	650	18.3	439	15.9	508	17.8
60 to 69	1,496	28.5	1,196	33.7	699	25.4	839	29.4
70 to 79	1,782	34.0	1,229	34.6	851	30.9	1,013	35.4
80 and over	1,163	22.2	474	13.4	766	27.8	498	17.4
Men	3,626	68.9	2,660	74.6	1,907	68.9	2,035	71.0
Women	1,639	31.1	905	25.4	859	31.1	832	29.0
Smoking status								
Current smoker	1,291	24.7	1,187	33.4	668	24.4	1,199	42.0
Ex-smoker	2,733	52.3	2,013	56.6	1,293	47.1	1,319	46.2
Never smoked	1,206	23.1	356	10.0	782	28.5	338	11.8
Comorbidities								
None	635	12.1	400	11.2	201	7.3	319	11.1
Diabetes	2,564	48.9	1,269	35.6	1,853	67.2	1,257	43.9
Hypertension	3,242	61.9	2,477	69.5	1,714	62.2	1,841	64.3
Chronic lung disease	947	18.1	910	25.5	497	18.0	745	26.0
Ischaemic heart disease	1,423	27.2	1,160	32.6	814	29.5	1,001	35.0
Chronic heart failure	430	8.2	206	5.8	389	14.1	271	9.5
Chronic renal disease	778	14.8	363	10.2	695	25.2	344	12.0
Stroke	433	8.3	293	8.2	268	9.7	253	8.8
Medication								
None	217	4.1	10	0.3	98	3.6	8	0.3
Antiplatelet	4,017	76.6	3,027	84.9	1,925	69.7	2,181	76.1
Statin	3,527	67.2	2,934	82.3	1,821	65.9	2,154	75.2
Beta blocker	1,350	25.7	965	27.1	895	32.4	783	27.3
ACE inhibitor	1,631	31.1	1,359	38.1	924	33.4	1,006	35.1

2.3 Procedure characteristics

Most endovascular procedures in 2022 (91.4%) were performed under local anaesthetic, with 1.7% under regional and 6.9% under general anaesthetic.

The procedures involved interventions in 13,050 vessels in 2022, a small increase from 11,609 in 2021 but still below the 14,188 in 2019 before the COVID-19 pandemic (Table 2.4).

Half of the endovascular procedures involved treatment of a single vessel (54.1%), with 32.4% treating two, 10.9% treating 3 and 2.5% treating 4 or more vessels.

Balloon angioplasty alone was the most common type of intervention (9,950 vessels, 76.2%), while 3,100 (23.8%) 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.

Table 2.4: Treated vessels during lower limb endovascular procedures between 2020 and 2022

	2020		2021		2022	
Artery	Number	%	Number	%	Number	%
Aorta	103	0.9%	66	0.6%	71	0.5%
Common iliac	1,603	14.4%	1,489	12.8%	1,639	12.6%
External iliac	1,208	10.8%	1,232	10.6%	1,378	10.6%
Superficial femoral	3,296	29.6%	3,412	29.4%	3,868	29.6%
Common femoral/ profunda femoral	386	3.5%	374	3.2%	457	3.5%
Popliteal	2,092	18.8%	2,220	19.1%	2,436	18.7%
Tibial/pedal	2,073	18.6%	2,372	20.4%	2,720	20.8%
Within graft	379	3.4%	444	3.8%	481	3.7%
Total vessels	11,140		11,609		13,050	

Table 2.5: Characteristics of lower limb endovascular procedures undertaken in 2022 by anatomical location

	Vessels treated		Stent insertion		Non-occlusive[1]		Procedure success[2]	
	n	%	n	%	n	%	n	%
Aorta	71	0.5	42	59.2	-	-	-	-
Common iliac	1,639	12.6	1,115	68.0	1,129	68.9	1,573	96.0
External iliac	1,378	10.6	641	46.5	1,065	77.3	1,330	96.5
Superficial femoral	3,868	29.6	754	19.5	2,209	57.1	3,611	93.4
CFA, PFA	457	3.5	75	16.4	344	75.3	424	92.8
Popliteal	2,436	18.7	337	13.8	1,391	57.1	2,238	91.9
Tibial/pedal	2,720	20.8	114	4.2	1,305	48.0	2,298	84.5
Within graft	481	3.7	22	4.6	429	89.2	447	92.9

[1] The other indication for intervention was occlusion.

[2] The other outcomes were residual stenosis and failure.

Table 2.6: Characteristics of lower limb revascularisation procedures undertaken in 2022

	Elective		Non-elective	
	Endovascular	**Open**	**Endovascular**	**Open**
Chronic limb ischaemia				
Asymptomatic	278 (5.3%)	31 (0.9%)	31 (1.1%)	18 (0.6%)
Intermittent claudication	1,781 (33.8%)	927 (26%)	88 (3.2%)	43 (1.5%)
Nocturnal/resting pain	942 (17.9%)	1,193 (33.5%)	280 (10.1%)	516 (18%)
Necrosis/gangrene	2,047 (38.9%)	923 (25.9%)	2,128 (77%)	1,563 (54.5%)
Acute limb ischaemia	144 (2.7%)	150 (4.2%)	204 (7.4%)	584 (20.4%)
Trauma	8 (0.2%)	9 (0.3%)	13 (0.5%)	35 (1.2%)
Aneurysm	64 (1.2%)	331 (9.3%)	21 (0.8%)	108 (3.8%)

VSGBI: PAD QIF

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

Endovascular

Overall, 96.4% of the endovascular revascularisations were performed between 8am and 6pm on a weekday, which was assumed to mean they had been on planned operating lists. The percentage of endovascular procedures performed on planned lists was at least 75% for all but one NHS trust among those that submitted 10 or more procedures in 2022. This suggests that, among those Trusts with high case ascertainment, most met the VSGBI PAD QIF target of at least 75% during the 2022 audit period (62 out of 63 NHS trusts, 98.4%).

Open surgical (bypass/hybrid)

There were 3,565 elective open procedures in 2022, which was an increase of about 8% compared to 3,307 in 2021, and of 23% to 2,889 in 2020. There was also a small increase in non-elective procedures, with 2,867 in 2022 compared to 2,783 procedures in 2021 and 2,554 in 2020. For open procedures in 2022, 85.4% were performed under general anaesthetic, 12.1% under regional and 2.5% under local.

There were 5,856 (92.7%) open procedures undertaken in 2022 that were performed between 8am and 6pm. This was 97.7% for elective and 86.4% for non-elective procedures. The percentage of open surgical procedures performed on planned lists was at least 75% for all but three NHS trusts that submitted 10 or more procedures in the NVR in 2022 (63 out of 66 NHS trusts, 95.5%).

VSGBI: PAD QIF

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

Endovascular

There were 5,397 patients presenting with CLTI who underwent endovascular revascularisation in 2022, of whom 2,408 (44.6%) were admitted non-electively. Among these non-elective patients:

- 48.6% were revascularised within 5 days in 2022,
- 54.5% in 2021, and
- 57.5% in 2020.

The median time from admission to intervention was:

- 6 days (IQR 3-10 days) in 2022
- 5 days (IQR 2-9 days) in 2021, and
- 4 days (IQR 2-8 days) in 2020.

Open surgical

The amount of open surgical procedures (n=4,195) for CLTI in 2022 was about the same as the number in 2021 (n=4,079). Among the 2022 cohort, 49.6% (2,079) were admitted non-electively, compared to 48.0% (1,956) in 2021. Among these non-elective patients with CLTI:

- 53.8% were revascularised within 5 days in 2022,
- 53.5% in 2021, and
- 59.4% in 2020.

The median time from admission to intervention was:

- 5 days (IQR 2-8 days) in 2022,
- 5 days (IQR 2-8 days) in 2021, and
- 4 days (IQR 2-8 days) in 2020.

All revascularisation procedures

Overall, 4,487 patients were admitted non-electively with CLTI and underwent revascularisation in 2022 (vs. 3,924 in 2021). The proportion of patients revascularised within 5 days from admission was:

- 51.0% in 2022,
- 54.0% in 2021, and
- 58.4% in 2020.

The median time from admission to intervention was:

- 5 days (IQR 3-9 days) in 2022,
- 5 days (IQR: 2-9 days) in 2021, and
- 4 days (IQR 2-8 days) in 2020.

The marked improvement noted in 2020 may have been associated with the reduction in elective activity due to the COVID-19 pandemic and has since deteriorated slightly.

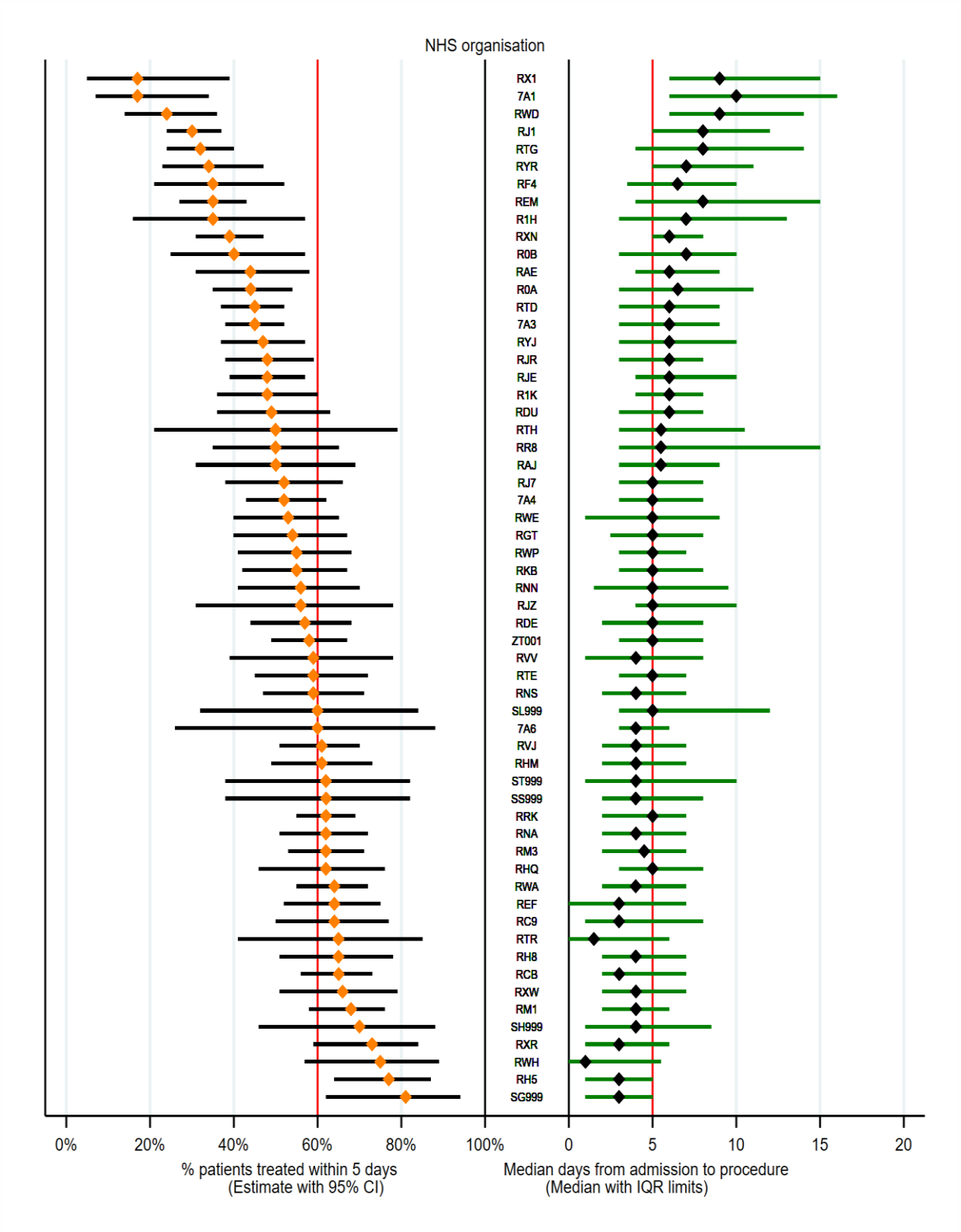
Figure 2.2 depicts the proportion of patients revascularised within 5 days from admission (left panel) across the 59 NHS trusts that performed 10 or more revascularisation procedures for non-elective CLTI admissions in 2022. The right panel summarises the median (IQR) time from admission to procedure for the same NHS trusts. The figure shows considerable variation between NHS trusts in terms of the proportion of patients with timely revascularisation in 2022.

In summary:

- at 23 vascular units, the pathway from admission to surgery took more than five days for half of patients with CLTI,
- at 12 vascular units, the pathway took longer than 10 days for a quarter of patients,
- 22 vascular units had more than half of their non-elective CLTI patients operated on within 5 days.

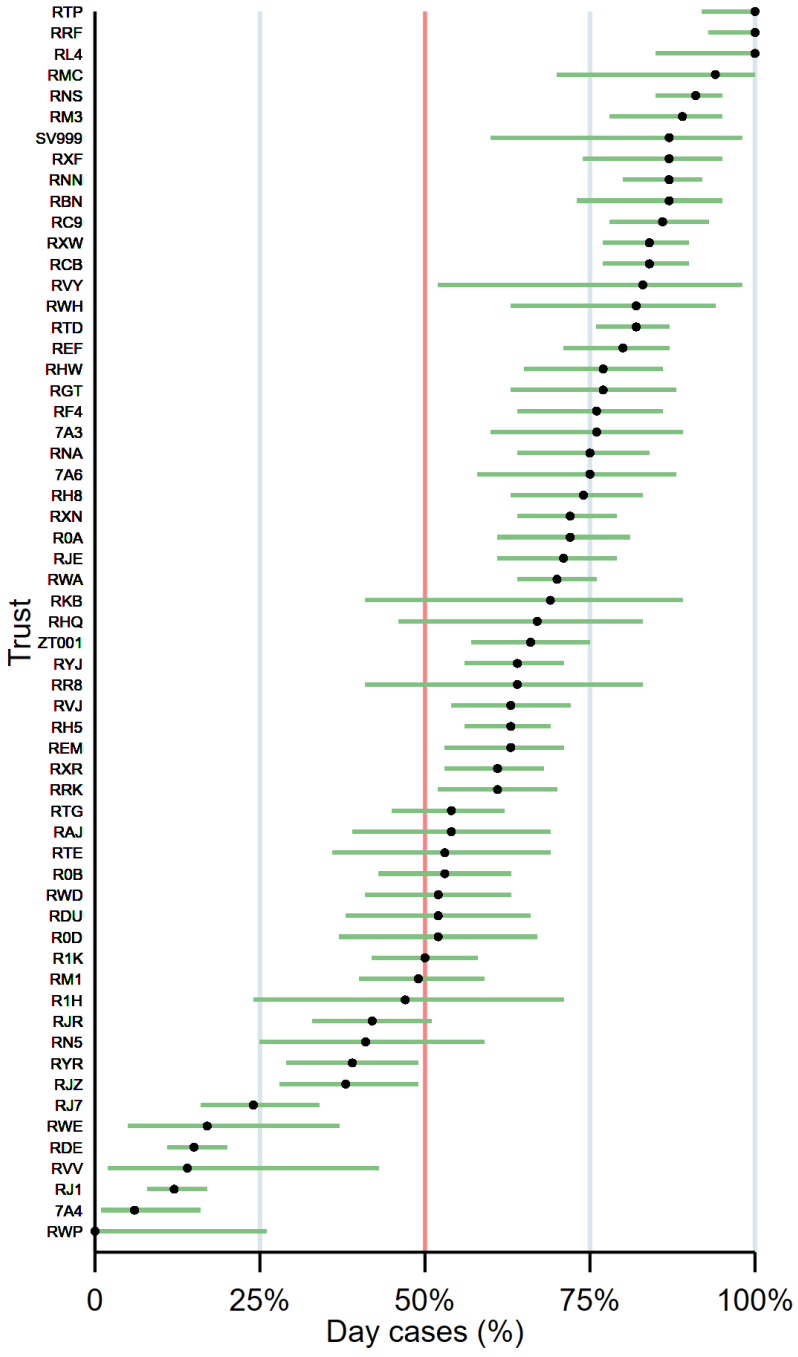
More in-depth analysis of delays to revascularisation in patients with chronic limb-threatening ischaemia can be found in Birmpili et al [2021] and Li et al [2022].

Figure 2.2: 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 2022.



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 2022 revealed substantial variation in the proportion of elective procedures done as day cases (Figure 2.3). Overall, 61.2% of elective endovascular procedures were performed as day cases in 2022, compared to 60.3% in 2021 and 58.5% in 2020.

Figure 2.3: Proportion of elective endovascular procedures performed as day cases, by NHS trust with a volume of ≥10 elective cases per year in 2022.



2.4 Outcomes of lower limb revascularisation procedures

Table 2.7 summarises the outcomes of the lower limb endovascular and open revascularisation procedures, by mode of admission. As expected, patients undergoing procedures as non-elective admissions generally had higher complication rates and re-intervention rates than those undergoing elective procedures. Patients undergoing revascularisation procedures for acute limb ischaemia also had worse outcomes, with an in-hospital mortality rate of 1.7% (95% CI 0.5-3.9) for elective and 6.5% (95% CI 4.9-8.4) for non-elective admissions, compared to 1.1% (95% CI 0.8-1.4) and 4.2% (95% CI 3.6-4.8) for CLTI patients with elective and non-elective admissions, respectively.

Table 2.7: Postoperative outcomes after lower limb revascularisation for 2022 by procedure type

	Elective		Non-elective	
	Endovascular	**Open**	**Endovascular**	**Open**
Total procedures	5,265	3,565	2,766	2,867
Post-op destination	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Ward	2,280 (43.4%)	2,637 (74.0%)	2,625 (95.1%)	2,081 (72.6%)
Level 2 (HDU/PACU)	43 (0.8%)	742 (20.8%)	52 (1.9%)	599 (20.9%)
Level 3 (ICU)	9 (0.2%)	158 (4.4%)	17 (0.6%)	185 (6.5%)
Died in theatre	0 (0.0%)	0 (0.0%)	0 (0.0%)	<5 (0.0%)
Day-case unit	2,919 (55.6%)	27 (0.8%)	66 (2.4%)	<5 (0.0%)
Complications	**Rate**	**Rate**	**Rate**	**Rate**
None	94.5	85.0	84.7	71.6
Cardiac	0.3	2.0	1.6	3.9
Respiratory	0.3	2.5	2.5	5.1
Limb ischaemia	0.4	3.1	3.7	8.0
Renal failure	0.2	0.8	0.9	2.0
Further procedures				
None	95.0	92.8	78.6	79.9
Angioplasty/stent	1.9	1.4	7.2	3.4
Bypass	1.0	1.9	3.2	3.6
Minor amputation	1.2	1.5	10.3	4.4
Major amputation	0.7	1.1	6.0	7.5
30-day major amputation	1.3	1.6	9.1	9.1
In-hospital mortality	0.6	1.4	4.2	4.6
Re-admission to higher level care	0.7	1.7	2.7	3.2
Re-admission within 30 days	7.7	10.0	16.8	13.6
	Median (IQR)	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Overall LOS (days)	0 (0 - 1)	5 (3 - 8)	14 (7 - 27)	14 (9 - 26)
Admission-to-procedure (days)	0 (0 - 0)	0 (0 - 0)	5 (2 - 9)	4 (1 - 7)
Post-op LOS (days)	0 (0 - 1)	4 (3 - 7)	6 (2 - 17)	9 (5 - 19)

Patients admitted non-electively and undergoing endovascular procedures had a similar mortality rate (4.2% [95% CI 3.5-5.0]) compared to open procedures (4.6% [95% CI 3.8-5.4]). However, a higher readmission rate within 30 days (16.8% [95% CI 15.4-18.3] for endovascular vs 13.6% [95% CI 12.3-15.0] for open surgical revascularisation) (Table 2.7).

The outcomes of the revascularisation procedures for patients with CLTI admitted non-electively are summarised in Table 2.8 for 2022, by type of revascularisation procedure (endovascular or open surgical). There are differences in outcomes according to whether patients met the 5-day target for the delay between admission and procedure, although we caution against the over-interpretation of these figures. Further work is required to identify the degree to which these differences arise from the time to surgery or from the patients having more severe disease, for which outcomes would be expected to be worse.

Table 2.8: Postoperative outcomes following lower limb revascularisation, for patients with CLTI[1] undergoing non-elective revascularisation in 2022, by admission-to-procedure time in days

	Admission-to-procedure ≤5 days		Admission-to-procedure >5 days	
	Endovascular	**Open**	**Endovascular**	**Open**
Procedures	1,164 (48.6%)	1,117 (53.8%)	1,230 (51.4%)	959 (46.2%)
	Median (IQR)	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Overall length of stay (LOS)	8 (5 - 16)	11 (7 - 19)	21 (12 - 36)	21 (14 - 36)
Post-op LOS	5 (2 - 13)	8 (4 - 16)	8 (3 - 20)	10 (6 - 23)
Complications	**Rate**	**Rate**	**Rate**	**Rate**
None	87.7	74.2	82.5	69.4
Cardiac	1.6	3.3	1.4	4.6
Respiratory	1.8	3.8	2.7	5.9
Limb ischaemia	2.6	7.8	4.2	7.3
Renal	0.9	1.5	1.1	1.9
Further unplanned procedures				
None	78.4	80.7	78.4	78.8
Angioplasty/stent	7.0	4.0	7.4	3.3
Bypass	3.3	3.4	2.2	3.6
Minor amputation	11.2	5.0	11.2	6.5
Major amputation	5.5	7.4	6.0	6.7
30-day major amputation	8.6	9.0	9.3	8.0
In-hospital mortality	2.8	3.9	5.3	4.8
Re-admission to higher level care	1.9	2.6	2.9	2.5
Re-admission within 30 days	16.4	14.4	18.2	12.4

[1] Fontaine score 3 or 4

There were 2,003 hybrid procedures in 2022, of which 1,032 had endovascular elements above the surgical element angioplasties (618 elective, 414 non-elective), and 381 hybrid procedures in which the endovascular element was below (198 elective, 183 non-elective); the other procedures did not fit within these simple categories. The rate of postoperative complications differed slightly depending on whether the endovascular element was proximal (above) or distal (below) the surgical element. The rate of any complication was 13.1% for proximal and 9.1% for distal elective cases and 26.1% for proximal and 27.3% for distal non-elective cases. The rates of unplanned procedures after proximal and distal angioplasties were 7.4% vs 6.1% for elective and 18.6% vs 24.0% for non-elective procedures. The reasons for this will be explored in the coming year.

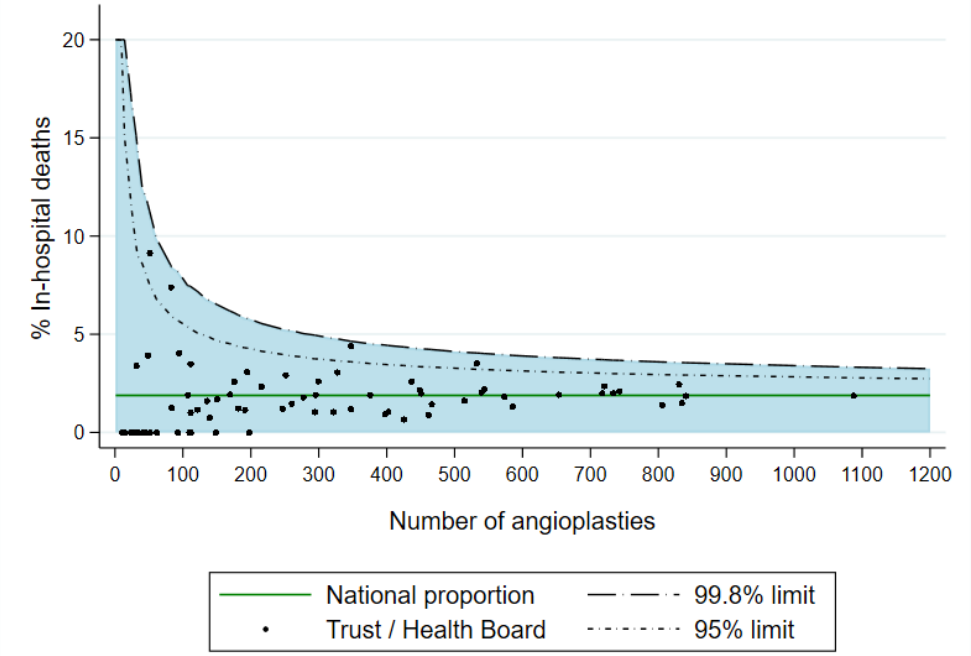
2.5 Postoperative mortality rates for lower limb revascularisations

Figure 2.5 presents the risk-adjusted mortality rates for each NHS trust that submitted 10 or more endovascular revascularisations between January 2020 and December 2022. 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 1.9% (95% CI: 1.7 to 2.1).

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 and smoking status.

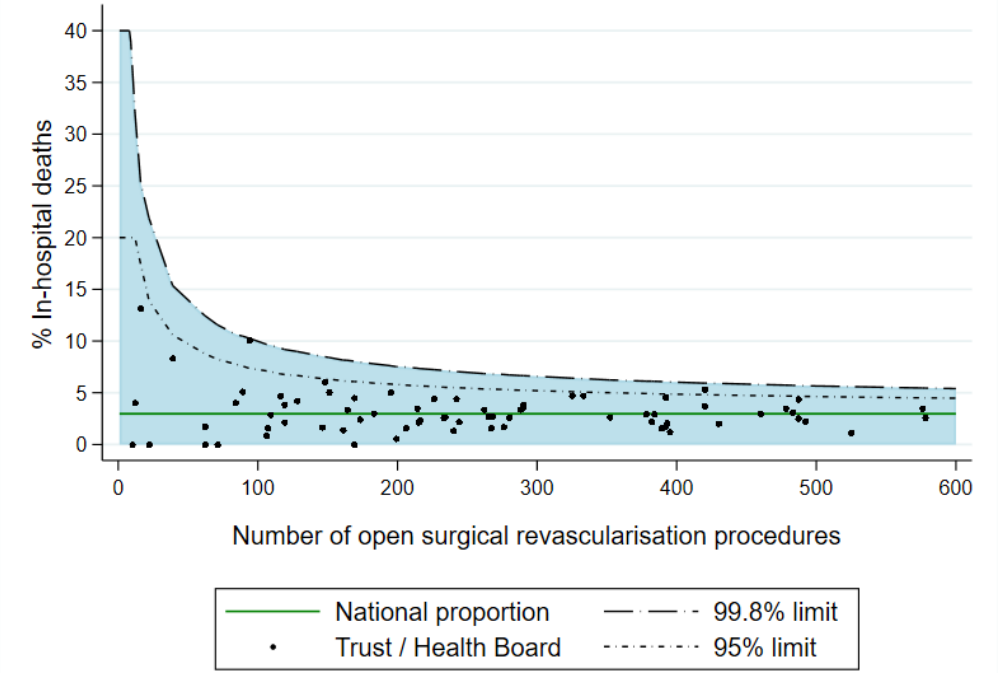
The funnel plot for open surgical procedures is shown in Figure 2.6. All NHS trusts had risk-adjusted mortality rates that were within the expected range of the national average (=3.0%, 95% CI: 2.7 to 3.2). The risk adjustment model accounted for age, sex, procedure type, Fontaine score, mode of admission, ASA grade, chronic lung disease, use of antiplatelets, white blood count and haemoglobin, creatinine, sodium and potassium levels.

Figure 2.5: Funnel plot of risk-adjusted in-hospital deaths after lower limb endovascular revascularisation for NHS trusts from January 2020 to December 2022.



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

Figure 2.6: Funnel plot of risk-adjusted in-hospital deaths from lower limb bypass for NHS trusts, shown for procedures performed between January 2020 and December 2022.



3. Major lower limb amputation

3.1 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 2022 to December 2022.

During this period, 3,505 primary major unilateral amputations were recorded in the NVR, which consisted of 1,850 (52.8%) below the knee amputations (BKAs) and 1,655 (47.2%) above the knee amputations (AKAs). Through knee amputations (TKAs) have been analysed as part of the BKA group. TKAs accounted for 3.7% of all major amputations recorded on the NVR during the 1-year audit period.

In addition, NHS hospitals submitted information on 913 minor amputations, and other types of major amputation (58 bilateral, 30 due to trauma and 534 that were performed within 30 days of a lower limb revascularisation procedure). This chapter focuses on major unilateral lower limb amputations that were primary procedures, and these other types of procedure were not included in the analysis.

During the pandemic, there was a slight reduction in the number of unilateral major amputations undertaken within the NHS in 2020 and 2021, compared to 2019 (3,703 procedures). However, an increase of more than 300 major amputations were performed in 2022 than in 2019, which could be an indirect impact from COVID 19 (Table 3.1).

The estimated case ascertainment for major unilateral lower limb amputations has remained stable, and the overall level exceeds the target of 85% recommended within the 2018 GIRFT vascular surgery report [Horrocks 2018]. Nonetheless, many NHS trusts are still failing to record a large proportion of their major lower limb amputations in the NVR.

Table 3.1: Estimated case ascertainment for major lower limb vascular amputations by year

Case ascertainment	2019	2020	2021	2022
NVR procedures	3,262	3,677	3,601	4,032
Expected procedures	4,338	4,287	4,343	4,587
Estimated case ascertainment	75%	86%	83%	89%

Table 3.2: Estimated case ascertainment rates in 2022 by UK country

	Major Lower Limb Amputation
England	90%
Wales	100%
Scotland	44%
Northern Ireland	100%

3.2 Patient Characteristics

Table 3.3: Characteristics of patients undergoing major unilateral lower limb amputation in 2022

	Below knee	%	Above knee	%
Total procedures	1,850		1,655	
Age group (years)				
Under 60	584	31.7	299	18.1
60 to 64	286	15.5	224	13.6
65 to 69	290	15.7	265	16.1
70 to 74	243	13.2	285	17.3
75 to 79	239	13.0	257	15.6
80 and over	203	11.0	320	19.4
Sex				
Men	1,425	77.0	1,171	70.8
Women	425	23.0	484	29.2
Smoking				
Current smoker	533	29.4	645	39.3
Ex-smoker	848	46.7	734	44.7
Never smoked	435	24.0	263	16.0
Presenting problem				
Acute limb ischemia	167	9.0	329	19.9
Chronic limb ischemia	528	28.6	460	27.8
Neuropathy	24	1.3	12	0.7
Tissue loss	663	35.9	582	35.2
Uncontrolled infection	466	25.2	255	15.4
Aneurysm	1	0.1	15	0.9
Previous ipsilateral limb procedure	1,019	61.2	745	50.9
Type of previous ipsilateral limb procedure				
Minor amputation only	183	18.2	34	4.6
Angioplasty/stent	458	45.7	209	28.6
Surgical revascularisation	310	30.9	309	42.2
Major amputation	52	5.2	180	24.6

Table 3.4: Preoperative risk factors among patients undergoing lower limb amputation in 2022

	Below knee	%	Above knee	%
Total procedures	1,850		1,655	
Pre-op ASA grade				
Normal	8	0.4	5	0.3
Mild disease	126	6.8	48	2.9
Severe, not life-threatening disease	1,329	71.8	966	58.4
Severe, life-threatening disease, or moribund patient	387	20.9	635	38.4
Comorbidities				
None	133	7.2	148	8.9
Diabetes	1,334	72.1	813	49.1
Hypertension	1,108	59.9	1,039	62.8
Chronic lung disease	345	18.6	456	27.6
Ischaemic heart disease	608	32.9	591	35.7
Chronic heart failure	211	11.4	252	15.2
Chronic renal disease	433	23.4	301	18.2
Stroke	145	7.8	229	13.8
Active/managed cancer	112	6.1	135	8.2
Medication				
None	14	0.8	11	0.7
Anti-platelet	1,259	68.1	1,055	63.7
Statin	1,305	70.5	1,131	68.3
Beta-blocker	532	28.8	541	32.7
ACE inhibitor/ARB	641	34.6	528	31.9
Antibiotic prophylaxis	1,682	90.9	1,485	89.7
DVT prophylaxis	1,281	69.2	1,135	68.6
Oral anticoagulant	393	21.2	408	24.7

3.3 Care Pathways

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 patients' condition before their operation. The median time from vascular assessment to amputation in 2022 was:

- 8 days (IQR: 3 to 20 days) for non-elective patients,
- 37 days (IQR: 14 to 102 days) for elective patients, and
- 10 days (IQR: 3 to 29 days) for all patients.

Figure 3.1 describes the median and interquartile range (IQR) of the time to amputation from vascular assessment for patients admitted non-electively between 2020 and 2022. On average, patients undergoing a major amputation in non-elective admission in 2022 waited about one day longer than those in 2021 and 2020.

Figure 3.1: Distribution of times from vascular assessment to non-elective amputation by month between January 2020 and December 2022. The median is shown by the line within the blue box (whose limits are the 25th and 75th percentile). The red line is the overall median time of 7 days

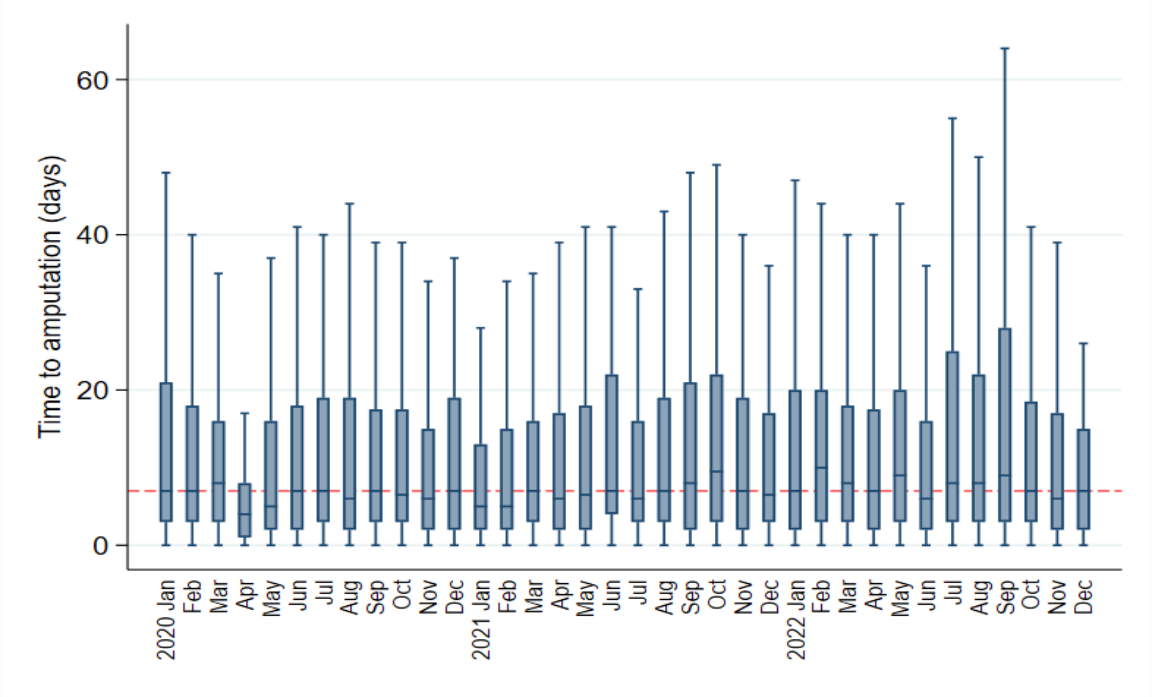


Figure 3.2 describes the times from vascular assessment to amputation by NHS trust for patients admitted non-electively in 2022. The graph shows some variation across NHS trusts in the median wait, but among the 25% of patients at each trust who have the longest waits, there was a considerably greater variation across NHS trusts.

At 14 NHS trusts, more than 25% of patients had a wait that exceeded 30 days.

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 shown in Figure 3.2. Vascular units should investigate the cause of this and attempt to reduce the longer times as much as possible.

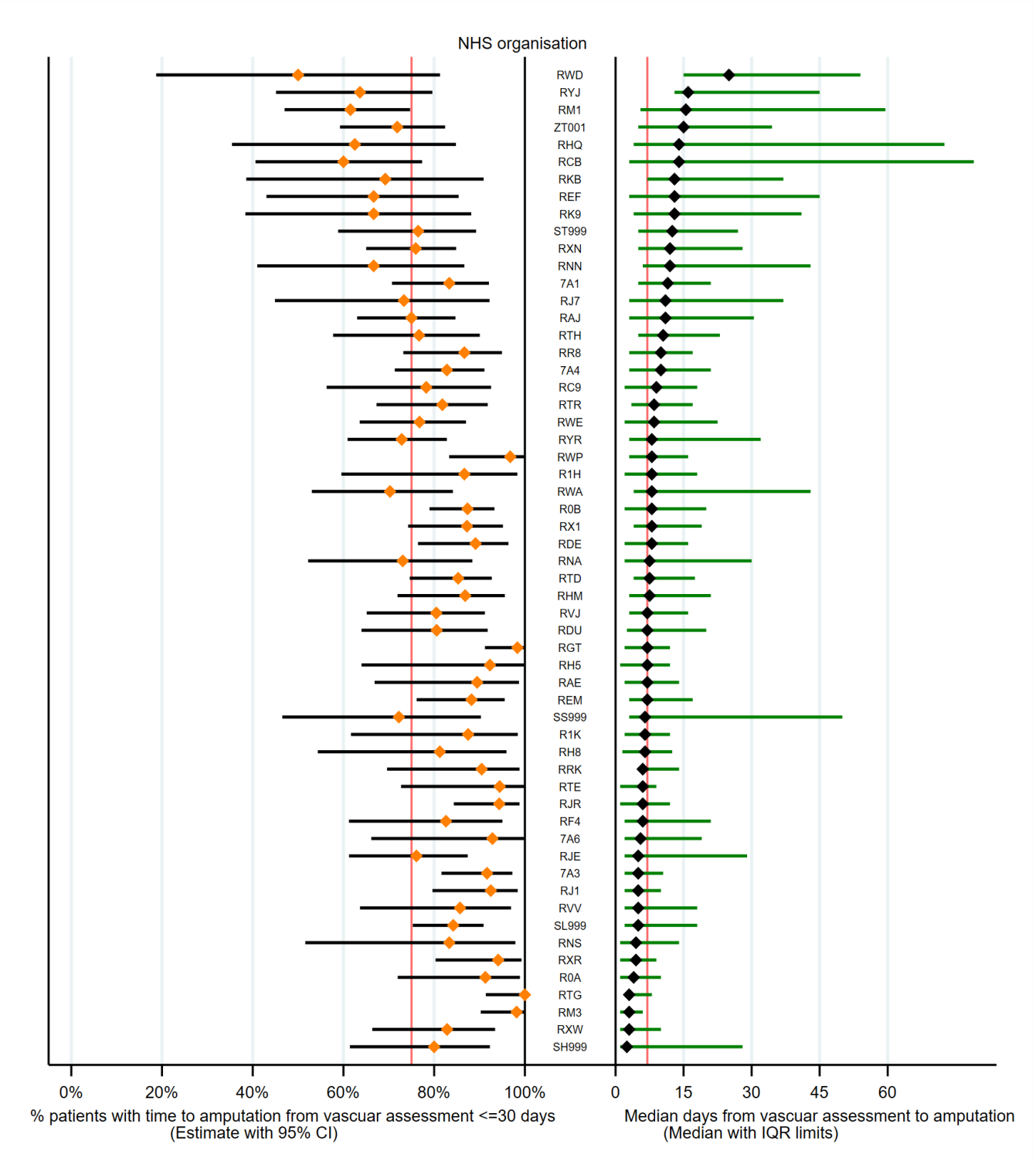
VSGBI: Amputation QIF

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

Figure 3.3 describes the volume of activity and the AKA:BKA ratio in 2022, by NHS trust. Nationally, the AKA:BKA ratio was 0.89 (95% CI: 0.84 to 0.96) in 2022, suggesting a marked decrease compared to 1.00 (95% CI: 0.93 to 1.07) in 2021. Most of the NHS trusts had a ratio of less than one (33 out of 60 trusts). Six vascular units that had a ratio above 2, and two of them had a ratio more than 5.

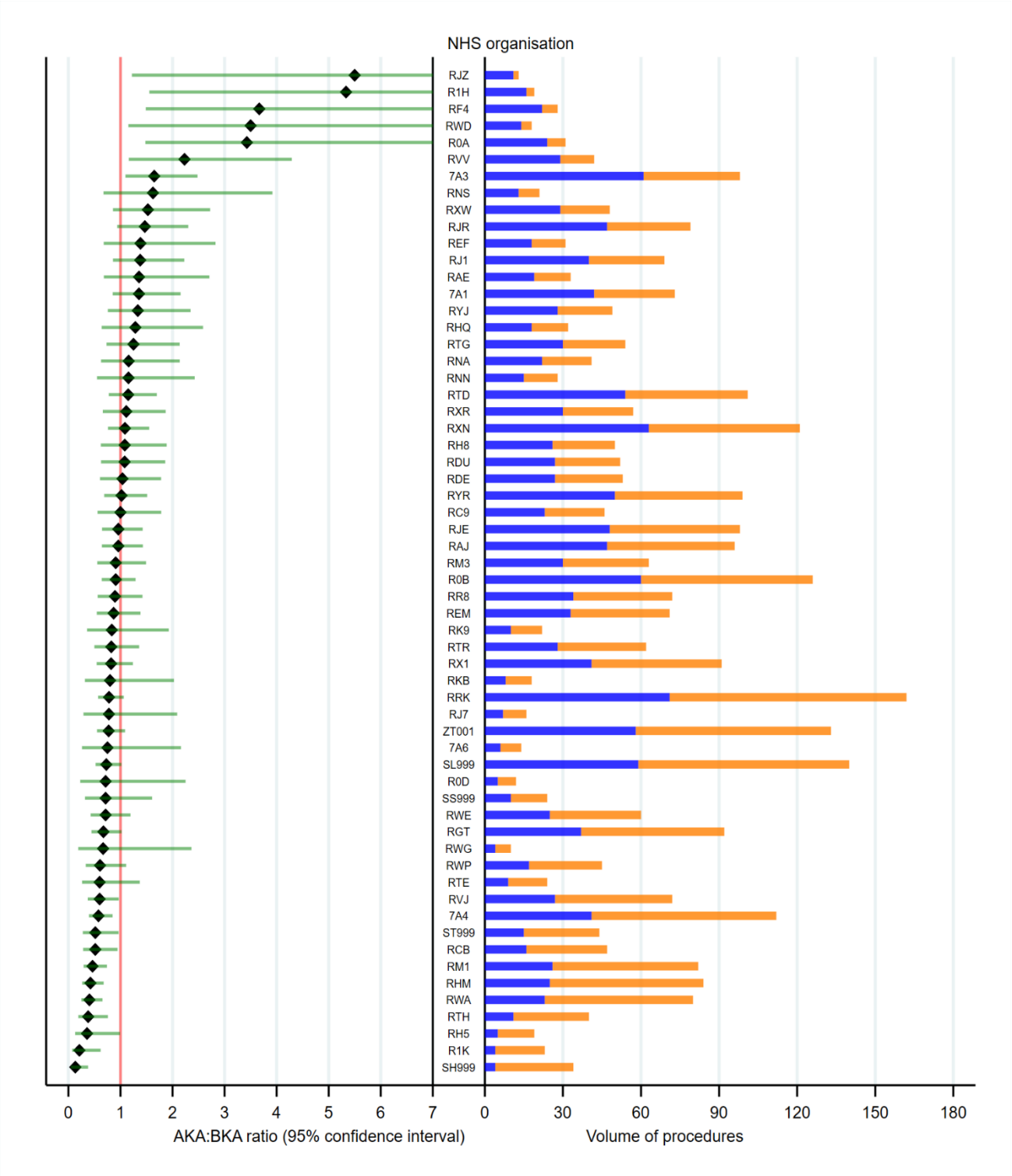
It is possible that the high ratios relate to some NHS trusts treating more severely ill patients, although it is not possible to confirm this with the data collected in the NVR.

Figure 3.2: Median (IQR) time from vascular assessment to non-elective amputation for procedures performed in 2022, by NHS trust[1], together with percentage (95% CI) of patients with time to amputation from vascular assessment <30 days.



[1]Figure presents NHS trusts reporting ≥10 non-elective major amputations in 2022.

Figure 3.3: Volume and ratio of above knee to below knee amputations for procedures performed in 2022, by NHS trust[1]. The blue horizontal line indicates the volume of above knee amputations, and the orange horizontal line shows the volume of below knee amputations.



[1]Figure presents NHS trusts reporting ≥10 major amputations in 2022.

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 3.5 summarises some key aspects of perioperative care for BKA and AKA patients. Performance against these standards was generally reasonable in 2022, but the figures suggest there is potential for improvement:

- The proportion of below knee and above knee major amputations performed during the day was 92.5% and 90.0%, respectively, which were similar to annual rates in years 2019 to 2021.
- A consultant surgeon was present for just over 70% of the procedures. The consultant presence rates were similar to 2021 (BKA=73.0%; AKA=72.2%), however they were lower than the pre-pandemic level in 2019 (BKA=80.0%; AKA=79.1%).
- Overall, prophylactic antibiotics and DVT medication were recorded for 90.4% and 68.9% of patients, respectively.

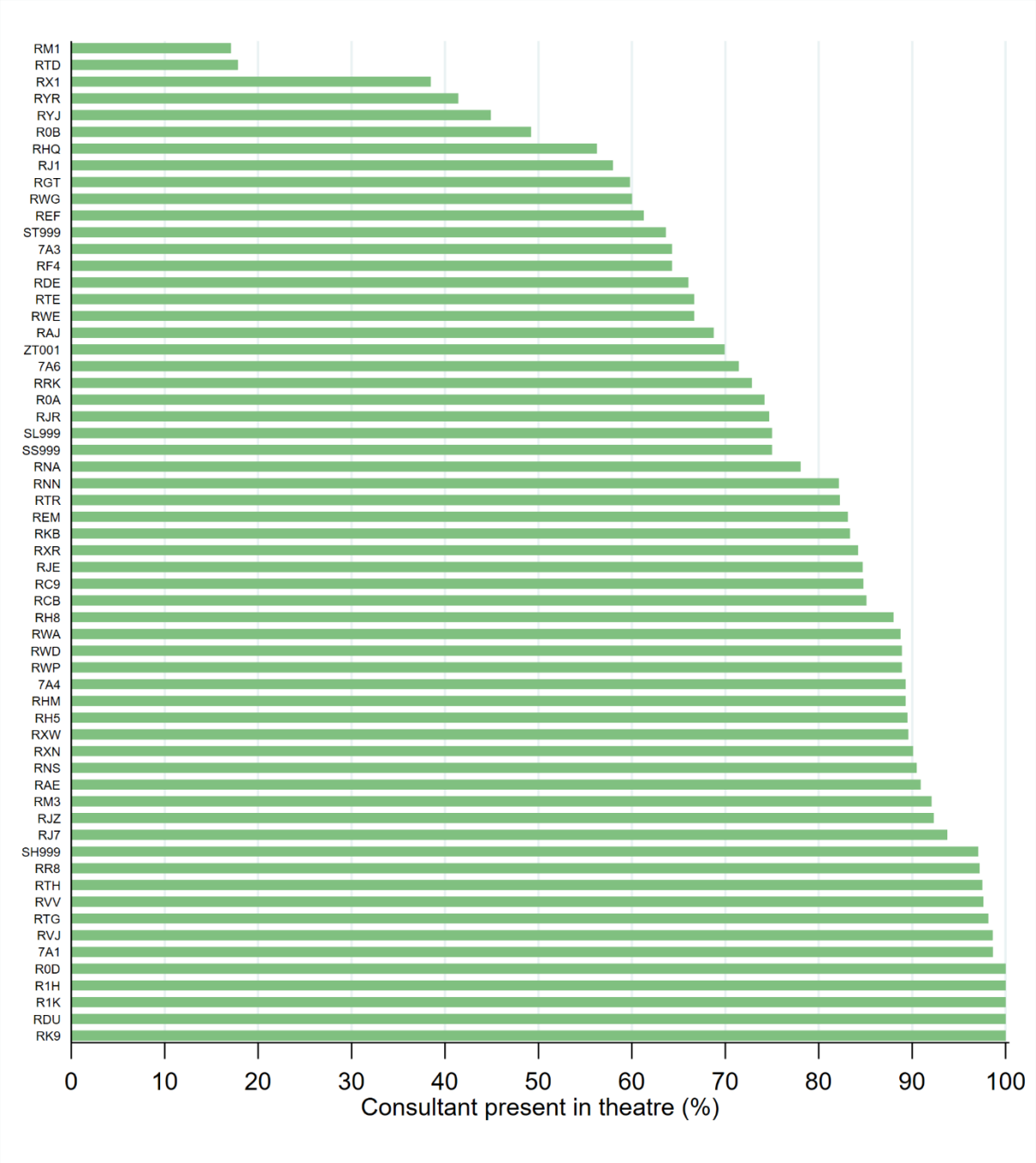
While many NHS trusts followed the recommendation that a consultant should be present in theatre during the audit period, there is some variation in practice across NHS organisations (Figure 3.4). Vascular units should investigate the reasons for this variation.

The NVR IT system was updated in July 2021 to make the collection of prophylaxis medication data more intuitive. The observed levels of prophylactic antibiotics were significantly improved ever since. More specifically, 90.4% of patients in 2022 were recorded having prophylactic antibiotics vs 83.3% in 2021, 68.4% in 2020 and 70.0% in 2019. The increase in the reported rates probably reflects the change of NVR IT system.

Table 3.5: Perioperative care of patients undergoing lower limb major amputation in 2022

	Below knee	%	Above knee	%
Procedures	1,850		1,655	
Mode of admission				
Elective	355	19.2	220	13.3
Non-elective	1,495	80.8	1,435	86.7
Time procedure started				
8am to 6pm	1,711	92.5	1,489	90.0
6pm to midnight	106	5.7	135	8.2
Midnight to 8am	33	1.8	31	1.9
Consultant present in theatre	1,386	74.9	1,211	73.2
Prophylactic medication				
Antibiotic prophylaxis	1,682	90.9	1,485	89.7
DVT prophylaxis	1,281	69.2	1,135	68.6

Figure 3.4: Percentage of major amputations where a consultant surgeon was present in theatre in 2022, by NHS trust[1]



[1]Figure presents NHS trusts reporting ≥10 lower limb major amputations performed in 2022

3.4 In-hospital outcomes following major amputation

Patient outcomes immediately following a major lower limb amputation are summarised in Table 3.6.

The overall rate of in-hospital death in 2022 was 7.8% (95% CI: 6.9% to 8.7%), similar to the rates in 2021 and 2019, whilst the mortality rate in 2020 was slightly higher, 8.4% (95% CI: 7.5% to 9.4%).

The 30-day in-hospital mortality was 6.3% (95% CI: 5.5% to 7.1%), which were similar to the rates in 2021 and 2019, whereas the rate in 2020 was slightly higher, 7.1% (95% 6.2% to 8.1%).

The overall median length of hospital stay in 2022 associated with major lower limb amputations was 22 days (IQR: 14 to 38). Most patients returned to the ward following a major amputation, while 9.8% of BKA patients and 16.8% of AKA patients were admitted to critical care (level 2 or level 3).

Overall, 27.8% of patients in 2022 suffered at least one of the reported complications following a major amputation. Respiratory complications occurred in 5.9% of BKAs and 9.6% of AKAs for procedures performed in 2022, which were similar to the rates in 2021 (6.3% BKAs and 9.0% AKAs), whilst a marked reduction from the rates of 8.1% and 11.3% for BKAs and AKAs, respectively, in 2020.

Table 3.6: Patient outcomes following major lower limb amputations undertaken in 2022

	Below knee		Above knee	
Procedures	1,850		1,655	
Post-op destination				
Ward	1,666	90.2%	1,374	83.2%
Level 2 (HDU/PACU)	125	6.8%	157	9.5%
Level 3 (ICU)	55	3.0%	121	7.3%
	Median	**IQR**	**Median**	**IQR**
Days in level 2 critical care	2	1 to 4	3	1 to 5
Days in level 3 critical care	3	2 to 6	5	2 to 8
Overall length of stay (days)	22	14 to 38	23	14 to 37
Postoperative length of stay (days)	15	9 to 27	16	10 to 27
	Rate	**95% CI**	**Rate**	**95% CI**
Overall in-hospital mortality	5.9	4.8 to 7.0	10.0	8.6 to 11.6
30-day in-hospital mortality	4.4	3.5 to 5.5	8.4	7.1 to 9.9
Procedure complications				
Respiratory	5.9	4.9 to 7.1	9.6	8.2 to 11.1
Cardiac	3.5	2.7 to 4.4	5.6	4.6 to 6.8
Limb ischaemia	3.4	2.6 to 4.3	2.7	1.9 to 3.6
Renal failure	1.8	1.2 to 2.5	3.1	2.3 to 4.0
Surgical site infection	4.9	4.0 to 6.0	4.4	3.4 to 5.4
Postoperative confusion	2.5	1.8 to 3.3	2.4	1.7 to 3.3
Haemorrhage	0.2	0.1 to 0.5	0.5	0.2 to 1.0
Cerebral	0.4	0.2 to 0.8	0.5	0.2 to 1.0
No defined complications	74.2	72.1 to 76.1	70.1	67.8 to 72.3
Return to theatre	8.8	7.5 to 10.1	6.3	5.2 to 7.6
Re-admission to higher level care	2.3	1.7 to 3.1	2.4	1.7 to 3.2

Table 3.7: Patient outcomes following major lower limb amputation performed in 2022

	Admission-to-procedure ≤5 days		Admission-to-procedure >5 days	
	No.		**No.**	
Procedures	2,017	57.5%	1,488	42.5%
Days in critical care	**Median**	**IQR**	**Median**	**IQR**
Level 2	2	1 to 4	3	2 to 5
Level 3	4	2 to 7	5	2 to 9
Overall length of stay (days)	16	10 to 26	33	22 to 53
Post-op length of stay (days)	14	8 to 24	17	10 to 30
	Rate	**95% CI**	**Rate**	**95% CI**
Overall in-hospital mortality	7.0	5.9 to 8.2	8.9	7.5 to 10.5
30-day in-hospital mortality	5.9	4.9 to 7.1	6.8	5.5 to 8.2
No defined complications	73.9	71.9 to 75.8	70.0	67.6 to 72.3
Return to theatre	7.7	6.6 to 8.9	7.5	6.2 to 8.9
Re-admission to higher level care	2.2	1.6 to 2.9	2.6	1.8 to 3.5

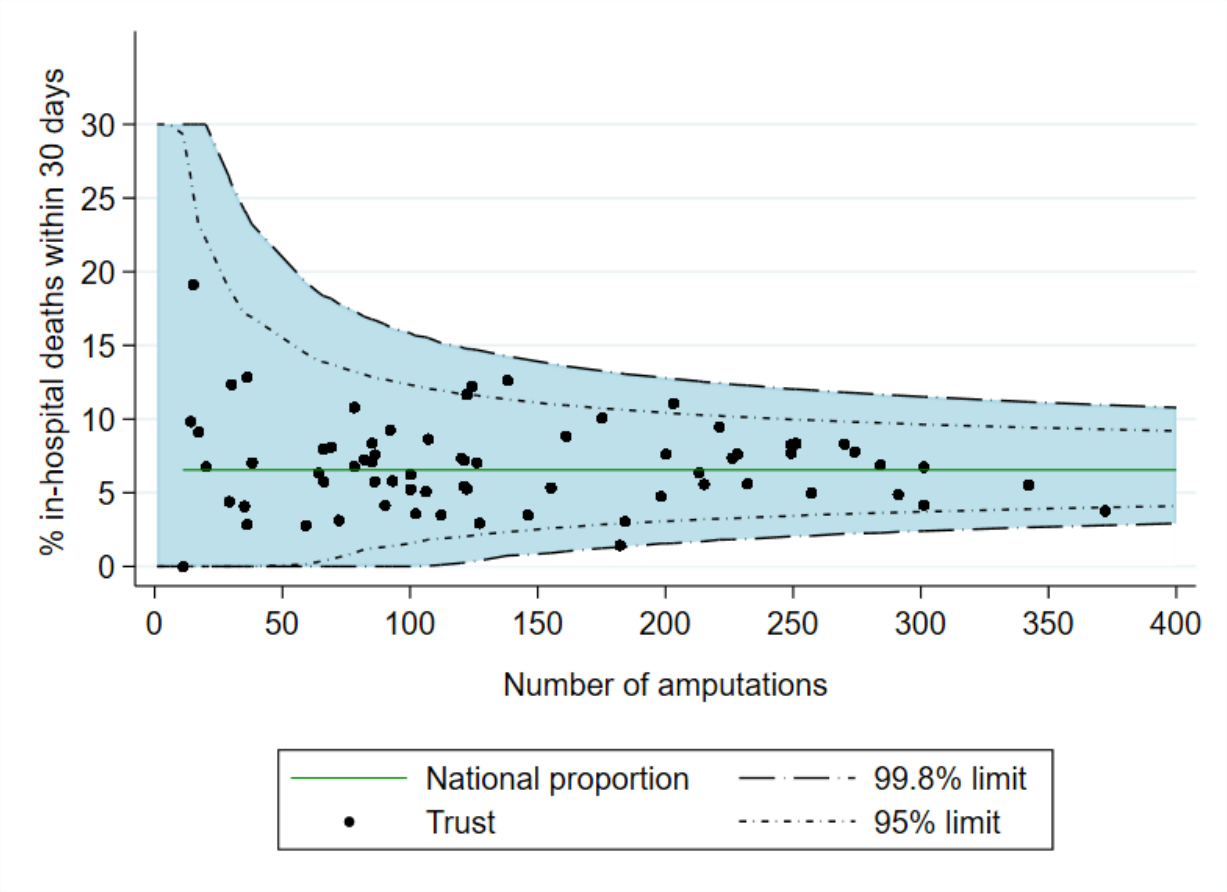
Outcomes for patients undergoing major amputations, by preoperative length of stay, are summarised in Table 3.7. About 58% of the patients underwent amputation within 5 days of admission. In comparison with the results for lower limb bypass and endovascular revascularisation, the differences in outcomes were small between patients with comparatively short and long times from admission to surgery.

The adjusted 30-day in-hospital mortality figures following a major unilateral lower limb amputation for NHS trusts are shown in Figure 3.5. All NHS trusts had an adjusted rate that fell within the expected range from the national average of 6.5%.

For elective cases, the rates were adjusted for age, ASA grade (1-3 vs 4-5) and comorbid chronic renal disease. For non-elective cases, the risk adjustment model also included level of amputation (below or above the knee).

Among those who had unilateral major lower limb amputations undertaken within 30 days after revascularisation and were excluded from the main analysis, the overall rate of in-hospital death was 9.5% (95% CI: 7.1% to 12.3%) and the 30-day in-hospital mortality was 6.8% (95% CI: 4.8% to 9.3%).

Figure 3.5: Risk-adjusted 30-day in-hospital death rate following major amputation for procedures undertaken during January 2020 and December 2022[1], shown in comparison to the three-year overall national average of 6.5%



[1]Figure presents NHS trusts reporting ≥10 major lower limb amputations between January 2020 and December 2022.

3.5 Discharge and follow-up

Table 3.8: Discharge and follow-up of patients undergoing lower limb amputations in 2022, among patients discharged alive

	Below knee (n=1,688)	%	Above knee (n=1,471)	%
Wound healed at 30 days*	592	77.9	576	86.9
Referred to rehabilitation/limb fitting	1,440	85.6	1,054	71.8
Re-admission within 30 days*	164	9.8	140	9.5

* Figures calculated from patient records with available follow-up data

4. Repair of elective infra-renal abdominal aortic aneurysm

4.1 Background

An abdominal aortic aneurysm (AAA) 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 organisation of vascular services undertaking AAA repair continues to evolve. The number of NHS vascular units performing any AAA repairs decreased from 72 in 2020 to 69 in 2022.

The National Abdominal Aortic Aneurysm Screening Programme (NAAASP) 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 number of elective infra-renal AAA repairs being performed has decreased over the last three years, partly as a consequence of the COVID-19 pandemic. The number of procedures was 3,551 in 2019, but fell to 2,399 in 2020, a reduction of 32% from the previous year. In 2021 and 2022, the numbers increased again to around 2,800 procedures, but this is still below the level observed in 2019 and suggests there is a large backlog of patients with an AAA waiting for surgery.

In the last decade, there has been a decrease in the proportion of elective AAA repairs performed as endovascular (EVAR) procedures. The reasons for this could be a more conservative approach to treatment (particularly in older, sicker patients) and the influence of the draft NICE guidance, which favoured open repair over an endovascular approach.

Table 4.1: Estimated case ascertainment of elective infra-renal AAA repairs*

	2019	2020	2021	2022
Audit procedures	3,551	2,399	2,858	2,833
Expected procedures	3,827	2,620	3,089	3,158
Estimated case ascertainment	93%	92%	93%	90%

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

Table 4.2: Estimated case ascertainment rates in 2022 by UK country

	Elective infra-renal AAA repair
England	90%
Wales	100%
Scotland	66%
Northern Ireland	100%

Over the last three years, the proportion of EVAR procedures has been fairly stable, fluctuating around 60% (Table 4.3). There is a distinct pattern in the numbers of patients having open and endovascular procedures among the age groups, with open repairs being more common among patients aged under 70 (Figure 4.1). The majority of procedures were performed for patients with an AAA diameter between 5.5 and 7.0 cm.

Figure 4.2 shows the proportion of EVARs in the left panel. The black horizontal bars depict their 95% confidence intervals. The right panel shows the number of open repairs (orange bars) and EVARs (blue bars) for 2022 by NHS trust. 21 of the 61 (34%) Trusts were performing more open repairs than EVARs.

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.

Table 4.3: Split of open and endovascular elective infra-renal AAA procedures by year

Year	Open	EVAR	Total	% EVAR
2020	945	1,454	2,399	60.6
2021	1,128	1,730	2,858	60.5
2022	1,144	1,689	2,833	59.6
Total	3,217	4,873	8,090	60.2

Figure 4.1: Distribution of elective infra-renal AAA repairs by age group between 2020 and 2022

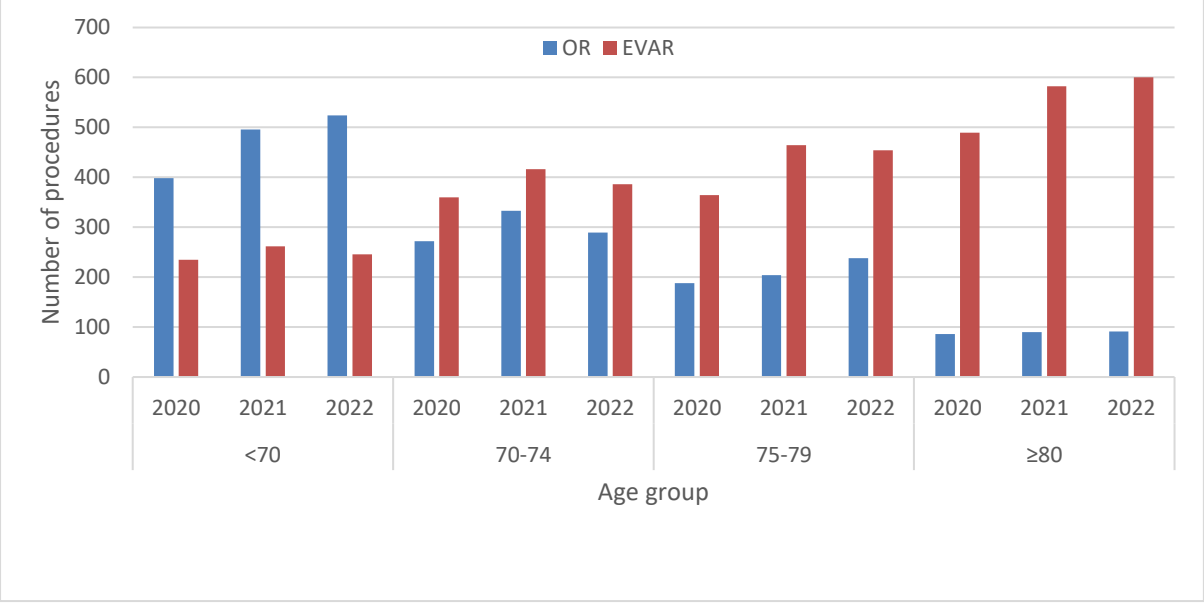
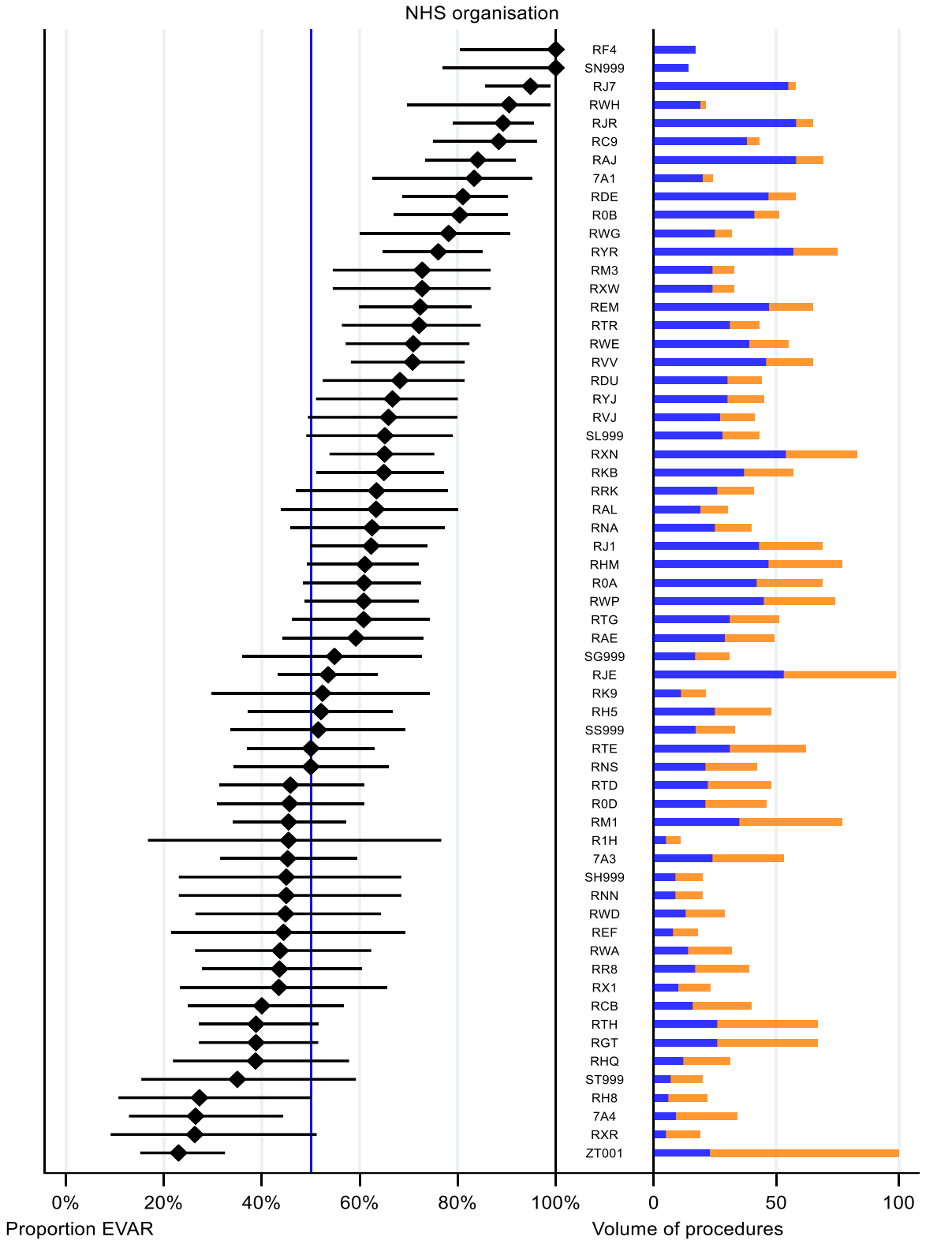


Figure 4.2: Percentage of EVARs (left panel) and number of open repairs and EVARs (right panel) by NHS trust in 2022 with at least 10 procedures. Orange bars show open repairs and blue bars show EVARs.



4.2 Patient Characteristics

Table 4.4: Characteristics of patients who had elective infra-renal AAA repair between January and December 2022

		Open repair	%	EVAR	%	Total
Total procedures		1,144		1,689		2,833
Age group (years)	Under 66	241	21.1	89	5.3	330
	66 to 75	637	55.8	641	38.0	1278
	76 to 85	262	22.9	802	47.6	1064
	86 and over	2	0.2	154	9.1	156
Male		1,061	92.7	1,542	91.3	2,603
Female		83	7.3	147	8.7	230
Current smoker		303	26.5	303	18.0	606
Previous AAA surgery		23	2.0	104	6.2	127
Indication	Screen detected	672	60.0	757	47.8	1,429
	Non-screen	326	29.1	607	38.3	933
	Other	122	10.9	219	13.8	341
AAA diameter (cm)	Under 5.5	85	7.4	186	11.0	271
	5.5 to 6.9	923	80.7	1,283	76.1	2,206
	7.0 and over	136	11.9	218	12.9	354
ASA fitness grade	1,2	329	28.8	277	16.4	606
	3	772	67.5	1,289	76.3	2,061
	4,5	43	3.8	123	7.3	166
Comorbidities	Hypertension	736	64.3	1,145	67.8	1,881
	Ischemic heart disease	322	28.1	633	37.5	955
	Chronic heart failure	27	2.4	109	6.5	136
	Stroke	56	4.9	130	7.7	186
	Diabetes	163	14.2	296	17.5	459
	Chronic renal failure	127	11.1	229	13.6	356
	Chronic lung disease	249	21.8	478	28.3	727

4.3 Pre-operative pathway for elective infra-renal aneurysms

Table 4.5: Overall compliance with standards related to the VSGBI elective AAA care pathway

	Percentage of patients meeting standard		
	2022	2021	2020
Elective patients were discussed at MDT meetings	2,490/2,833 (87.9%)	86.0%	85.2%
Patients with an AAA diameter ≥5.5cm deemed suitable for repair had a preoperative CT/MR angiography assessment	2,395/2,560 (93.6%)	91.8%	90.9%
Patients underwent a formal anaesthetic review	2,749/2,833 (97.0%)	97.1%	97.2%
Patients whose anaesthetic review was done by a consultant vascular anaesthetist	2,529/2,748 (92.0%)	92.2%	92.1%
Patients who had their fitness measured	2,352/2,831 (83.1%)	83.0%	80.4%
Most common assessment methods:			
CPET	1,344/2,352 (57.1%)	51.4%	51.9%
Echocardiogram	1,086/2,352 (46.2%)	46.2%	42.2%

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].

Figure 4.3 (overleaf) summarises the variation among the 59 NHS organisations with 10 or more AAA repairs in the median (IQR) time from vascular assessment to surgery in 2022.

In the right panel, the black diamonds show that the median delay at the majority of vascular units tended to fall within the range of 50 to 160 days (median 87: IQR 48-146). At three vascular units, a quarter of patients who had operations in 2022 waited more than 240 days.

In the left panel of Figure 4.3, the orange diamonds show the proportion of patients who had their procedure within 8 weeks after their CT/MR angiography assessment (32% nationally). The grey horizontal bars depict their 95% confidence intervals. The red line shows the 80% target indicated by NAAASP.

There are legitimate reasons why patients wait for surgery, such as the optimisation of comorbid medical conditions. However, 240 days is four times greater than the National AAA Screening Programme target of 8 weeks from date of referral to surgery (and this analysis also under-estimates this figure by being restricted to the time from vascular assessment to surgery). The values for the individual organisations can be found in the online appendices spreadsheet.

Figure 4.4 shows the distribution of patient times within each month between January 2020 and December 2022. 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.

Figure 4.3: Median (IQR) time from assessment to treatment (days) for patients who had elective infra-renal AAA repair between January and December 2022 (black diamonds) and proportion seen within 8 weeks of assessment (orange diamonds)

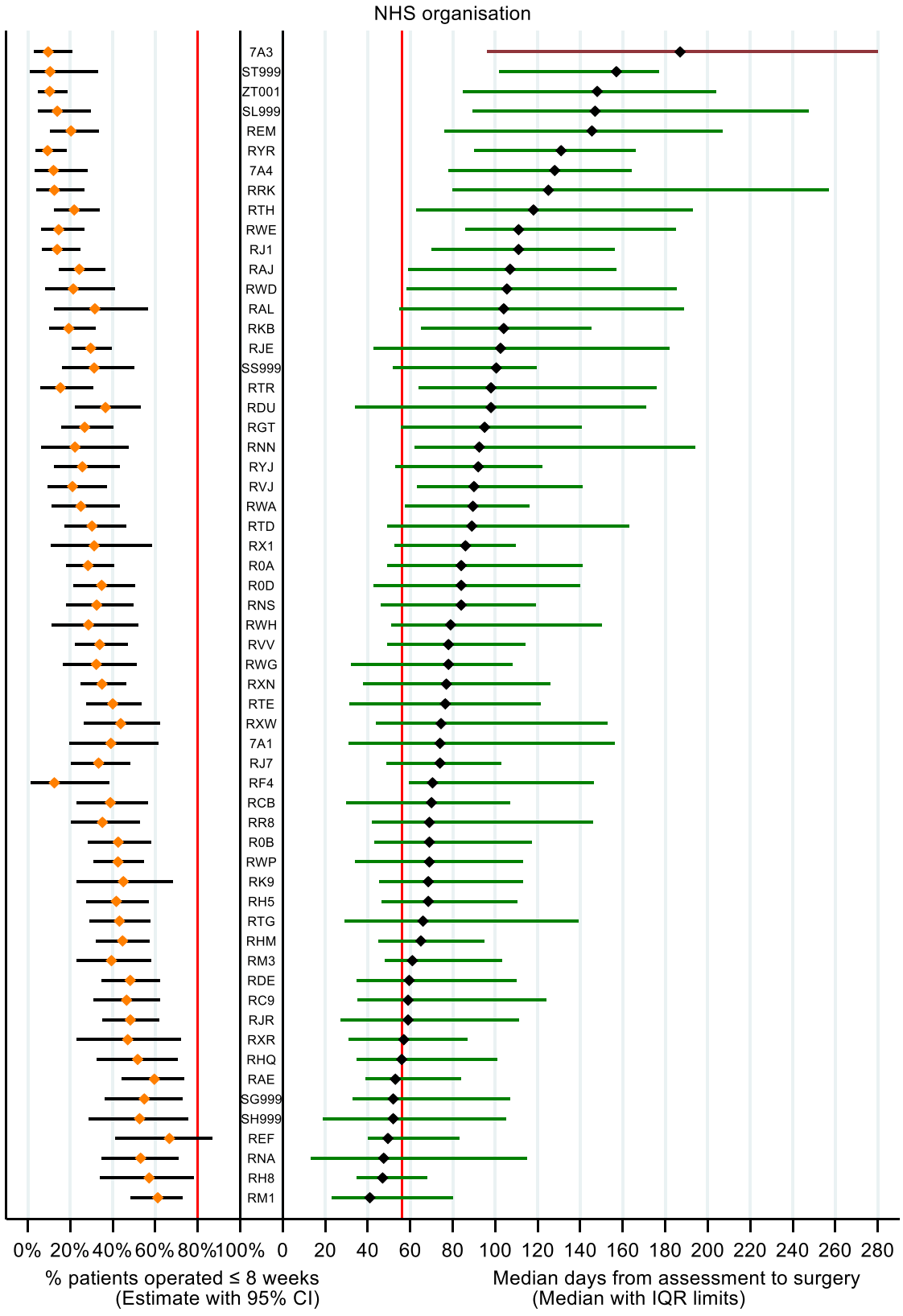
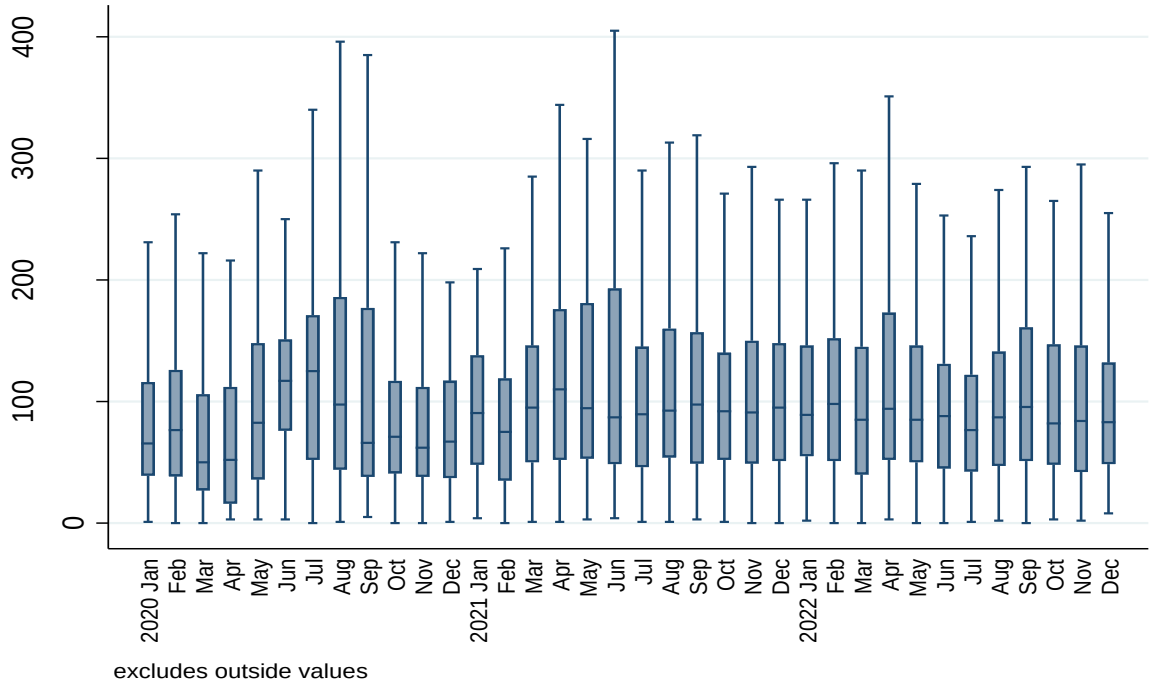


Figure 4.4: Distribution of times from assessment to treatment (days) by month for patients who had an elective infra-renal AAA repair between January 2020 and December 2022*. The median is shown as the bar within the blue box (whose outer limits are the 25th and 75th percentile)



*Excludes outlier values that exceed the upper whisker.

4.4 Postoperative outcomes after elective infra-renal AAA repair

Table 4.6 describes various aspects of postoperative care for 2022.

- For EVAR, over 65% of patients went to a standard ward after surgery, and the median length of postoperative stay was 2 days.
- For patients undergoing open repair, over 95% of patients were admitted to a level 2 or level 3 critical care unit after surgery. Patients typically remained in critical care for 3 days and the median total postoperative stay was 7 days.

The in-hospital mortality rate for open repair in 2022 was 3.0% (95% CI 2.1 to 4.1), comparable to 2.9% (95% CI 2.0 to 4.1) observed in 2021. The in-hospital mortality rate for EVAR was 0.4%.

Patients undergoing open repair were more susceptible to cardiac, renal and respiratory complications, and the rate of return to theatre was also higher.

For open repair, the rate of respiratory complications was 9.2% (95% CI 7.6 to 11.0) in 2022, a slight fall from 12.1% (95% CI 10.1 to 14.3) observed in 2020. For EVARs, respiratory complications decreased from 1.4% (95% CI 0.9 to 2.2) to 1.2% (95% CI 0.8 to 1.9) between 2020 and 2021. However, it increased to 1.4% (95% 0.9 to 2.0) in 2022.

Table 4.6: Postoperative details of elective infra-renal repairs undertaken in 2022

		Open repair (n=1,144)		EVAR (n=1,689)	
Admitted to	Ward	2.7%		68.0%	
	Level 2	60.8%		29.7%	
	Level 3	36.4%		2.2%	
	Died in theatre	0.2%		0.1%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	3	2 to 4	1	0 to 1
	Level 3	3	2 to 4	1	1 to 2
Post-op length of stay (days)		7	6 to 10	2	1 to 3
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		3.0	2.1 to 4.1	0.4	0.2 to 0.9
Defined complications					
	Cardiac	5.1	3.9 to 6.5	0.7	0.3 to 1.2
	Respiratory	9.2	7.6 to 11.0	1.4	0.9 to 2.0
	Haemorrhage	1.9	1.2 to 2.9	1.1	0.6 to 1.7
	Limb ischaemia	3.0	2.1 to 4.1	0.2	0.0 to 0.5
	Renal failure	4.9	3.7 to 6.3	0.5	0.2 to 0.9
	Other	10.1	8.4 to 12.0	3.9	3.0 to 4.9
	None of the above	70.3	67.6 to 73.0	92.4	91.0 to 93.6
Return to theatre		7.3	5.8 to 8.9	1.2	0.8 to 1.9
Readmission within 30 days		5.2	4.0 to 6.7	5.6	4.5 to 6.8

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 2022, 79 (4.8%) patients were recorded as experiencing a type I endoleak. There were 92 endoleaks (of any type) which required intervention at the time of the procedure. The rate of type I endoleaks has been relatively stable over the last three years, with 65 (4.6%) type I endoleaks recorded in 2020 and 88 (5.3%) in 2021.

Among the 2022 cohort, there were 127 patients (4.5%) who had the indication for their procedure recorded as re-intervention. Among these, 82% had an EVAR.

The indication for re-intervention was sac expansion for 66 patients and a graft problem (migration/occlusion/infection) for 27 patients. The most frequent re-intervention was a relining (29.8%) or distal procedure (36.4%).

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.

The level of incomplete data on frailty is relatively high within the NVR. In 2021, frailty was recorded in 72% of patients and 71% in 2022. We encourage vascular units to identify at risk 'frail' patients and ensure their degree of frailty is submitted to the NVR.

4.5 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 2020 to 31 December 2022 to give robust outcome estimates.

The risk-adjusted mortality rates for individual NHS trusts are shown in a funnel plot in Figure 4.5. 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.

Figure 4.5: Risk-adjusted in-hospital mortality rates after elective infra-renal AAA repair among NHS vascular units (January 2020 and December 2022). The overall in-hospital mortality rate was 1.4%.

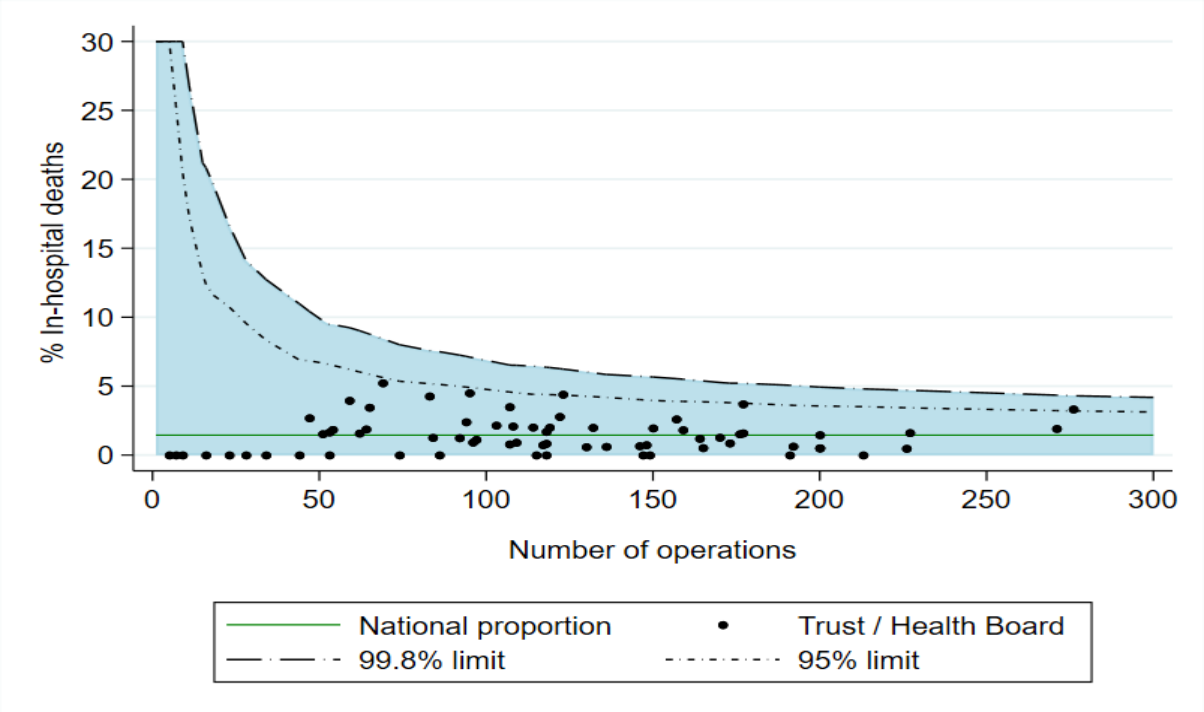
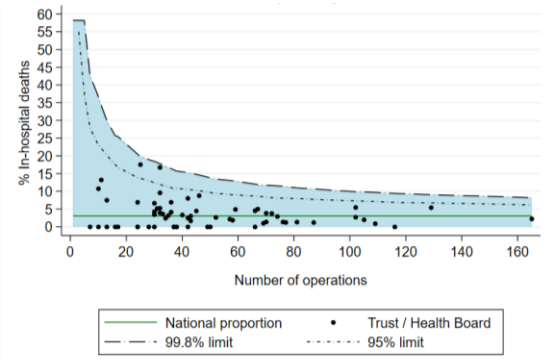
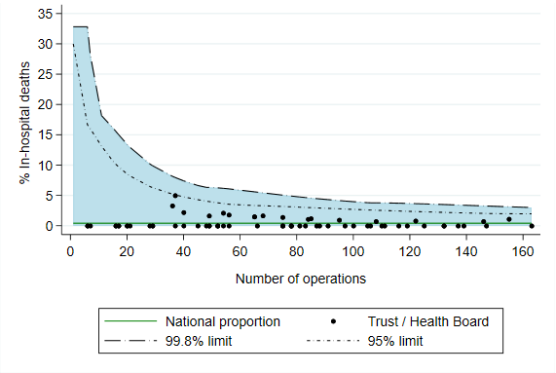


Figure 4.6: Funnel plot of risk-adjusted in-hospital mortality after elective AAA repair for open and EVAR procedures performed between 2020 and 2022.



A: Open repairs

The postoperative in-hospital mortality rate for open repair procedures was 3.0%



B: EVAR procedures

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

Figures 4.6A and 4.6B 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 2020 and 2022 were 3.0% and 0.4%, respectively

Postoperative in-hospital mortality after open repair has been slightly higher in 2020 (3.2%), 2021 (2.9%) and 2022(3.0%) compared to 2.2% in 2019. For EVARs, the rate has remained around 0.3-0.5%.

The low rate of in-hospital mortality 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.

5. Other elective repair of aortic conditions

5.1 Background

Aneurysms can occur at various locations along the aorta. In addition to infra-renal aneurysms, a distinction is made between two other types:

- juxta-renal (that occur near to the renal arteries)
- supra-renal (that occur above the renal arteries), and

The two most common procedures are Fenestrated EVAR (FEVAR), performed when aneurysms are close to the renal arteries, and branched EVAR (BEVAR), performed when other arteries branching from the aorta are involved. For the period 2020-2022, 84% of the elective procedures were FEVARs and 13% were BEVARs.

5.2 Patient Characteristics

Table 5.1: Characteristics of patients who had other repairs between Jan 2020 and Dec 2022

Other elective procedures		Open	%	Endovascular	%	Total
Total procedures		228		1,266		1,494
Age group (years)	Under 66	63	27.6	118	9.4	181
	66 to 75	118	51.8	577	45.8	695
	76 to 85	46	20.2	535	42.5	581
	86 and over	1	0.4	30	2.4	31
Male		196	86.0	1,103	87.1	1,299
Female		32	14.0	163	12.9	195
Current smoker		90	39.5	300	23.9	390
ASA fitness grade	1,2	48	21.1	178	14.1	226
	3	166	72.8	1,002	79.1	1,168
	4,5	14	6.1	86	6.8	100
Comorbidities	Hypertension	158	69.3	938	74.1	1,096
	Ischemic heart disease	50	21.9	478	37.8	528
	Chronic heart failure	1	0.4	77	6.1	78
	Stroke	18	7.9	111	8.8	129
	Diabetes	35	15.4	204	16.1	239
	Chronic renal failure	24	10.5	211	16.7	235
	Chronic lung disease	63	27.6	444	35.1	507

Table 5.2: Postoperative details of other elective repairs undertaken between January 2020 and December 2022

Other elective procedures		Open repair (n=228)		EVAR (n=1,266)	
Admitted to	Ward	2.2%		21.3%	
	Level 2	39.9%		63.1%	
	Level 3	57.5%		15.5%	
	Died in theatre	0.4%		0.1%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	3	2 to 4	2	1 to 2
	Level 3	3	2 to 7	2	1 to 3
Post-op length of stay (days)		9	6 to 15	4	2 to 7
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		10.1	6.5 to 14.8	1.7	1.0 to 2.5
Return to theatre		11.5	7.6 to 16.3	5.9	4.7 to 7.4
Readmission within 30 days		5.0	2.4 to 9.0	7.7	6.2 to 9.3

5.3 Repair of thoracic aortic conditions

Patients who suffer from a thoracic aortic aneurysm or aortic dissection are increasingly treated using a thoracic endovascular aortic repair (TEVAR). This procedure is performed in either a cardiothoracic unit or specialist vascular unit. Of the thoracic repairs, non-elective patients were younger and more likely to smoke. ASA fitness was higher for non-electives. Elective cases had more comorbidities

Table 5.3: Characteristics of patients who had TEVARs between January 2020 and December 2022

TEVARS		Elective	%	Non-elective	%	Total
Total procedures		394		405		799
Age group (years)	Under 66	107	27.2	186	46.2	293
	66 to 75	158	40.2	108	26.8	266
	76 to 85	119	30.3	93	23.1	212
	86 and over	9	2.3	16	4	25
Male		258	65.5	274	67.7	532
Female		136	34.5	131	32.3	267
Current smoker		70	17.8	108	27.1	178
AAA diameter (cm)	Under 5.5	110	27.9	251	62.0	361
	5.5 to 6.9	197	50.0	66	16.3	263
	7.0 and over	79	20.1	65	16.0	144
ASA fitness grade	1,2	47	11.9	42	10.4	89
	3	298	75.6	150	37.3	448
	4,5	49	12.4	210	52.2	259
Comorbidities	Hypertension	302	76.6	264	65.2	566
	Ischemic heart disease	102	25.9	69	17.0	171
	Chronic heart failure	27	6.9	18	4.4	45
	Stroke	27	6.9	26	6.4	53
	Diabetes	47	11.9	33	8.1	80
	Chronic renal failure	57	14.5	39	9.6	96
	Chronic lung disease	96	24.4	82	20.2	178

Table 5.4: Postoperative details of TEVARs undertaken between January 2020 and December 2022

TEVARS		Elective (n=394)		Non-elective (n=405)	
Admitted to	Ward	25.9%		10.7%	
	Level 2	53.6%		41.4%	
	Level 3	20.6%		46.9%	
	Died in theatre	0.0%		1.0%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	2	1 to 3	2	1 to 4
	Level 3	2	1 to 3	4	2 to 9
Post-op length of stay (days)		4	2 to 6	9	5 to 19
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		2.0	0.9 to 4.0	11.6	8.7 to 15.1
Return to theatre		3.8	2.2 to 6.2	16.5	13.0 to 20.5
Readmission within 30 days		8.5	5.9 to 11.9	8.5	5.8 to 11.9

For elective cases, over 50% were admitted to level 2 care where they stayed for 2 days. Nearly half of non-electives procedures were admitted to level 3 care with a median length of stay of 4 days. Median postoperative length of stay was 4 days for elective TEVARs in the last three years compared with 9 days for non-elective patients. Non-elective mortality was six times more than elective cases. However, 30-day readmissions were similar for both admission modes.

6. Repair of ruptured abdominal aortic aneurysms

6.1 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 2020 and 31 December 2022. Details of 1,458 procedures were submitted to the NVR, giving an estimated case ascertainment of 78%. In 2020 and 2021, there were 498 and 522 procedures recorded on the NVR, but for 2022, this reduced to 438 procedures.

The proportion of patients having an EVAR in recent years has changed over time (Figure 6.2). In 2018, around 30% of all procedures were EVARs; in 2020 and 2021, this has risen to around 40%. For 2022, it was 37%.
Over the three years, around a quarter of all NHS trusts performed more EVARs than open repairs for ruptured AAA (Figure 6.1).

Table 6.1: Characteristics of patients who had a repair of a ruptured AAA between January 2020 and December 2022

		Open repair	%	EVAR	%	Total
Total procedures		891		567		1,458
Age group (years)	Under 66	140	15.7	43	7.6	183
	66 to 75	280	31.5	151	26.7	431
	76 to 85	419	47.1	291	51.5	710
	86 and over	51	5.7	80	14.2	131
Male		728	81.7	486	85.7	1,214
Female		163	18.3	81	14.3	244
Previous AAA surgery		46	5.2	87	15.3	133
AAA diameter (cm)	Under 5.5	57	6.4	89	15.9	146
	5.5 to 6.9	215	24.3	159	28.4	374
	7.0 and over	614	69.3	312	55.7	926
ASA fitness grade	1 or 2	36	4.0	23	4.1	59
	3	71	8.0	93	16.4	164
	4	559	62.7	371	65.4	930
	5	225	25.3	80	14.1	305

Figure 6.1: Percentage of EVARs (left panel) and number of open repairs and EVARs (right panel) by NHS trust between January 2020 and December 2022 with at least 10 procedures. Orange bars show open repairs and blue bars show EVARs.

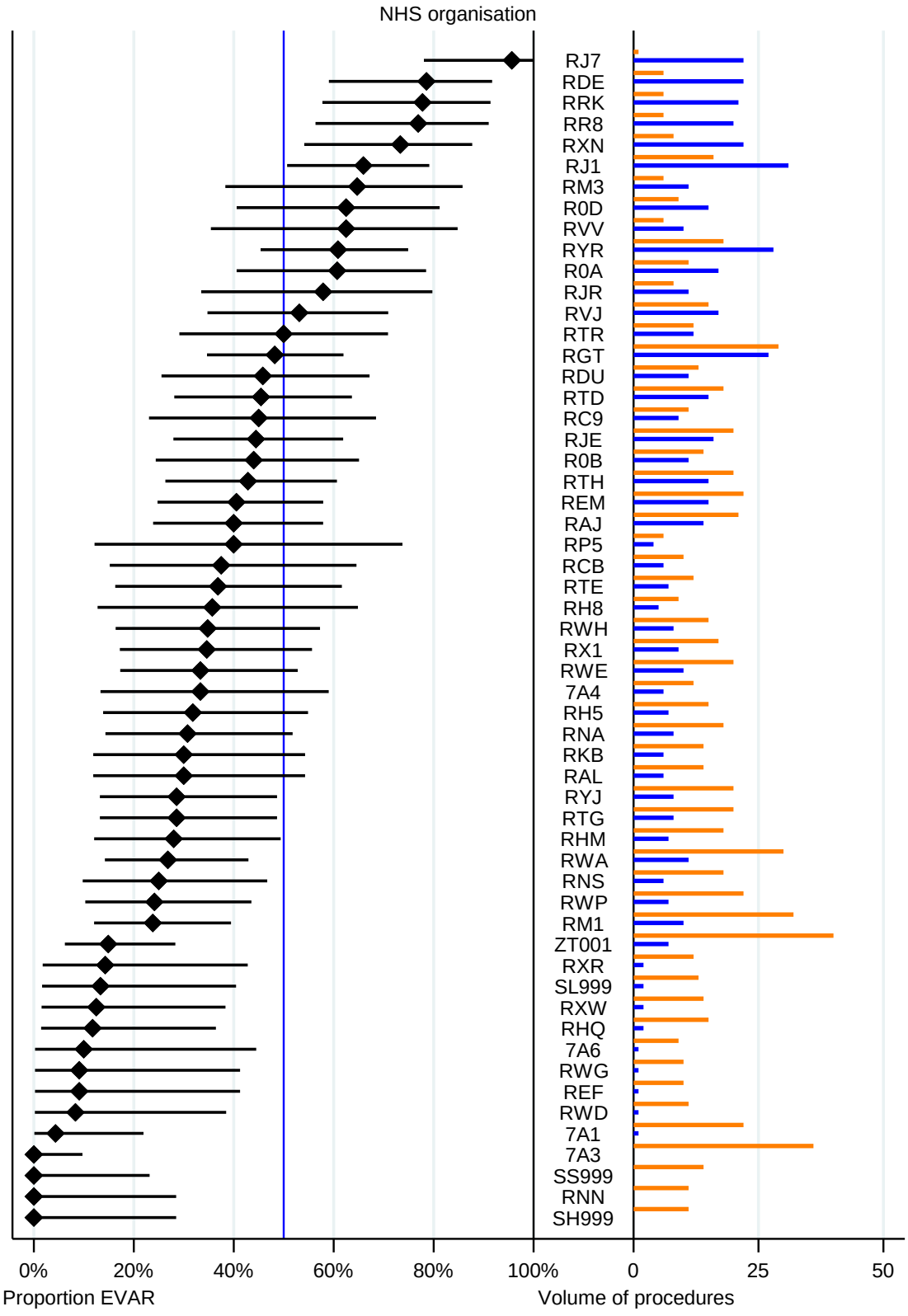


Figure 6.2: Number of open repairs and EVARs for ruptured AAAs between January 2020 and December 2022.

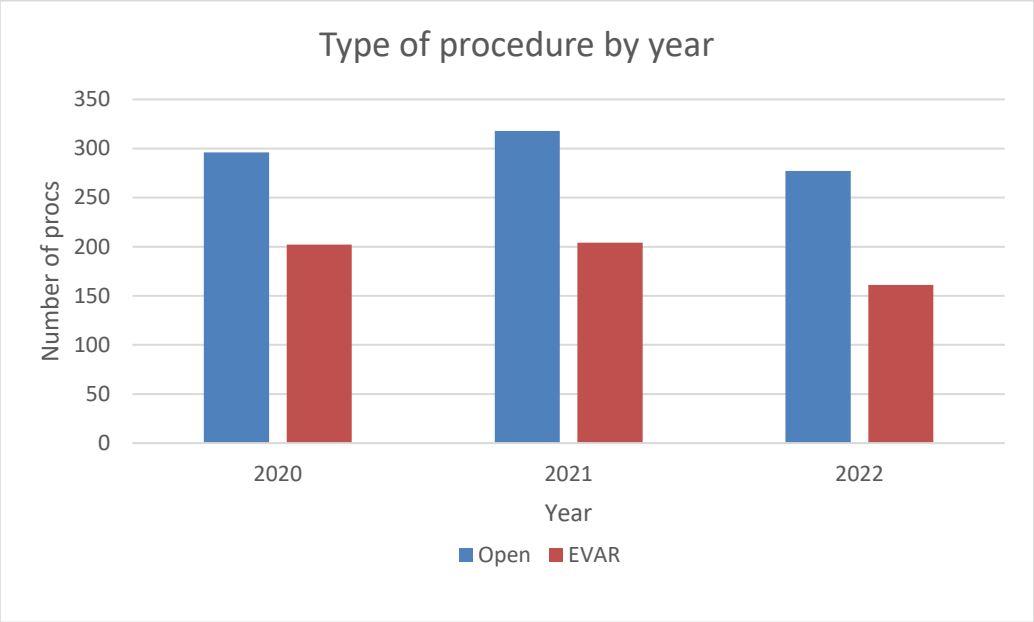


Table 6.2: Postoperative details of emergency repairs for ruptured AAAs undertaken between January 2020 and December 2022

2020-2022		Open repair (n=891)		EVAR (n=567)	
Admitted to	Ward	0.3%		16.6%	
	Level 2	9.6%		37.5%	
	Level 3	82.4%		42.6%	
	Died in theatre	7.8%		3.4%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care: Level 2		4	2 to 6	2	1 to 3
Level 3		4	2 to 9	2	1 to 5
Post-op length of stay (days)		10	2 to 20	7	3 to 13
Post-op length of stay for patients discharged alive (days)		16	10 to 27	8	4 to 14
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		47.3	43.9 to 50.6	21.7	18.4 to 25.3
Defined complications					
	Cardiac	20.0	17.3 to 22.8	11.0	8.5 to 13.9
	Respiratory	33.1	29.9 to 36.4	17.2	14.1 to 20.6
	Stroke	2.2	1.3 to 3.4	1.3	0.5 to 2.6
	Haemorrhage	4.4	3.1 to 6.0	2.6	1.4 to 4.3
	Limb ischaemia	13.0	10.8 to 15.5	3.3	2.0 to 5.2
	Renal failure	27.1	24.1 to 30.3	10.1	7.7 to 12.9
	Ischaemic bowel	11.4	9.3 to 13.8	3.3	2.0 to 5.2
	None of predefined	28.8	25.8 to 32.1	56.3	52.0 to 60.5
Return to theatre		21.7	18.9 to 24.6	11.1	8.6 to 14.1
Readmission within 30 days		8.3	6.0 to 11.2	9.0	6.5 to 12.1

6.2 Postoperative in-hospital mortality for ruptured AAA repair

For NHS organisations undertaking repair of a ruptured AAA between 1 January 2020 and 31 December 2022, the risk-adjusted postoperative mortality rates are shown in Figure 6.3. The in-hospital postoperative mortality rates for the years 2020, 2021 and 2022 for open procedures were 50.3%, 45.0% and 46.6% respectively. For EVARs, the corresponding rates were 19.8%, 23.5% and 21.7%.

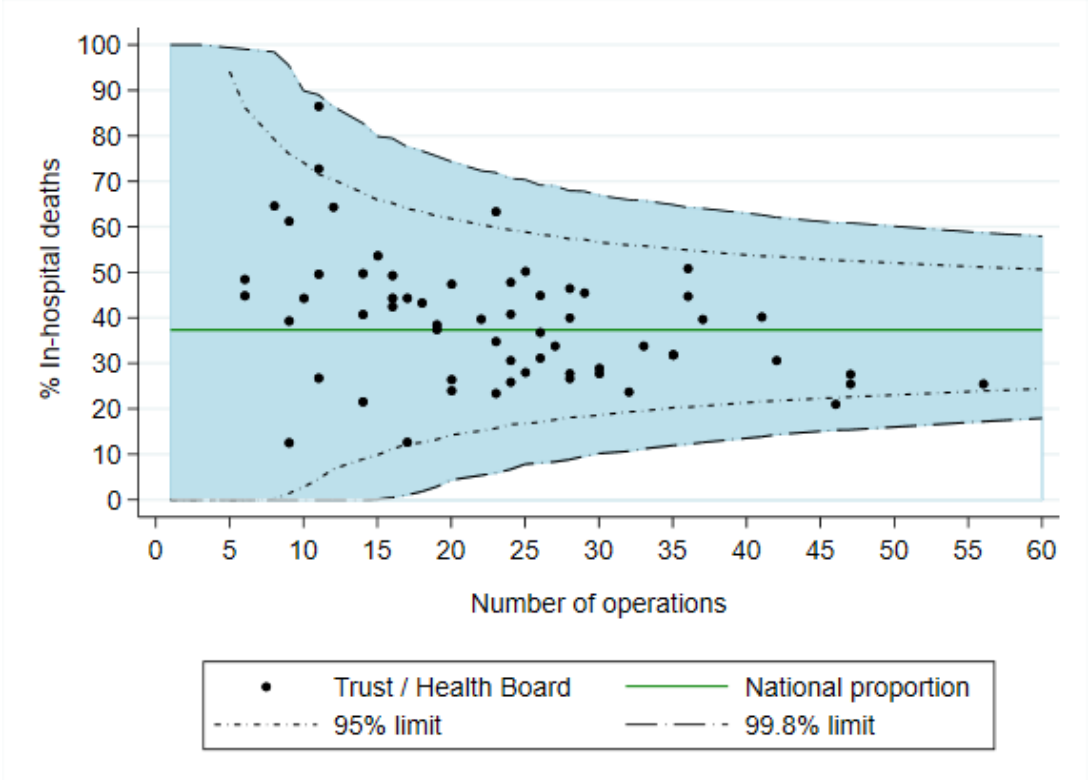
All NHS trusts had a risk-adjusted rate of in-hospital postoperative mortality that fell within the expected range around the national average of 37.3%, given the number of procedures performed.

The rates among NHS trusts typically ranged from 20% to 60%, which reflects the relatively low volumes used to calculate these rates.

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 6.3: Risk-adjusted in-hospital mortality for emergency repairs of ruptured AAAs between January 2020 and December 2022 by NHS trust. The overall mortality rate was 37.3%.



7. Carotid endarterectomy

7.1 Background

In the UK, around 3,000-3,500 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 chapter focuses primarily on carotid procedures performed within NHS hospitals between 1 January 2022 and 31 December 2022.

The number of procedures reported to the NVR in 2020 showed 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. Whether this resulted in an increase in the incidence of stroke during the pandemic is unclear.

This reduced level of activity has remained in 2021 and 2022. 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.

The estimated case ascertainment rates in 2022 for each UK nation were:

- 94% in England
- 100% in Wales
- 60% in Scotland, and
- 100% in Northern Ireland.

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

	2019	2020	2021	2022
Audit procedures	4,162	3,103	3,260	3,257
Expected procedures	4,338	3,372	3,567	3,525
Estimated case ascertainment	96%	92%	91%	92%

Table 7.2: Estimated case ascertainment rates in 2022 by UK country

	Carotid endarterectomy
England	94%
Wales	100%
Scotland	60%
Northern Ireland	100%

7.2 Patient and Procedure Characteristics

Table 7.3: Characteristics of patients who had carotid endarterectomy in 2022, compared with characteristics from 2020 and 2021

Patient characteristics	No. of procedures	2022 %	2021 %	2020 %
Total procedures	3,257			
Age (years), (n=3,244)				
Under 66	930	28.7	28.1	28.1
66 to 75	1,159	35.7	36.0	35.5
76 to 85	1,012	31.2	31.4	31.5
86 and over	143	4.4	4.4	4.8
Male	2,266	69.6	69.1	69.2
Female	991	30.4	30.9	30.8
Asymptomatic	173	5.3	4.2	4.3
Patients symptomatic for carotid disease				
Index symptom if symptomatic: (n=3,083)				
Stroke	1,205	39.1	39.2	39.5
TIA	1,387	45.0	44.6	43.8
Amaurosis fugax	414	13.4	13.5	15.4
None of the three above	77	2.5	2.8	1.3
Grade of ipsilateral carotid stenosis* (n=3,256)				
<50%	49	1.5	1.5	1.1
50-69%	893	27.4	27.3	26.0
70-89%	1,326	40.7	40.9	41.8
90-99%	982	30.2	30.1	30.9
Occluded	6	0.2	0.2	0.2
Rankin score prior to surgery (n=3,257)				
0-2	2,944	90.4	88.6	91.6
3	288	8.8	10.3	7.6
4-5	25	0.8	1.1	0.8
Comorbidities (n=3,255)				
Diabetes	822	25.3	24.9	23.4
Cardiac disease	779	23.9	26.4	28.0

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

Table 7.4: Operative details of carotid endarterectomies performed from 2020 to 2022

Operation details		Procedures (n=3,257)	2022 %	2021 %	2020 %
Anaesthetic	General	2,097	64.4	63.7	64.5
	GA + block	387	11.9	10.6	8.8
	Block or regional	547	16.8	17.7	17.9
	Local	226	6.9	8.0	8.8
Type of endarterectomy	Standard	240	7.4	8.6	7.5
	Standard + patch	2,829	86.9	86.6	87.5
	Eversion	188	5.8	4.8	5.0
Carotid shunt used		2,115	64.9	64.0	61.8
Ipsilateral patency check		2,233	70.0	67.5	70.4

7.3 Treatment pathways

Patients may be referred for carotid endarterectomy from various medical practitioners. In 2022, the most common source of referral was the stroke physician (86.6%), vascular surgeons (2.8%), followed by neurologists (2.5%), and ophthalmologist (1.9%).

- There were 3,083 patients (94.7%) with symptomatic disease. TIA was the most common symptom (45.0%), followed by stroke (39.1%).
- Over 70% 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:

- 91.7% were on antiplatelet medication
    - 51.8% on single and
    - 48.2% on dual therapy,
- 82.4% 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 2020, the proportion of patients who were treated within the 14-day target rose from 37% to 62%. In 2022, this decreased to 52% of patients.

The median time from symptom onset to surgery for symptomatic patients in 2022 was 14 days (IQR 9-25). For the three distinct phases within this pathway, the median time delays were:

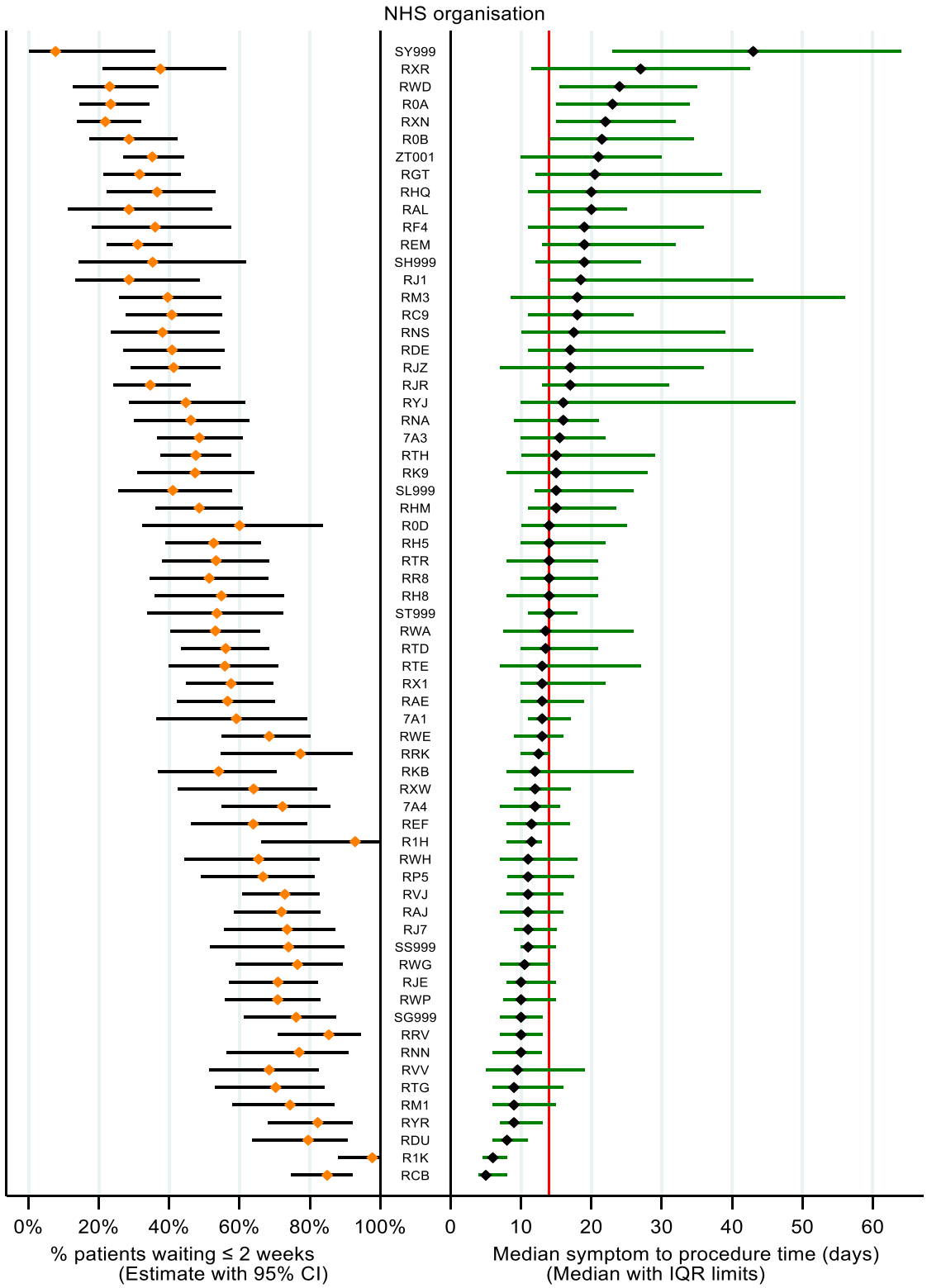
- 4 days (IQR 1-9) from symptom to first medical referral
- 1 day (IQR 0-5) from first medical referral to being seen by the vascular team, and
- 6 days (IQR 3-11) from being seen by the vascular team to undergoing CEA.

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 2022 (right panel, Figure 7.1):

- 38 of the 65 NHS organisations had a median time of 14 days or less
- the median exceeded 20 days for 8 vascular units, an increase from 4 in 2021
- 27 Trusts had less than half of their patients operated on within 14 days.

Figure 7.1: Median time (and interquartile range) from symptom to procedure by NHS trust for procedures performed between January and December 2022 (black diamonds) and proportion waiting less than 2 weeks following symptoms (orange diamonds)



7.4 Outcomes after carotid endarterectomy

The complication rates for the 3,257 procedures performed in NHS hospitals in 2022 are summarised in Table 7.5. The rates of the different complications tended to be around 0.4-2.1% and have remained fairly consistent over the last few NVR Annual Reports.

Over this 12-month period:

- the median length of stay was 2 days (IQR: 1 to 4 days)
- the rate of return to theatre was 2.3% (95% CI 1.8 to 2.9), and
- the rate of readmission within 30 days was 4.5% (95% CI 3.8 to 5.2).

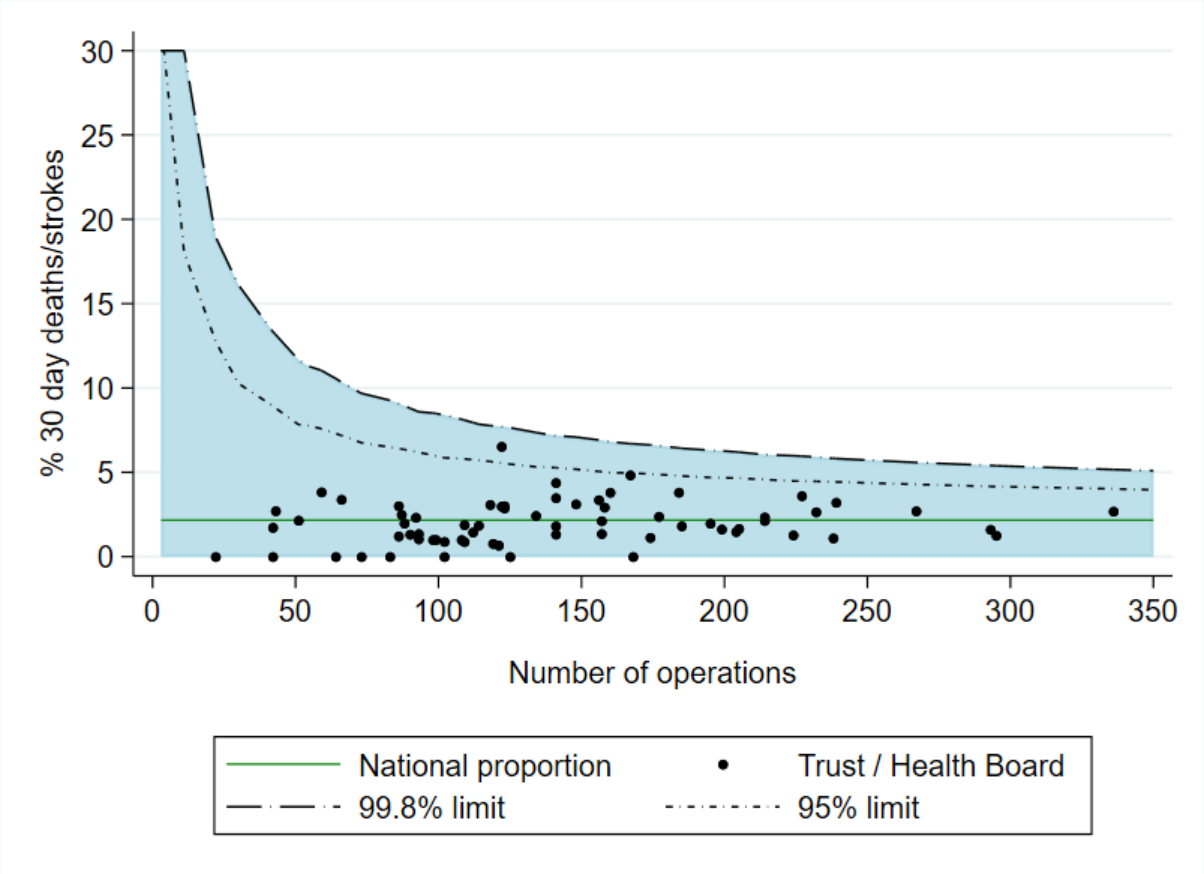
Table 7.5: Postoperative outcomes following carotid endarterectomy for 2022

Procedures	**3,257**
Complication	**Complication rate (%) 2022**
Death and/or stroke within 30 days	2.1 (1.6 – 2.6)
Stroke within 30 days	1.9 (1.4 – 2.4)
Death within 30 days	0.4 (0.2 – 0.7)
Bleeding within admission	1.8 (1.4 – 2.4)
Myocardial infarct within admission	1.1 (0.7 – 1.5)
Cranial nerve injury within admission	1.9 (1.4 – 2.4)

7.5 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 Figure 7.2. Between 2020 and 2022, 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).

Figure 7.2: Funnel plot of risk-adjusted rates of stroke/death within 30 days for NHS trusts, for carotid endarterectomies between January 2020 and December 2022



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

Appendix 1: NHS organisations that perform vascular procedures

Code	Organisation Name	AAA	CEA	Angio	Bypass	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
7A5	Cwm Taf Morgannwg University Health Board	No	No	Yes	No	No
7A6	Aneurin Bevan University Health Board	No	No	Yes	No	No
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	No	Yes	Yes	Yes	Yes
RA9	Torbay and South Devon NHS Foundation Trust	Yes	No	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	No	Yes
RC9	Bedfordshire Hospitals NHS Foundation 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

Code	Organisation Name	AAA	CEA	Angio	Bypass	Amp
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
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	Yes	No	No
RM1	Norfolk and Norwich University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RM3	Northern Care Alliance NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RMC	Bolton NHS Foundation Trust	No	No	Yes	No	No
RN3	Great Western Hospitals NHS Foundation Trust	No	No	Yes	No	No
RN5	Hampshire Hospitals NHS Foundation Trust	No	No	Yes	No	No
RNA	The Dudley Group NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RNN	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	Yes	No	No
RR8	Leeds Teaching Hospitals NHS trust	Yes	Yes	Yes	Yes	Yes
RRF	Wrightington, Wigan And Leigh NHS Foundation Trust	No	No	Yes	No	No
RRK	University Hospitals Birmingham NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RRV	University College London Hospitals NHS Foundation Trust	No	Yes	Yes	No	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	Yes	No	No
RTP	Surrey and Sussex Healthcare NHS trust	No	No	Yes	No	No
RTR	South Tees Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RVJ	North Bristol NHS trust	Yes	Yes	Yes	Yes	Yes

Code	Organisation Name	AAA	CEA	Angio	Bypass	Amp
RVV	East Kent Hospitals University NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RVY	Southport and Ormskirk Hospital NHS trust	No	No	Yes	No	No
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
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	Yes	No	No
RX1	Nottingham University Hospitals NHS trust	Yes	Yes	Yes	Yes	Yes
RXF	Mid Yorkshire Hospitals NHS trust	No	No	Yes	No	No
RXN	Lancashire Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RXP	County Durham and Darlington NHS Foundation Trust	No	No	Yes	No	No
RXQ	Buckinghamshire Healthcare NHS trust	No	No	Yes	No	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	Yes	No	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	Yes	No	No
SY999	NHS Dumfries and Galloway	No	Yes	Yes	Yes	Yes
ZT001	Belfast Health and Social Care Trust	Yes	Yes	Yes	Yes	Yes

Key

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

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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 is 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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