



NATIONAL VASCULAR REGISTRY

2020 Annual Report

November 2020



**Royal College
of Surgeons
of England**
ADVANCING SURGICAL CARE



**VASCULAR
SOCIETY**

OF GREAT BRITAIN AND IRELAND



**British Society of
Interventional
Radiology**

Registered Charity No: 1084852



HQIP

Healthcare Quality
Improvement Partnership

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

The RCS managed the publication of the 2020 Annual report.



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



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

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The Healthcare Quality Improvement Partnership (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 in patient outcomes, and in particular, to increase the impact that clinical audit, outcome review programmes and registries have on healthcare quality in England and Wales. HQIP holds the contract to commission, manage and develop the National Clinical Audit and Patient Outcomes Programme (NCAPOP), comprising around 40 projects covering 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 projects, other devolved administrations and crown dependencies. www.hqip.org.uk/national-programmes. Registered charity no: 1127049

Contents

Acknowledgements.....	5
Foreword.....	6
Executive Summary.....	8
Recommendations	19
1. Introduction	20
1.1 The 2020 Annual Report	21
1.2 Publication of information on the VSQIP website	22
1.3 How to read this report	22
1.4 Preliminary results on the impact of the Covid-19 pandemic on NHS vascular services in early 2020	24
2. Repair of elective infra-renal abdominal aortic aneurysm	26
2.1 Background	26
2.2 Preoperative care pathway for elective infra-renal AAA.....	28
2.3 Postoperative outcomes after elective infra-renal AAA repair	31
2.4 Postoperative in-hospital mortality for elective infra-renal AAA repair.....	33
3. Elective repair of complex aortic conditions.....	35
3.1 Patterns of complex aortic surgery.....	35
3.2 Postoperative in-hospital mortality for complex endovascular procedures	40
3.3 Comment	41
4. Repair of ruptured abdominal aortic aneurysms.....	42
4.1 Surgical activity for ruptured AAA	42
4.2 Postoperative in-hospital mortality for ruptured AAA repair.....	44
5. Lower limb bypass for PAD	45
5.1 Introduction	45
5.2 Time to revascularisation for patients with CLTI	46
5.3 Postoperative outcomes for lower limb bypasses.....	49
5.4 Rates of in-hospital death after lower limb bypass	50
6. Lower limb angioplasty/stent for peripheral arterial disease	52
6.1 Introduction	52

6.2 Procedure characteristics	54
6.3 Outcomes of lower limb angioplasty/stents.....	58
6.4 Risk-adjusted in-hospital deaths.....	61
7. Major lower limb amputation.....	62
7.1 Introduction	62
7.2 Care pathways.....	63
7.3 In-hospital outcomes following major amputation	67
7.4 Discharge and follow-up	70
8. Carotid Endarterectomy.....	71
8.1 Background	71
8.2 Treatment pathways.....	72
8.3 Outcomes after carotid endarterectomy.....	75
8.4 Rates of stroke/death within 30 days among NHS Trusts	76
Appendix 1: NVR Governance structure	77
Appendix 2: NHS organisations that perform vascular surgery.....	78
Appendix 3: Summary of procedures and patient characteristics.....	82
Appendix 4: Audit methodology	91
References	93
Glossary.....	95

Acknowledgements

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

We would also like to thank:

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- Bristol Vascular Patient and Public Involvement (PPI) Group
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Foreword

As President of the Vascular Society of Great Britain and Ireland, I am delighted to provide a foreword for the 2020 NVR Annual Report.

Vascular and endovascular surgery remains one of the most challenging of the surgical sub-specialities. These are technically complex and physiologically challenging interventions in a high-risk population. Balancing the individual risk and benefit are key components to the multi-disciplinary decisions that are made prior to any intervention. The best contemporaneous data to guide and inform our choices comes from the NVR Annual Report. This has been brought home with the recent COVID 19 pandemic, which has further highlighted some of the challenges around getting the risk/benefit balance correct.

It has been a busy year on many fronts, and of note, it started with the VSGBI quality improvement framework (QIF). This was developed in response to recommendations made in the vascular surgery GIRFT programme report (2018). The report suggested the delivery of revascularisation in CLTI was not always consistent across the UK, in terms of service provision, length of hospital stays and patient outcomes. The QIF aims to reduce unwanted variation in services for people with PAD. Key to achieving this aim is the development of evidence-based, multi-disciplinary care pathways that include timelines to access urgent care for CLTI. Eleven early adopting vascular centres have been working hard to improve the vascular surgical outcomes with the inaugural meeting last October and a subsequent webinar. Panagiota (Penny) Birmipili, the first CF/RCS PAD-QIF fellow, started in February and has been working closely with the early adopting centres. Data from last year showed a reduction in the time to treatment for emergency admitted CLTI from 5 days to 4

days (median) giving some early evidence the QIF has had some traction.

The NICE AAA Guidelines on diagnosis and management (NG156) were finally published in February 2020 after a somewhat protracted course. The 2020 NVR data show evidence that prior to the COVID 19 crisis there was already a move towards an increase in the proportion of AAA patients undergoing open AAA repair to EVAR. There was a modest rise from 32% open repair in 2017 to 39% in 2019.

The Independent Medicines and Medical Devices Safety Review, led by Baroness Cumberlege, recently reported on how the healthcare system in England responded to reports about harmful side effects from medicines and medical devices. I am delighted by the proactive response taken by the Audit Committee to avert potential problems with vascular implants. The updated NVR AAA data sets (as of 21st July 2020) now include key details of medical devices implanted. Mortality following elective EVAR is now so low that it may no longer be the best measure of quality and the recently introduced AAA dataset changes will capture information on longer-term outcomes such as re-intervention.

The earlier the carotid surgical intervention following an index TIA, the greater the benefit. The 2020 NVR gives evidence that the time from event to surgery continues to fall to a median of 12 days. However, significant variations between NHS trusts remain and there is room for further improvement.

The 2020 NVR report continues to provide vital information on vascular activity and outcomes. The data are important to surgeons, MDTs, units, and networks. It is also key to planning, improving and delivering vascular services.

The VSGBI has continued to collaborate closely with GIRFT and specialist commissioning during the COVID 19 crisis. Advising on the broader provision of vascular services is in part based upon the evaluation of clinical outcomes. The NVR represents the most complete dataset available, and continues to provide a basis for improvements in the pathways of care and clinical outcomes for our patients.

Finally, I would like to thank Jon Boyle for his vision, hard work and leadership that he has shown as the Audit Committee Chair over the last three years. Arun Pherwani is a worthy successor, and I am sure will work closely with Sam Waton and the rest of the great NVR team

Prof Chris Imray
President of the Vascular Society of Great Britain and Ireland

Executive Summary

Abdominal aortic aneurysms (AAA)

1) *Elective infra-renal AAA*

Although aneurysms can develop anywhere along the aorta, they occur most frequently in the aorta below the arteries to the kidneys (infra-renal AAA). The NVR received information on 3,445 patients having an elective infra-renal AAA repair in 2019, of which 61% were endovascular repair (EVAR) and 39% were open repair. Estimated case-ascertainment was 94%.

VSGBI AAA Quality Improvement Framework

All elective procedures should be reviewed preoperatively in an MDT that includes surgeon(s) and radiologist(s) as a minimum.

All patients should undergo standard preoperative assessment and risk scoring, as well as CT angiography to determine their suitability for EVAR.

All patients should be seen in pre-assessment by an anaesthetist with experience in elective vascular anaesthesia.

Ideally, a vascular anaesthetist should also be involved to consider fitness issues that may affect whether open repair or EVAR is offered.

The Vascular Society AAA Quality Improvement Framework has established a number of standards for preoperative assessment of patients who require AAA repair. In 2019, performance by NHS vascular units against these standards show that most

patients received care consistent with the recommended pathway:

- 84.8% were discussed at MDT meetings
- 90.5% had preoperative CT/MR angiography
- 94.7% underwent a formal anaesthetic review
- 83.2% had documented formal fitness assessment tests.

The National AAA Screening Programme (NAAASP) recommends a target of 8 weeks from the date of referral from the NAAASP to the date of repair. The Screening Programme states that NHS trusts should meet this standard for 80% of patients.

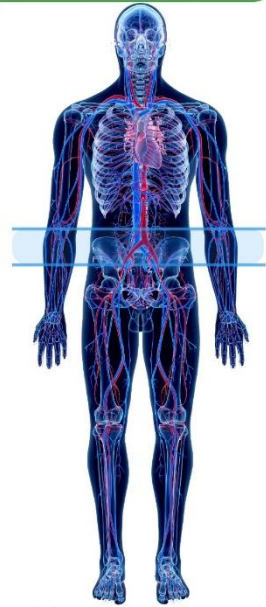
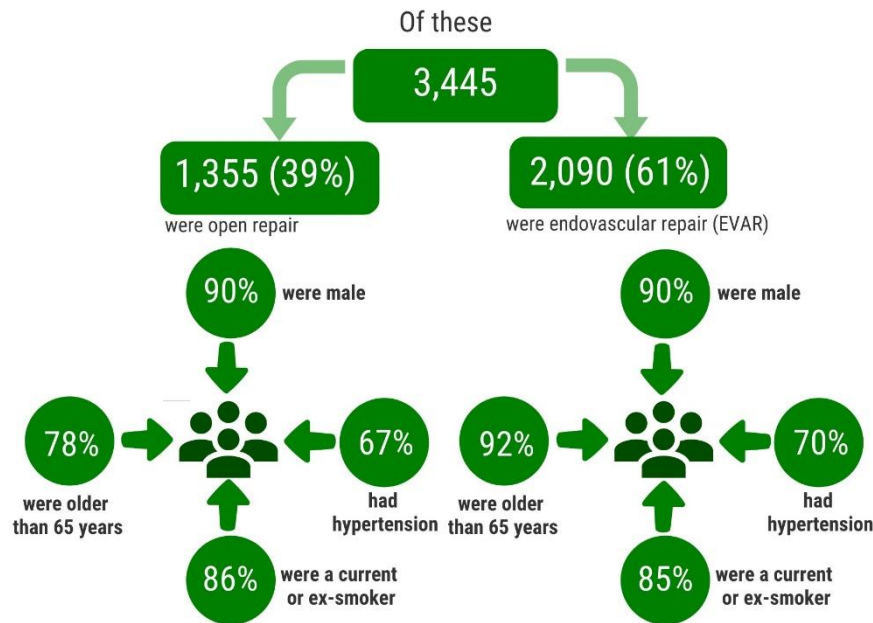
Across the 69 NHS vascular units performing infra-renal AAA repair, the median delay from vascular assessment to AAA repair was typically between 50 and 90 days. However, at 10 vascular units, a quarter of patients waited more than 140 days for their procedure in 2019. In relation to the 8 week target, this was met for 49.8% of screened patients and 36.5% of non-screened patients. This is well below the 80% target indicated by NAAASP.

NHS vascular units continue to achieve good patient outcomes after elective infra-renal AAA repair. In 2019, the in-hospital postoperative mortality was 2.3% after open repair and 0.4% after EVAR. Over the 3-year period from January 2017 to December 2019, the risk-adjusted in-hospital mortality rates for all NHS vascular units were within the expected range of the national average (1.4% for 2017-19).

Repair of abdominal aortic aneurysm (AAA) to prevent rupture

AAA is an abnormal expansion of the aorta (the largest vessel taking blood away from the heart). If left untreated, it may enlarge and rupture causing fatal internal bleeding. An infra-renal aneurysm occurs below the level of the renal (kidney) arteries within the aorta.

There were 3,445 elective infra-renal AAA repairs submitted to the NVR in 2019, which is approximately 94% of all procedures carried out in the UK.



Glossary

The average is the median; "typical range" is the interquartile range.

Waiting Times

Most patients waited 70 days between vascular assessment and AAA repair

However for 16/72 vascular units, 25% of patients waited more than 140 days

The National AAA Screening Programme recommends that patients have their procedure within 8 weeks of referral.

In 2019, only 42% of patient met this target (50% in screened patients and 37% in non-screened patients).

How were patients assessed?

discussed at multi-disciplinary team meeting

85%

had fitness measured

83%

had pre-operative angiography assessment

91%

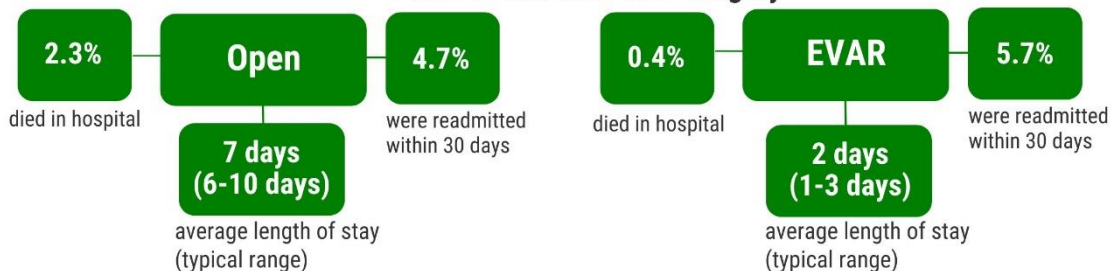
had formal anaesthetic review

95%

of these had review by consultant vascular anaesthetist

91%

Patient outcomes after surgery



2) Complex aneurysm repair

Aneurysms that occur above or around the arteries to the kidneys are more complex than infra-renal AAA to repair. Between January 2017 and December 2019, there were 2,577 complex AAA repairs, of which 2,306 were endovascular - 1,303 fenestrated repairs (FEVAR), 216 branched repairs (BEVAR) and 469 thoracic repairs (TEVAR); just 271 patients had an open repair. Among the 73 vascular units that reported complex AAA repairs to the NVR between 2017 and 2019, 52 units submitted fewer than 10 cases per year.

The median time from vascular assessment to surgery at these 73 vascular units varied greatly. In 13 units, the median delay was less than 100 days. However, at seven units, the median delay exceeded 180 days.

Postoperative outcomes remain favourable for endovascular repair compared with open repair of complex AAA, with in-hospital postoperative mortality rates of 2.7% and 14.0%, respectively. In-hospital mortality after FEVAR and TEVAR was 2.3% and 3.4%, respectively.

3) Repair of ruptured AAA

Emergency repair of a ruptured abdominal aneurysm remains a high risk procedure, with only about two-thirds of patients surviving surgery to be discharged home. The NVR recorded 2,229 cases from January 2017 to December 2019, which represents a case-ascertainment rate of approximately 93%.

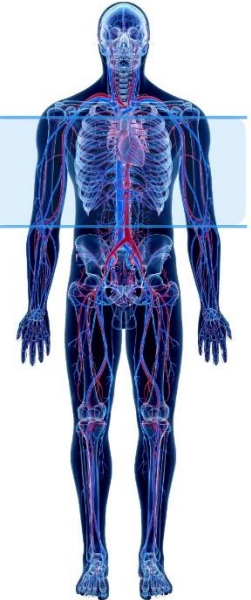
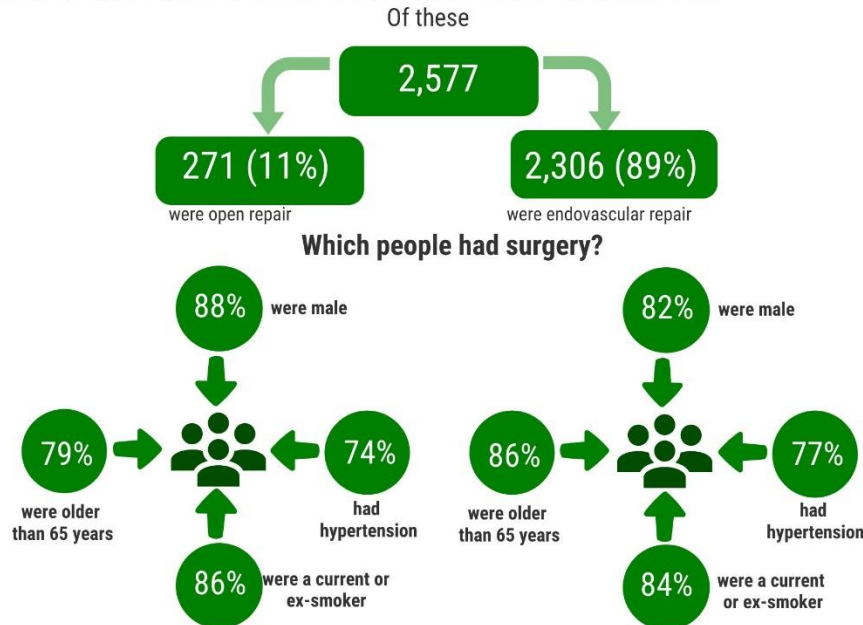
Open repair remains the dominant surgical approach, although the use of EVAR has increased over time. In the period 2017-19, 31.5% of patients with ruptured AAA underwent EVAR. The in-hospital postoperative mortality rates for EVAR and open repair were 20.2% and 41.1%, respectively, for this period. We caution against the figures for EVAR and open repair being compared because open procedures may represent the more complex cases.

All NHS Trusts demonstrated in-hospital postoperative mortality rates after repair for ruptured AAA within the expected range around the overall national average (34.5%), given the number of procedures performed at the vascular units.

Repair of elective complex aortic aneurysms to prevent rupture

The term complex is used to describe those aneurysms that occur above the level of the renal (kidney) arteries. These are more complicated than the standard infra-renal repairs and require specialist teams, often within a specialist hospital.

There were 2,577 repairs of elective complex AAAs carried out in 2017-2019.



Glossary

The average is the median; "typical range" is the interquartile range.

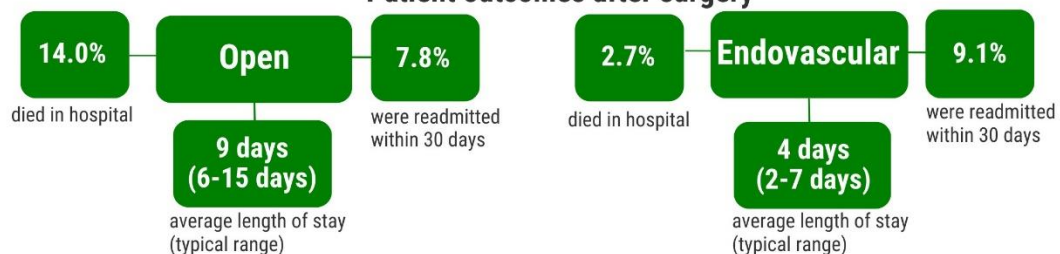
Most patients waited 131 days between vascular assessment and complex repair

However for 10/72 vascular units, 25% of patients waited more than 240 days

The most common complex endovascular procedures were:

Fenestrated EVARs (FEVAR), which involves a graft containing holes (fenestrations) to allow the passage of blood vessels from the aorta.
 Branched EVAR (BEVAR), which involves separate grafts being deployed on each blood vessel from the aorta after the main graft has been fitted.
 Thoracic endovascular aortic/aneurysm repair (TEVAR), which involves a repair of the aorta within the chest region of the body.

Patient outcomes after surgery



Lower Limb Interventions for Peripheral Arterial Disease

Peripheral arterial disease of the lower limbs causes a range of symptoms extending from lifestyle restrictions due to intermittent claudication to potential limb loss because of limited blood flow in the lower limb arteries (chronic limb-threatening ischaemia).

1) Lower limb bypass surgery

Between January 2017 and December 2019, NHS Trusts submitted 18,090 bypass procedures to the NVR, with an estimated case-ascertainment rate of 90%. Among these patients, 55.9% were admitted with chronic limb-threatening ischaemia (CLTI).

VSGBI: PAD QIF

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

During 2017-2019, 49.9% of patients admitted non-electively with CLTI had their bypass within five days. The proportion of patients treated within this timeframe varied among the 69 NHS Trusts that performed 10 or more bypass procedures for CLTI. At 23 vascular units, a quarter of patients waited longer than 10 days between their admission and surgery.

Surgical outcomes for bypass procedures remained very good. The in-hospital postoperative mortality rate was 1.0% for elective admissions and 4.8% for non-elective admissions. Over 80% of patients had no reported complications. A subsequent procedure after the initial operation was required in 6.1% of elective admissions and 14.6% of non-elective admissions. All NHS trusts had an adjusted postoperative in-hospital mortality rate that fell within the expected range given the volume of cases.

2) Lower limb endovascular procedures

The number of endovascular lower limb procedures (angioplasty or stents) submitted to the NVR has risen over the last 3 years, from 7,458 in 2017 to 8,709 in 2019. However, while a few NHS Trusts achieved 90% ascertainment rates, the overall case-ascertainment remains low at 47% for 2019. Therefore, the results for these procedures should be interpreted with appropriate caution. Greater effort must be made to improve the submission of data on these procedures.

VSGBI: PAD QIF

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

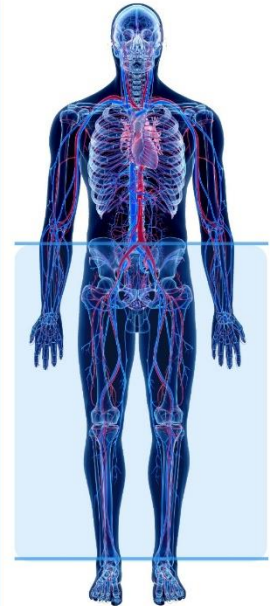
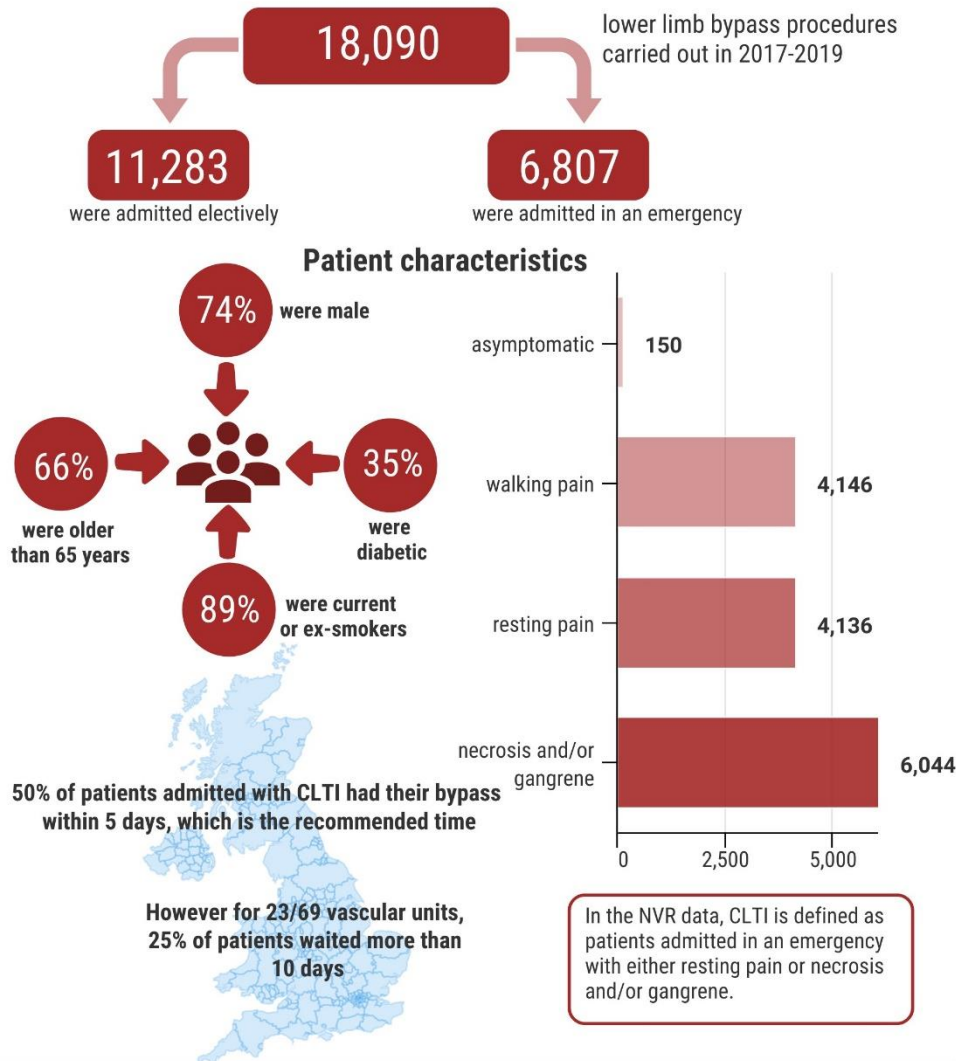
Among the patients who had endovascular interventions during the 2017-19 audit period, there were 5,174 patients with chronic limb-threatening ischaemia admitted non-electively. Overall, 48% of these waited for longer than five days for revascularisation. The proportion of patients treated within the five-day standard varied across the 58 NHS Trusts that performed 10 or more endovascular procedures. At 30 NHS Trusts, a quarter of patients waited longer than 10 days between their admission and procedure.

Outcomes after lower limb angioplasty / stents were good. The in-hospital postoperative mortality rate was 0.4% for elective admissions and 4.6% for non-elective admissions. All NHS trusts had an adjusted rate of postoperative in-hospital death that fell within the expected range given the volume of cases.

Lower limb bypass for peripheral arterial disease to prevent limb loss

Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower limb arteries that can severely affect a patient's quality of life, and risk their limb.

Open surgical (bypass) interventions become options when conservative therapies have proved to be ineffective.



Glossary

The average is the median; "typical range" is the interquartile range.

Chronic limb-threatening ischaemia (CLTI) is the most severe form of PAD, where the blood flow to the legs becomes severely restricted.

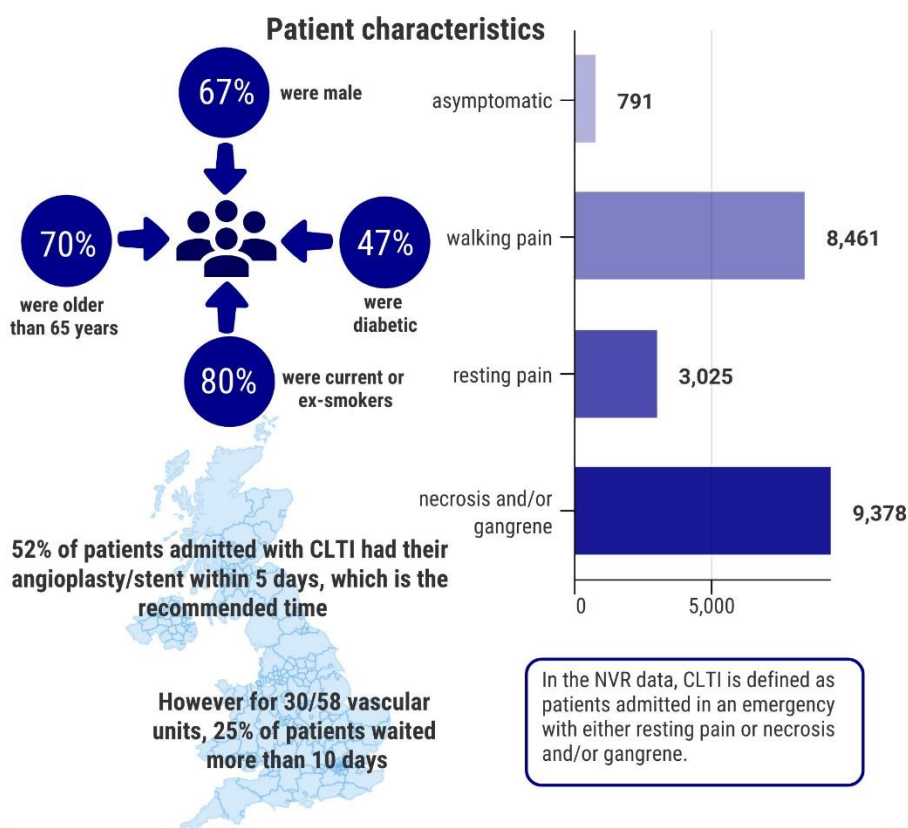
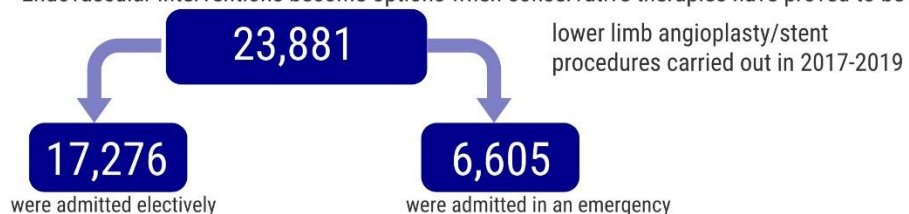
Patient outcomes post bypass



Lower limb angioplasty/stenting for peripheral arterial disease

Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower limb arteries that can severely affect a patient's quality of life, and risk their limb.

Endovascular interventions become options when conservative therapies have proved to be ineffective.



Glossary

The average is the median; "typical range" is the interquartile range.

Chronic limb-threatening ischaemia (CLTI) is the most severe form of PAD, where the blood flow to the legs becomes severely restricted.

Patient outcomes post procedure



3) Major lower limb amputation

During the three-years from 2017 to 2019, the NVR received details of 10,022 major lower limb amputations, giving an estimated case-ascertainment of around 80%, but there was significant variation in the level of case-ascertainment between NHS Trusts. The majority of patients who had a major amputation were admitted non-electively (79% non-elective vs 21% elective).

VSGBI: Amputation QIF

All patients undergoing elective major lower limb amputation should be admitted in a timely fashion.

The overall median time from vascular assessment to major lower limb amputation was 9 days (IQR: 3 to 26 days). The time differed for patients who had amputations as elective procedures (median=28 days; IQR: 8 to 74) compared with patients who had the procedure after a non-elective admission (median=7 days; IQR: 3 to 18). Among patients admitted non-electively, there were 11 NHS Trusts where a quarter of patients had a wait longer than 30 days.

VSGBI: Amputation QIF

Vascular units should aim to have an above knee amputation (AKA):below knee amputation (BKA) ratio below one.

Over the 2017-19 audit period, there were 5,204 below knee and 4,818 above knee amputations, giving an overall AKA:BKA ratio of 0.93. Most of the NHS Trusts had a ratio of less than one, but 27 organisations had ratios above 1.0, and 10 of these were above 1.5.

VSGBI Amputation QIF and NCEPOD Report

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.

NHS trusts performance against the VSQBI Amputation QIF / NCEPOD process measures was reasonable overall but requires improvement in several areas in which there variation in the levels achieved across NHS vascular units. Overall:

- over 80% of major amputations were performed during daytime hours (8am-6pm)
- a consultant surgeon was present for just over three-quarters of the procedures
- use of prophylactic antibiotics and DVT medication were reported for only just over 60% of patients but this is likely to reflect incomplete data rather than actual patient care.

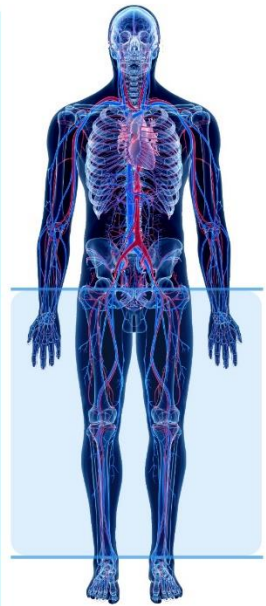
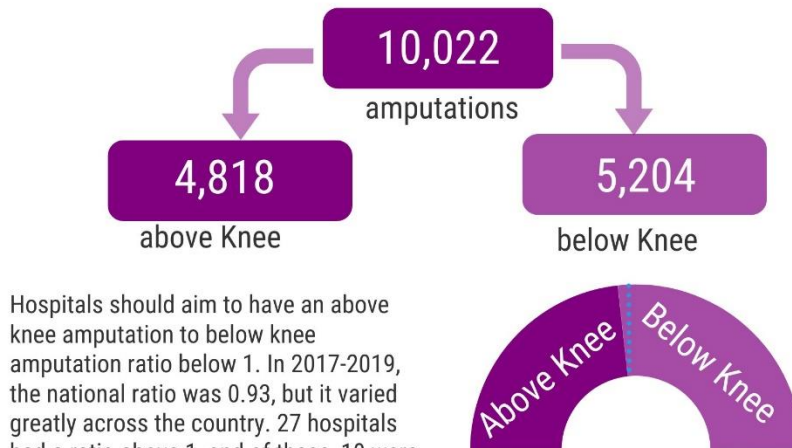
The overall rate of 30-day in-hospital death for major lower limb amputations was 4.6%. As expected, it was higher for AKA (7.2%) than BKA (2.4%). All NHS Trusts had an adjusted 30-day mortality rate that fell within the expected range of the overall 30-day in hospital mortality rate.

Lower limb major amputation for peripheral arterial disease

Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower limb arteries that can severely affect a patient's quality of life, and risk their limb.

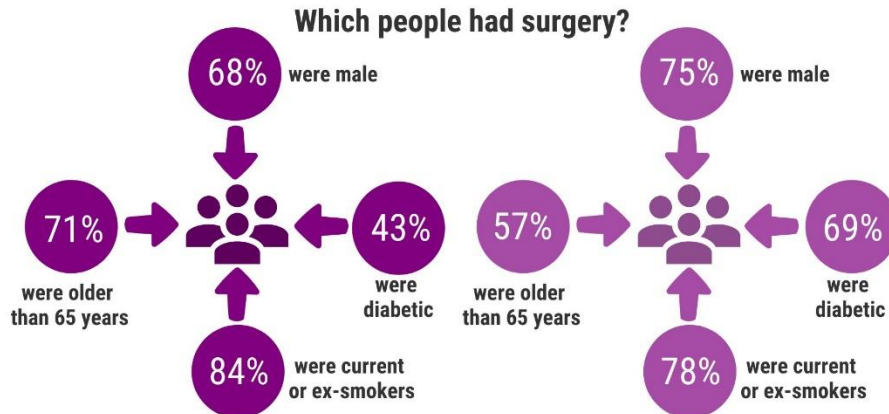
PAD can gradually progress in some patients and an operation to improve blood flow may no longer be possible. In these situations, people will require amputation of the lower limb.

In 2017-2019 there were 10,022 major lower limb amputations submitted to the NVR.

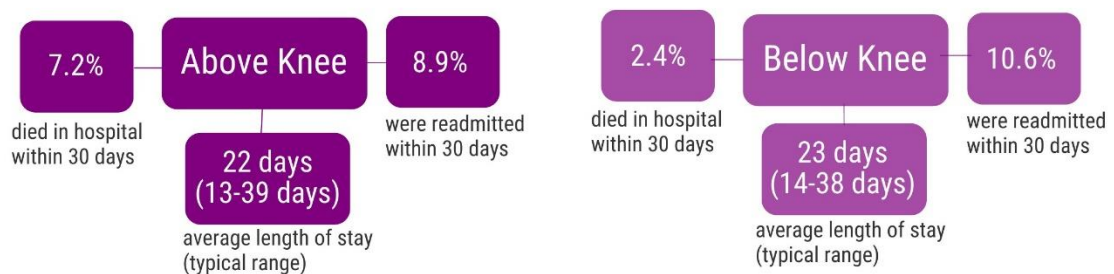


Glossary

The average is the median; "typical range" is the interquartile range.



Patient outcomes after surgery



Carotid endarterectomy

In 2019, the NVR received details of 4,141 carotid endarterectomies (CEAs) performed in the UK. Case-ascertainment remains high, and has been consistently over 90% since 2014. The number of CEA has decreased markedly since 2011 when nearly 6,000 procedures were performed.

VSGBI Provision of services

Vascular units are recommended to perform a minimum volume of 40 CEAs per annum.

In 2019, there were 22 out of the 75 active vascular units that did not perform at least 40 CEAs.

NICE guideline NG128

The delay from symptom to carotid surgery is recommended to be within 14 days to reduce the risk of patients developing a stroke.

The Carotid endarterectomy aims to reduce the risk of stroke, and can be performed in patients who have recently experienced symptoms or in patients with no symptoms but whose carotid arteries are partially blocked. Symptomatic patients made up 93.2% of the 2019 audit cohort.

The median time from symptom to surgery for patients who had CEA in 2019 was 12 days and 60% were treated within 14 days. This is similar to the level of performance observed since 2017. There remains some variation between NHS Trusts in the delays experienced by patients. The median delay exceeded 20 days at five vascular units, although this is less than a quarter of the number in 2016.

Among 12,698 patients undergoing carotid endarterectomy between 2017 and 2019, complication rates during the hospital admission remained low:

- 1.9% of patients died and/or had a stroke within 30 days (95% CI 1.7-2.2)
- 2.1% of patients had a cranial nerve injury during their admission (95% CI 1.8-2.4).

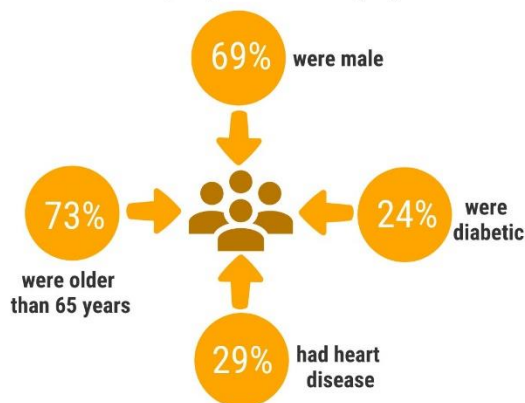
All NHS Trusts had an adjusted 30-day mortality / stroke rate after surgery within the expected range of the national average (1.9%), given the number of procedures performed at that organisation.

Carotid artery surgery to prevent stroke

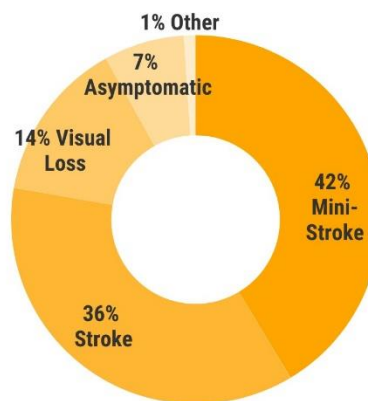
A procedure in which build-up of plaque is removed from the carotid artery in the neck is called a carotid endarterectomy (CEA).

There were 4,141 CEAs submitted to the NVR in 2019, which is approximately 97% of all procedures in the UK.

Which people had surgery?

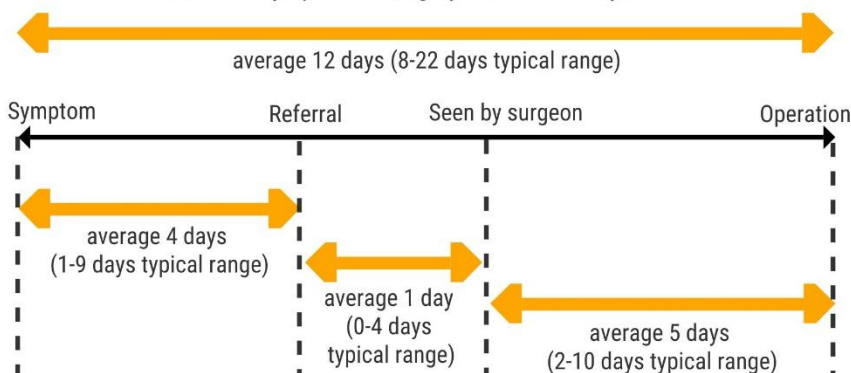


Reasons for surgery



Treatment times for symptomatic patients

Recommended time from symptom to surgery is within 14 days



Glossary

A mini stroke, also known as a transient ischaemic attack (TIA), resolves completely within 24 hours.

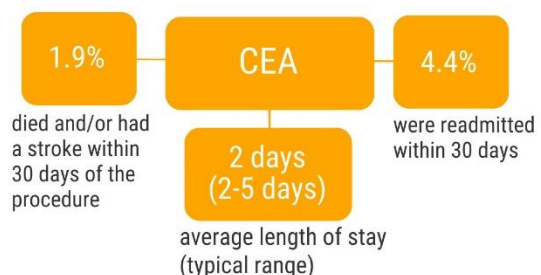
Visual loss, also known as amaurosis fugax, is the loss of vision in one eye due to an interruption of blood flow to the retina.

The average is the median; "typical range" is the interquartile range.

A patient showing symptoms is known to be symptomatic.

The average delay for symptom to surgery in NHS vascular units ranged from 4 to 29 days

Outcomes of surgery



Recommendations

1) Ensure compliance with the elective AAA care pathway standards and in particular, at least 90% of patients should: • have an assessment of their fitness and • be discussed at a vascular MDT meeting.	Page 28	NHS Trusts and vascular specialists
2) Reduce the time from referral for vascular assessment to elective AAA repair for patients with non-complex aneurysms, ensuring this is less than 8 weeks for both screen and non-screen detected patients. The recommendation from the National AAA Screening Programme is that this target should be met for 80% of patients.	Page 29-30	NHS Trusts and vascular specialists
3) Vascular units should only be commissioned to perform complex AAA repair if they submit data on all cases to the NVR, so that the safety of these services can be monitored. Vascular units should work together so that the provision of complex AAA care is organised effectively within their regions.	Page 35-36	Commissioners, NHS Trusts
4) Investigate how the time from vascular assessment to surgery can be shortened for patients requiring complex AAA repair, with the aim of achieving the best levels of organisational performance presented in this report.	Pages 37-38	NHS Trusts and vascular specialists
5) Evaluate how access to endovascular repair can be improved for emergency repair of ruptured aneurysms. This may require: • written network pathways for vascular surgery and anaesthesia • 24/7 access to hybrid operating theatres • addressing workforce for both vascular surgery and interventional radiology.	Pages 42-44	NHS Trusts and vascular specialists
6) Enter data into the NVR on all lower limb revascularisation and major amputation procedures. This might require reviewing the provision of administrative support, especially in interventional radiology.	Page 45, Pages 52-53; Page 62	NHS Trusts and vascular specialists
7) Review and improve pathways of care using the VSGBI Quality Improvement Frameworks (QIF) for peripheral arterial disease and amputation . Ensure that: • patients admitted non-electively with CLTI have their lower limb bypass or endovascular revascularisation procedure within 5 days • patients undergoing major amputation should be admitted in a timely fashion to a recognised arterial centre with agreed protocols and timeframes for transfer from networked hospitals • below knee amputation should be undertaken whenever appropriate (AKA:BKA ratio should be less than 1) • patients should have routine DVT and antibiotic prophylaxis according to local policy, and ensure this is accurately recorded in the NVR.	Pages 46-47; Pages 55-56; Pages 63-67	NHS Trusts and vascular specialists
8) Review and improve referral pathways and access to theatre within networks to ensure carotid endarterectomy within 14 days of patients experiencing symptoms.	Pages 73-74	NHS Trusts

1. Introduction

The National Vascular Registry (NVR) was established 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.

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

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

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

The audit period covered by this Annual Report extends from 1 January 2017 to 31 December 2019. However, due to the unprecedented impact that the Covid-19 pandemic had on the delivery of NHS health services during 2020, we have provided some preliminary results for the period between 1 January 2020 and 30 June 2020. These are presented in the last section of chapter 1.

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

1.1 The 2020 Annual Report

The aim of this report is to give an overall picture of the care provided by NHS vascular units, and outcomes delivered to patients.

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

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

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

The outcome indicators adopted by the NVR were chosen to help vascular specialists monitor and, where possible, reduce the risk associated with the procedure. Outcomes have been improving over the last decade with the refinement of surgical techniques, and the introduction of new hybrid operating theatres. The evolving reorganisation of NHS vascular services has also resulted in arterial surgery and complex endovascular interventions being performed in specialist regional centres. Short-term survival after surgery is the principal outcome measure for all arterial procedures, but the report also provides information of other outcomes, such as the types of complications that occur after individual procedures.

The NVR process measures are linked to standards of care that are drawn from various national guidelines. These focus on (i) specific aspects of care before and after the vascular intervention, and (ii) the time taken by

patients to move along the care pathway. An overall framework for vascular services is described by the “Provision of Services for Patients with Vascular Disease” published by the Vascular Society [VSGBI 2018].

Standards of care specific to the various conditions / arterial procedures are described within the following documents:

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 2009].

For peripheral arterial disease

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

For carotid endarterectomy

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

1.2 Publication of information on the VSQIP website

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

The website also provides access to:

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

Since 2013, the Registry has published information on the outcomes of elective infra-renal AAA repair and carotid endarterectomy for individual consultants currently working at English NHS vascular units, as part of NHS England's "Everyone Counts: Planning for Patients 2013/4" initiative. Consultant-level information has also been published for vascular consultants working in NHS hospitals in Wales, Scotland and Northern Ireland who consented to have their individual results shown.

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

1.3 How to read this report

The results in this report are based primarily on vascular interventions that took place within the UK between 1 January 2017 and 31 December 2019. As noted above, the scope of the NVR extends only to patients who underwent a procedure. Details of patients who were admitted to hospital with a vascular condition (e.g. a ruptured AAA) but were not operated upon, are not captured.

The data used in this report was extracted from the NVR IT system in July 2020. This was to allow sufficient time for NHS hospitals to enter follow-up information about the patients having these vascular interventions, and to provide a period in which NHS consultants could check the completeness and accuracy of their data. Only records that were

locked by NHS staff (i.e., the mechanism used in the IT system for a hospital to indicate that data entry is complete) were included in the analysis of the 2017-19 audit period. The data submission deadline was later in 2020 than in previous years due to impact of the COVID-19 pandemic on hospital services.

Results are typically presented as totals and/or percentages, medians and interquartile ranges (IQR). Where appropriate, numerators and denominators are given. In a few instances, the percentages do not add up exactly to 100%, which is typically due to the rounding up or down of the individual values. More details of the analytical methods are given in [Appendix 4](#).

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

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

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

Funnel plots are used to assess whether there are systematic differences in mortality rates between NHS organisations. This is a widely used graphical method for comparing the outcomes of surgeons or hospitals. In these plots, each dot represents an NHS organisation. The solid horizontal line is the

national average. The vertical axis indicates the outcome with dots higher up the axis showing trusts with a higher stroke and/or death rate. The horizontal axis shows NHS Trust activity with dots further to the right showing the trusts that perform more operations. The benefit of funnel plot is that it shows whether the outcomes of NHS Trusts differ from the national average by more than would be expected from random fluctuations. Random variation will always affect outcome information like mortality rates, and its influence is greater among small samples. This is shown by the funnel-shaped dotted lines. These lines define the region within which we would expect the outcomes of NHS Trusts to fall if their outcomes only differed from the national rate because of random variation.

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

1.4 Preliminary results on the impact of the Covid-19 pandemic on NHS vascular services in early 2020

Many NHS vascular services were able to submit data on patients treated in their units between January and June 2020 before the end of July 2020. We therefore present some preliminary results on the impact that the Covid-19 pandemic had on the provision of vascular care.

The results in this section should be regarded as preliminary. Information in the submitted records was not always complete, and a portion of the records had not been locked when the data extract was taken from the NVR data collection system (September 2020). Thus, the results are restricted to the data

from 84 NHS vascular units whose activity in the NVR between January and March 2020 was similar to that during the same period in 2019.

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

Figure 1.1: Weekly number of AAA repairs in 84 NHS vascular units between 5 January and 1 August 2020, by type of repair

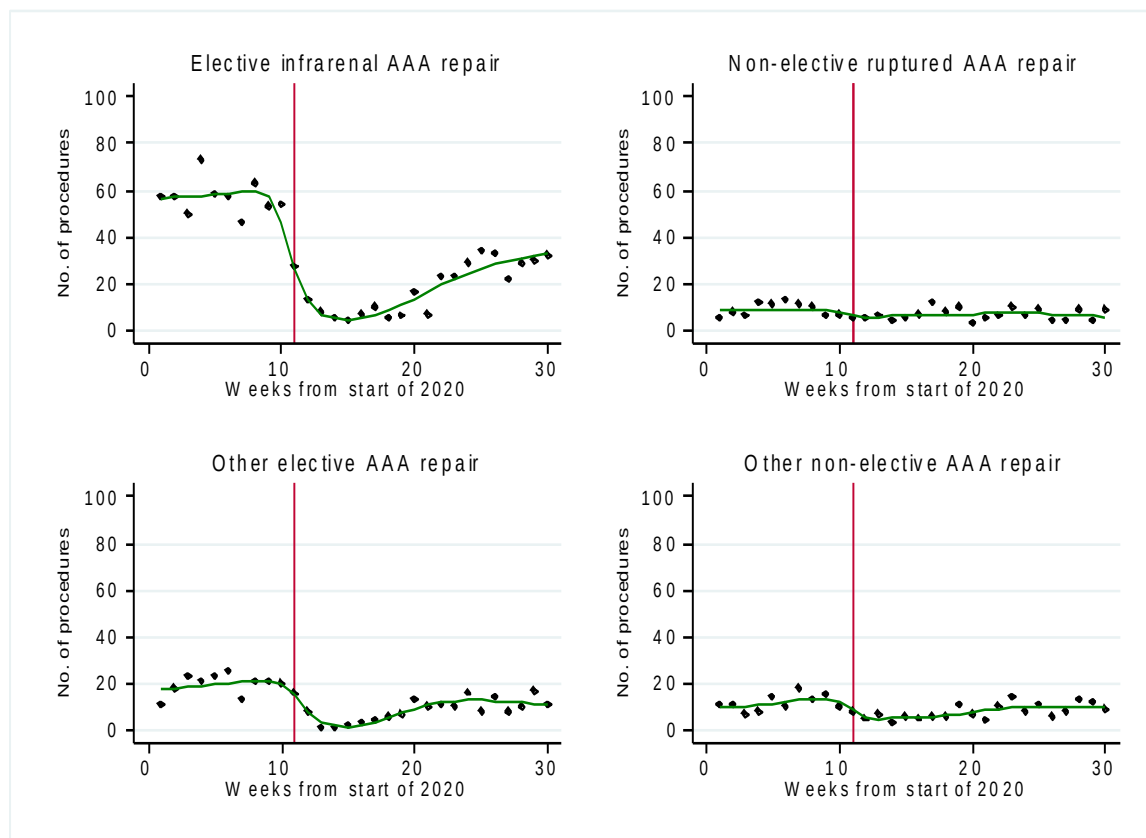
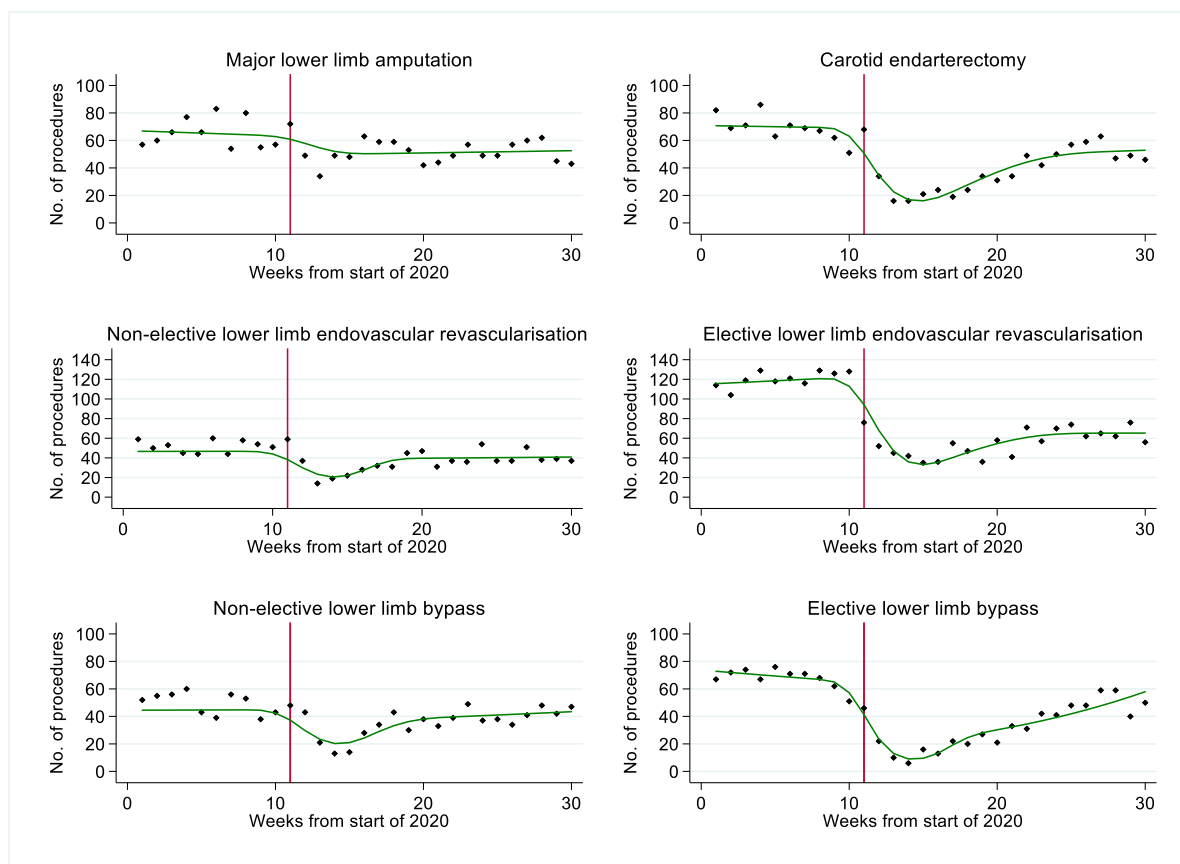


Figure 1.2: Weekly number of lower limb procedures and carotid endarterectomies in 84 NHS vascular units between 5 January and 1 August 2020.



Figures 1.1 and 1.2 clearly show a drop in vascular activity after 15 March, particularly among the elective procedures. Focusing on weeks 13-17 (29 March to 2 May) that cover the month of April (the period of the greatest impact on service provision), the level of activity was around 12% of the average for the weeks in 2020 before 15 March for elective AAA repair procedures. The level of activity for non-elective ruptured AAA repair and lower-limb major amputation was 71% and 74%, respectively.

Despite the preliminary nature of these findings, it clearly shows access to vascular interventions was severely restricted during April when the pressures on the NHS were greatest. By the end of June, service levels were beginning to return to pre-pandemic levels and it is hoped the resumption of services has continued. The impact of this disruption of care on the delays from referral to surgery and on patient outcomes is, as yet, unclear, and will be the topic of further evaluation by the NVR.

2. Repair of elective infra-renal abdominal aortic aneurysm

2.1 Background

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

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

The audit period from 1 January 2017 to 31 December 2019 covered in the 2020 Annual report saw a number of changes in the organisation of vascular services undertaking AAA repair. The number of NHS vascular units performing AAA repairs decreased from 78 in 2017 to 75 in 2019. Furthermore, the number

of elective infra-renal AAA repairs being performed continued to fall, with 3,445 procedures recorded in 2019 compared with 4,286 in 2017 (Table 2.1).

The estimated 2019 case-ascertainment figures for the four nations were: 95% for England, 100% for Wales, 100% for Northern Ireland and 73% for Scotland. The overall case-ascertainment has remained around 95% over the last three years (Table 2.1).

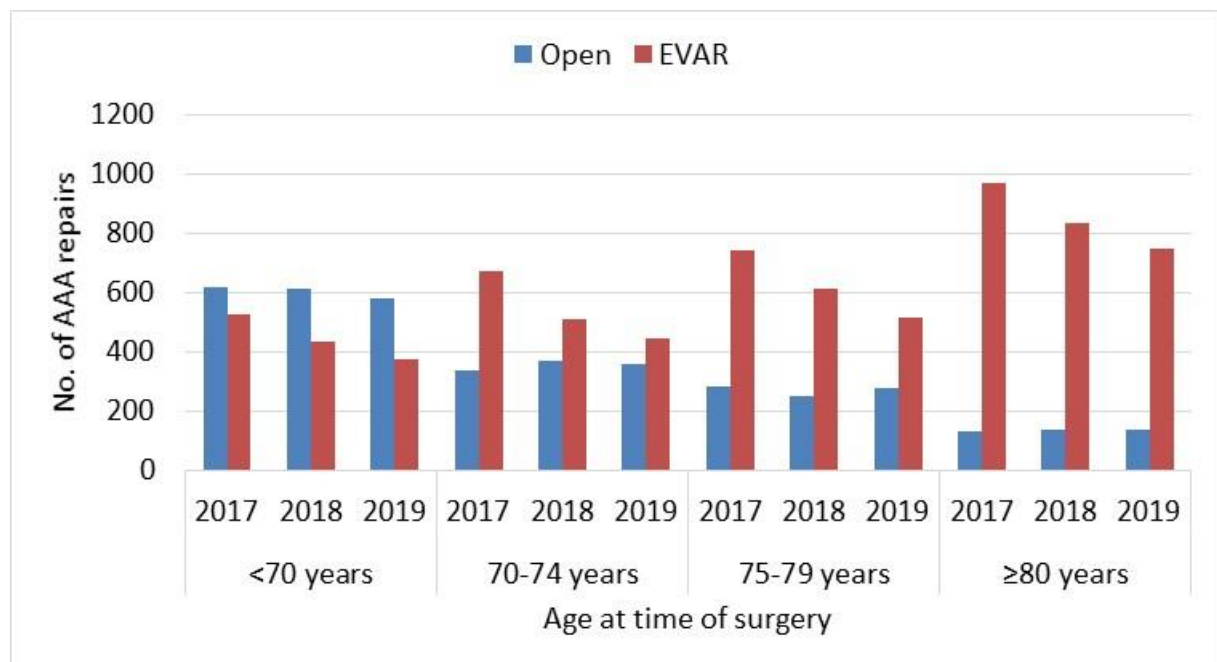
The fall in the volume of AAA repairs coincided with a decrease in the number of endovascular (EVAR) procedures, so that they accounted for 61% of the elective infra-renal AAA repairs in 2019 compared with 68% in 2017. The reduction has occurred over all age ranges (Figure 2.1). The numbers of open procedures remained relatively unchanged over the same period.

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

	2017	2018	2019	Total
Audit procedures	4,286	3,771	3,445	11,502
Expected procedures	4,401	4,032	3,674	12,107
Estimated case-ascertainment	97%	94%	94%	95%

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

Figure 2.1: Distribution of elective infra-renal AAA repairs by age group between 2017 and 2019



The reasons for this change could be a more conservative approach to treatment (particularly in older, sicker patients) and the influence of the draft NICE guidance which recommended open repair more strongly than an endovascular approach.

There were small differences in the characteristics of patients who had EVAR and those who had open procedures ([Appendix 3](#)), with patients undergoing EVARs being, on average, slightly older and having a greater burden of comorbid disease. The majority of procedures were performed for patients with an AAA diameter between 5.5 and 7.4 cm.

The suitability of a patient for an EVAR depends on various aspects of the aneurysm and its relationship to the normal aorta (e.g., the length and angle of the normal aorta). Among elective infra-renal EVAR repairs:

- the neck angle was less than 60 degrees for 90.8% of procedures

- the median proximal aortic neck diameter and length were 23 mm (IQR 21 to 25) and 24 mm (IQR 18 to 31), respectively
- there were 346 (17.4%) procedures that unilaterally extended into the iliac artery and 102 (5.1%) that required bilateral limb extensions.

The most common type of open repair was with a straight 'tube' graft (64.7%), followed by a bifurcated graft (35.1%).

We note that a full description of a vascular network's aortic practice should include those patients treated conservatively and turned down for elective and emergency procedures as well as the vascular procedures. The NVR is unable to record the number of patients turned down for surgery. However, a recent publication from NAAASP has shown differences in turndown rates for men with large aneurysms detected on initial screening or from surveillance with multiple comorbidities. Cardiac fitness or a concurrent malignancy were the main reasons for turndown [Meecham 2020].

2.2 Preoperative care pathway for elective infra-renal AAA

VSGBI AAA QIF

All elective procedures should be reviewed preoperatively in an MDT that includes surgeon(s) and radiologist(s) as a minimum.

All patients should undergo standard preoperative assessment and risk scoring, as well as CT angiography to determine their suitability for EVAR.

All patients should be seen in pre-assessment by an anaesthetist with experience in elective vascular anaesthesia.

Ideally, a vascular anaesthetist should also be involved to consider fitness issues that may affect whether open repair or EVAR is offered.

Table 2.2 describes the overall performance of NHS vascular units against the VSGBI AAA QIF standards over the past three years. The majority of patients received care that was consistent with the QIF recommendations but there is potential for increasing the proportion of patients who:

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

The figures in Table 2.2 may be conservative because patients for whom the dates were unknown were counted as equivalent to patients who did not receive these elements of care.

Table 2.2: Overall compliance with standards related to the elective AAA care pathway

	Percentage of patients meeting standard		
	2019	2018	2017
Elective patients were discussed at MDT meetings	84.8 2,922/3,445	82.0	83.0
Patients with an AAA diameter ≥ 5.5 cm deemed suitable for repair had a preoperative CT/MR angiography assessment	90.5 2,800/3,095	89.3	89.1
Patients underwent a formal anaesthetic review	94.7 3,263/3,445	95.4	96.3
Patients whose anaesthetic review was done by a consultant vascular anaesthetist	91.3 2,980/3,263	91.3	91.6
Patients had their fitness measured	83.2 2,860/3,438	85.5	84.7
Most common assessment methods:			
CPET	59.2 1,693/2,860	51.1	49.1
Echocardiogram	36.3 1,039/2,860	42.5	43.5

National AAA Screening Programme

The National AAA Screening Programme (NAAASP) recommends a target of 8 weeks from the date of referral from the NAAASP to the date of repair. The Screening Programme states that NHS trusts should meet this standard for 80% of patients

The National AAA Screening Programme established the 8 week target time from referral to treatment to ensure elective repairs are scheduled sufficiently soon to reduce the risk of a patient's AAA rupturing while waiting for treatment [NAAASP 2009]. Although the 8 week target was set for patients referred from the screening programme, the time from vascular assessment to surgery covers an important component of the care pathway and is relevant to all patients requiring elective infra-renal AAA repair.

Figure 2.2 (overleaf) summarises the variation among NHS Trusts in the median (IQR) time from vascular assessment to surgery for elective infra-renal procedures performed in 2019. The graph covers 69 organisations that had 10 or more infra-renal AAA repairs with assessment and procedure dates.

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 90 days (median 69: IQR 36 - 114). At 14% of the vascular units (10 of 69), a quarter of patients who had operations in 2019

waited more than 140 days; nevertheless, this is an improvement from the 22% of units where a quarter of patients waited as long in 2018.

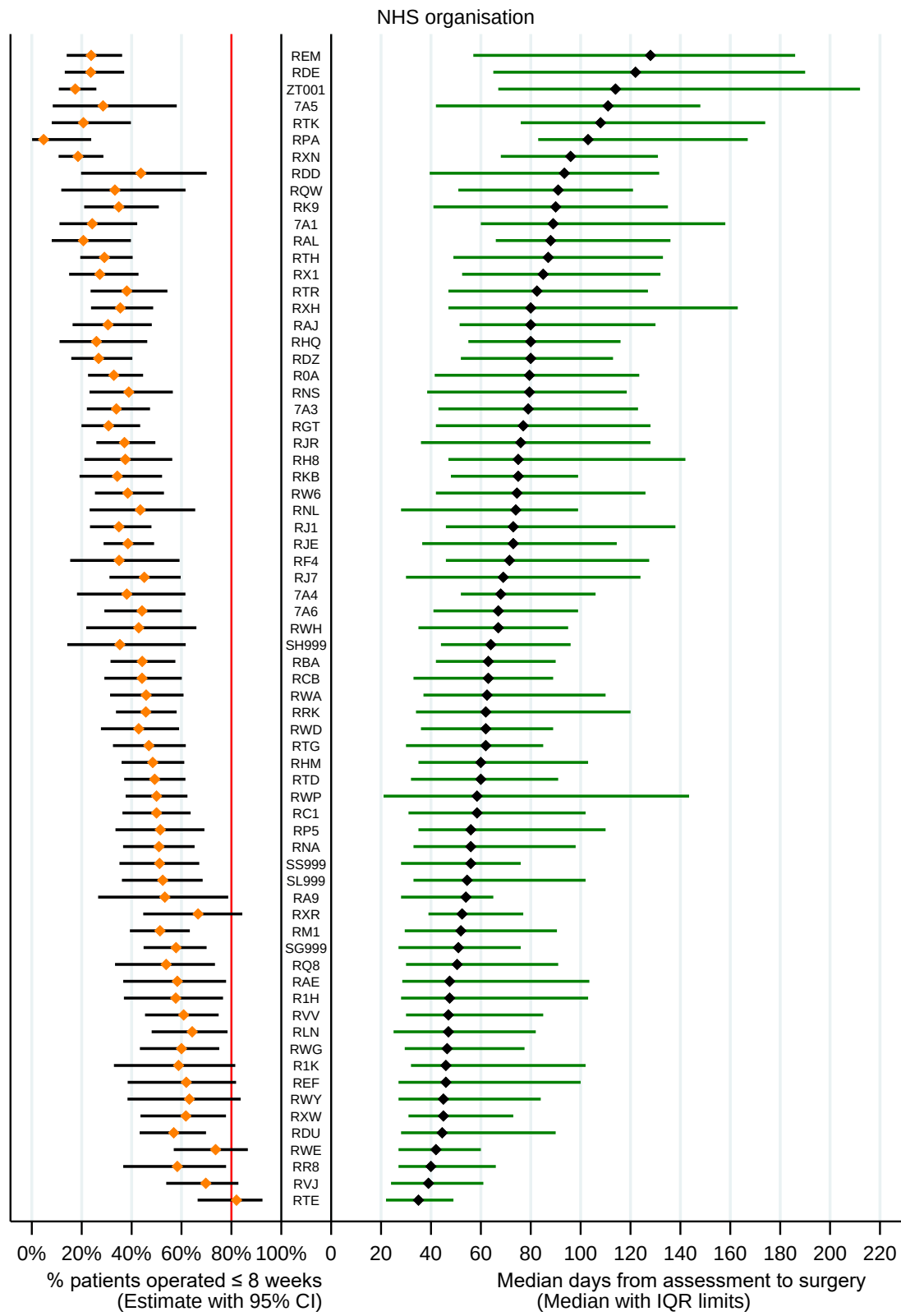
In the left panel of Figure 2.2, the orange diamonds show the proportion of patients that were seen within the recommended 8 weeks after their CT/MR angiography assessment. The grey horizontal bars depict their 95% confidence intervals. The red line shows the 80% target indicated by NAAASP.

For 44 NHS trusts, less than 50% of their patients had their AAA repair within 56 days. Overall, 41.9% of patients are operated on within the recommended 8-week target – this corresponded to 49.8% of screened patients and 36.5% of non-screened patients, and is well below the 80% target.

There are legitimate reasons for why patients wait for surgery, such as the optimisation of comorbid medical conditions. However, 140 days is 2.5 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 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 2.2: Median (IQR) time from assessment to treatment (days) for patients who had elective infra-renal AAA repair between January and December 2019 (black diamonds) and proportion seen within 8 weeks of assessment (orange diamonds)



2.3 Postoperative outcomes after elective infra-renal AAA repair

Table 2.3 describes various aspects of postoperative care and highlights some notable differences between patients having open repair and EVAR procedures.

- For EVAR procedures, over 65% of patients went to a normal hospital ward after surgery, and the median length of the overall postoperative stay was 2 days. The in-hospital mortality rate was 0.4% (95% CI 0.2 to 0.8)
- For patients undergoing open repair, 98% of patients were admitted to a level 2 or level 3 critical care unit after surgery. They typically remained there for 2 days and the median total postoperative stay was 7 days. Patients that had open repair were more susceptible to cardiac, renal and respiratory complications, and the rate of return to theatre was also higher. The in-hospital mortality rate for open repair was 2.3% (95% CI 1.6 to 3.2).

Table 2.3: Postoperative details of elective infra-renal AAA repairs undertaken between January and December 2019

		Open repair (n=1,355)		EVAR (n=2,090)	
Admitted to	Ward	1.8%		67.3%	
	Level 2	63.0%		29.7%	
	Level 3	35.2%		3.1%	
		Median	IQR	Median	IQR
Days in critical care:	Level 2	2	1 to 4	1	0 to 1
	Level 3	2	1 to 3	1	1 to 3
Hospital length of stay (days)		7	6 to 10	2	1 to 3
		Rate	95% CI	Rate	95% CI
In-hospital postoperative mortality		2.3	1.6 to 3.2	0.4	0.2 to 0.8
Defined complications					
	Cardiac	4.1	3.1 to 5.3	0.8	0.5 to 1.3
	Respiratory	9.2	7.7 to 10.9	1.1	0.7 to 1.7
	Haemorrhage	1.1	0.6 to 1.8	0.8	0.5 to 1.3
	Limb ischaemia	2.6	1.8 to 3.6	0.9	0.5 to 1.4
	Renal failure	5.2	4.1 to 6.6	1.1	0.7 to 1.7
	Other	7.4	6.0 to 8.9	3.7	3.0 to 4.6
	None of predefined complications	73.6	71.1 to 75.9	91.5	90.3 to 92.7
Return to theatre		6.8	5.5 to 8.3	2.1	1.5 to 2.8
Readmission within 30 days		4.7	3.6 to 6.0	5.7	4.8 to 6.8

Patients undergoing EVAR procedures may experience various types of 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 EVAR procedures performed in 2019:

- 1,703 (82.5%) procedures experienced no endoleak while the patient was in hospital
- 116 (5.6%) procedures experienced a type 1 endoleak
- 141 endoleaks (of any type) required intervention at the time of the procedure.

Patient frailty was one of the new quantities to be collected in the NVR from January 2019. 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 optimization with an elderly care physician review prior to vascular surgery.

For the first time, we highlight the influence of frailty in patients undergoing both open and endovascular procedures for elective infra-renal AAA repair (Table 2.4). For 2019, frailty was recorded in 2,516 patients (73.0%). Among these, 1,819 (72.3%) patients were rated as not frail, but the prevalence of frailty differed markedly between patients having open repairs (14.7%) and those having EVAR (36.7%). For open repairs, the median length of stay was slightly longer for frail patients (8 days vs 7 days) but was unchanged for EVARs. There was insufficient data to demonstrate a relationship between frailty and in-hospital postoperative mortality but there was a suggestion it could be higher among frail patients having EVAR (Table 2.4).

Going forward, we will publish more in-depth findings on the impact of frailty on AAA repair as well as for the other vascular procedures covered by the NVR. We encourage vascular units to identify at risk 'frail' patients and ensure their degree of frailty is submitted to the NVR.

Table 2.4: Postoperative details of elective infra-renal AAA repairs undertaken between January and December 2019 by patient frailty.

		Open repair (n=1,028)		EVAR (n=1,488)	
Procedures		No. of pats	%	No. of pats	%
		877	85.3	942	63.3
	Not frail				
	Frail	151	14.7	546	36.7
		Median	IQR	Median	IQR
Length of stay (days)	Not Frail	7	6 to 9	2	1 to 2
	Frail	8	7 to 13	2	1 to 3
		Rate	95% CI	Rate	95% CI
In-hospital mortality	Not Frail	1.9	1.1 to 3.1	0.2	0.0 to 0.8
	Frail	1.3	0.2 to 4.7	0.9	0.3 to 2.1

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

The principal performance measure used by the NVR for elective infra-renal AAA repair is the postoperative in-hospital mortality rate. In this section, we report this outcome for NHS organisations undertaking these elective infra-renal AAA repairs during the period from 1 January 2017 to 31 December 2019. A 3-year audit period was used to give robust outcome estimates.

The comparative, risk-adjusted mortality rates for individual NHS Trusts are shown in a funnel plot in Figure 2.3. 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.

Figures 2.4A and 2.4B 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 2017 and 2019 were 2.9% and 0.6%, respectively.

Figure 2.3: Risk-adjusted in-hospital mortality rates after elective infra-renal AAA repair among NHS vascular units for procedures performed between January 2017 and December 2019. The overall in-hospital mortality rate was 1.4%.

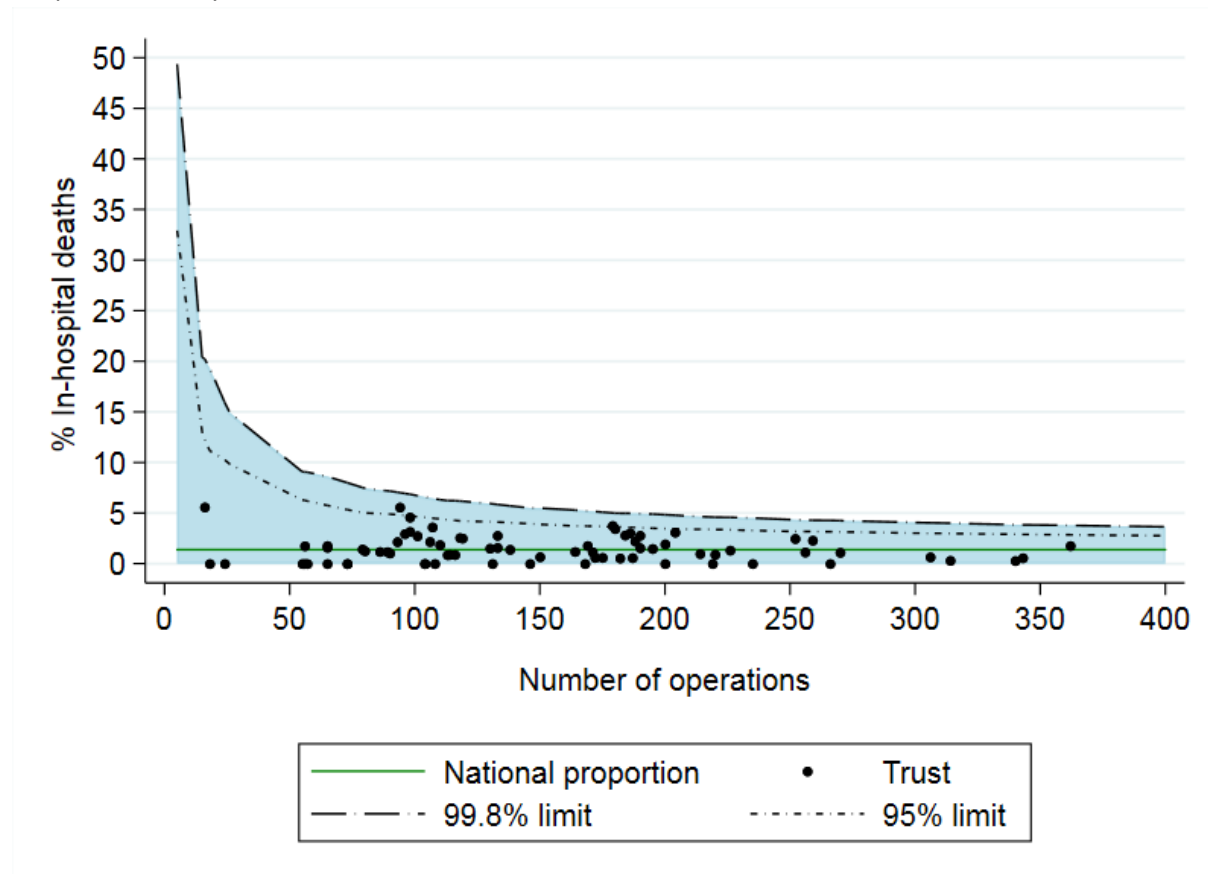
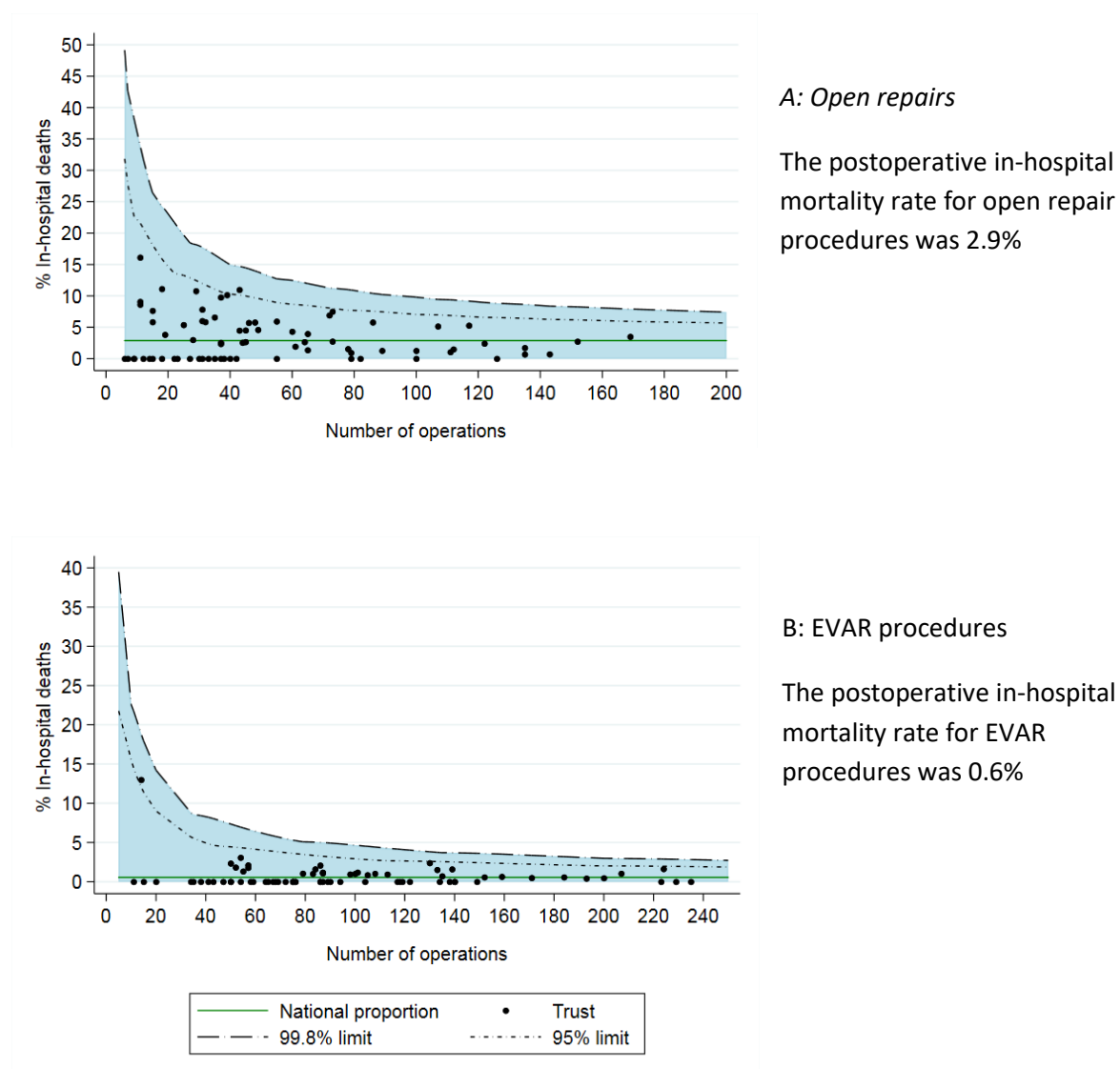


Figure 2.4: Funnel plot of risk-adjusted in-hospital mortality after elective AAA repair for open and EVAR procedures performed between 2017 and 2019.



Postoperative in-hospital mortality after both open repair and EVAR continues to fall; in 2019, the rates were 2.3% and 0.4% respectively. These improved outcomes are likely to reflect the residual impact of the AAA Quality Improvement Programme (QIP), the regular feedback of audit results both at unit and surgeon level provided by the National Vascular Registry, and the reconfiguration of vascular services.

The very low in-hospital mortality rates following elective EVAR repair raises the question of whether mortality remains the most valuable measure of outcome for infra-renal AAA [Boyle 2019]. Consequently, the NVR introduced a refined aortic dataset in 2020 to capture data on revision surgery and re-interventions following aortic surgery in the expectation that this will become a better measure of quality in time.

3. Elective repair of complex aortic conditions

3.1 Patterns of complex aortic surgery

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

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

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

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

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

This chapter provides results for the 3-year period between January 2017 and December

2019. The NVR received 2,577 records related to complex AAA procedures from 73 vascular units. The numbers have fluctuated over these three years, with 872 procedures in 2017, 917 in 2018 and 788 in 2019. Of these procedures, 2,306 (89%) were endovascular (Table 3.1), with just over half being fenestrated repairs.

The median annual volume at these 73 vascular units was 15 procedures but the level of activity differed markedly between them. One unit performed 340 complex repairs between 2017 and 2019 but 52 units performed fewer than 30 procedures.

The changes in the number of trusts providing elective repair of complex AAA is summarised in Figure 3.1. In 2017, 26 of the 73 (36%) trusts were performing at least 10 procedures annually and 14 had done no procedures. By 2019, there were 19 trusts (26%) performing at least 10 procedures and 17 carrying out no procedures. Evidently, a smaller number of trusts are now performing an ample number of procedures annually.

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

Figure 3.1: Number of trusts performing elective complex AAA repair

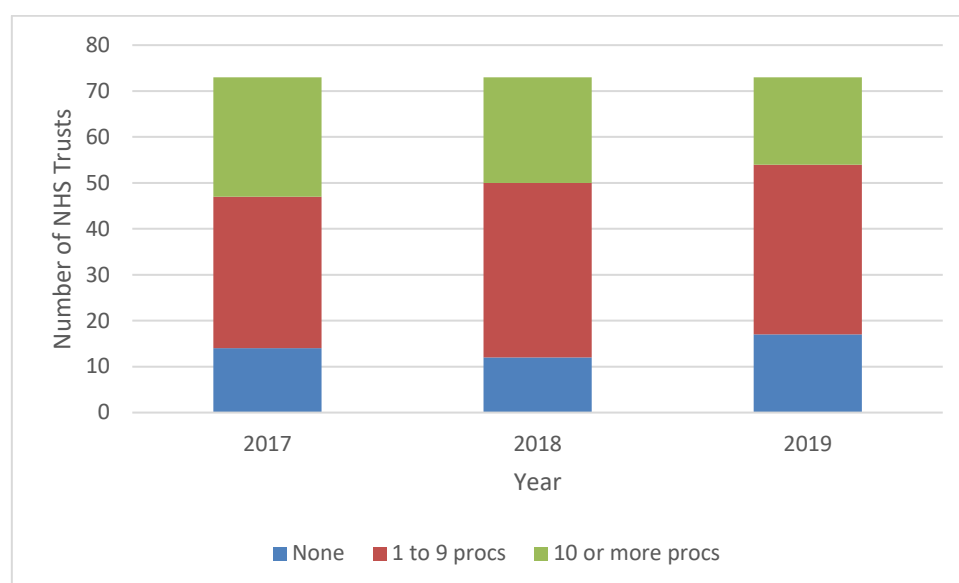


Table 3.1: Characteristics of patients who had an elective repair of complex AAA between January 2017 and December 2019

		Open repair	%	Endovascular	%	Total
Total procedures		271		2,306		2,577
Age group (years)	Under 66	57	21.0	320	13.9	377
	66 to 75	137	50.6	926	40.3	1,063
	76 to 85	76	28.0	968	42.1	1,044
	86 and over	<5	0.4	86	3.7	87
Male		239	88.2	1,883	81.7	2,122
Female		32	11.8	423	18.3	455
Type of procedure	FEVAR			1,303	56.6	
	BEVAR			216	9.4	
	TEVAR			469	20.4	
	Iliac branch graft			238	10.3	
	Composite graft			13	0.6	
	Other (e.g., chimney / snorkel / periscope)			64	2.8	

The time from vascular assessment to surgery for all complex AAA repairs between 2017 and 2019 is shown in Figure 3.2. The graph shows the results for 38 of the 73 organisations that had data available for 10 or more complex repairs during this time.

The median time from assessment to surgery for all patients was 131 days (IQR: 76-204). The median for a large number of vascular units tended to fall within the range of 100 to 160 days. However, the upper limit of the interquartile ranges shows that, at ten vascular units, a quarter of patients waited more than 240 days to have a complex AAA repair.

The 2016 NVR snapshot audit identified a number of reasons why patients having complex repairs typically had a longer delay

between vascular assessment and surgery than patients having infra-renal endovascular repair. These included:

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

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

Figure 3.2: Median (IQR) time from assessment to treatment (days) for patients who had an elective complex AAA repair between January 2017 and December 2019

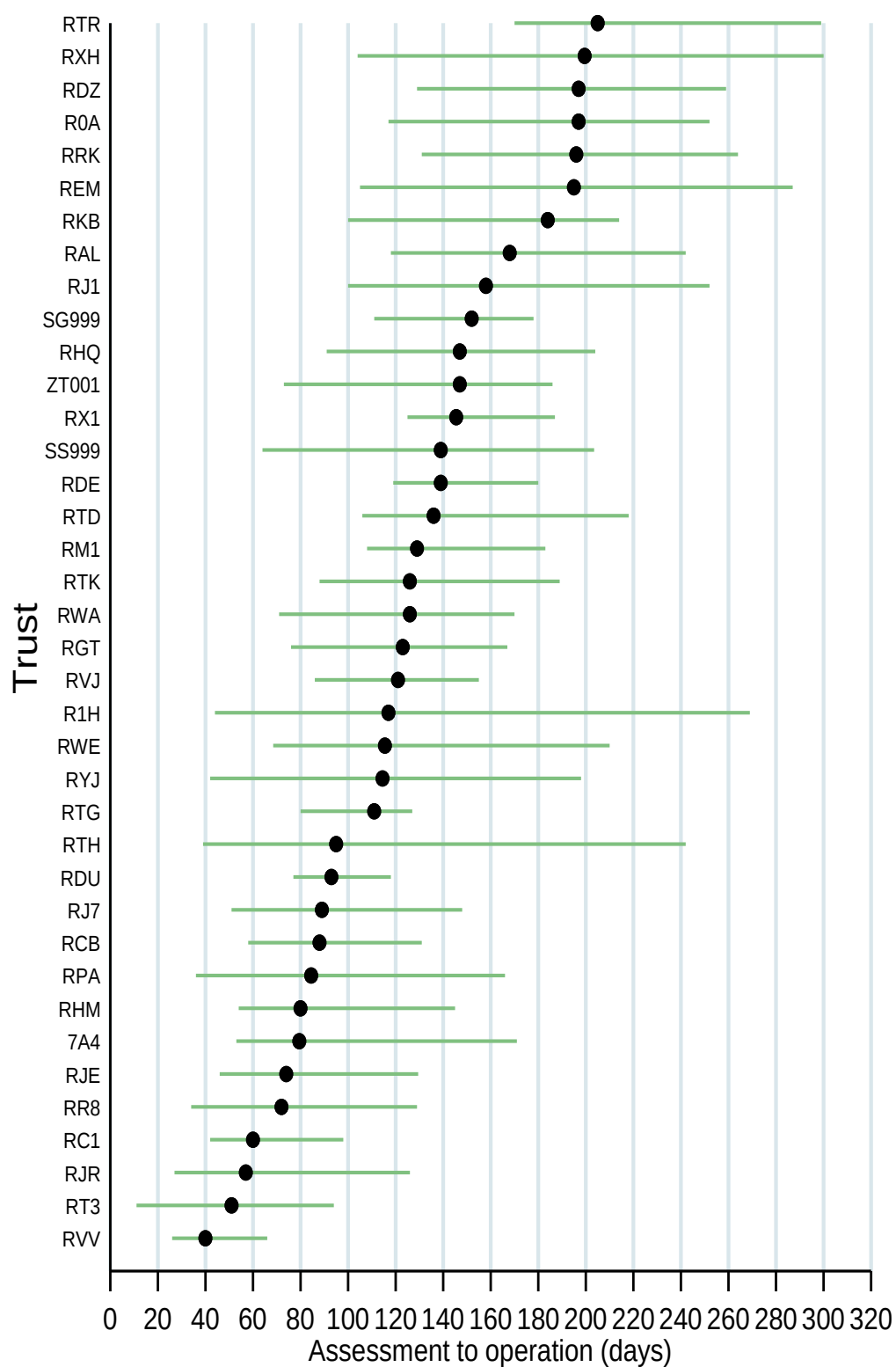


Table 3.2 describes the outcomes of elective complex AAA repairs. As with elective infra-renal AAA repairs, clear differences can be seen between open and EVAR procedures:

- For open repairs, over 50% of patients were admitted to a level 3 critical care unit. The median overall postoperative stay was 9 days.
- For EVAR, the majority of patients (62%) were admitted to level 2 critical care. The median length of stay was 4 days.

The in-hospital postoperative mortality rates for open and endovascular procedures were around five times greater than the equivalent

rates for infra-renal AAA repair, reflecting the complex nature of the disease and surgery. For open repairs, there was also a high risk of returning to theatre (14.3%). However, for open repairs, the rates of readmission to critical care, return to theatre, and 30 day readmission rate are all lower than reported in the 2019 NVR report.

For the two most common complex endovascular procedures, the mortality for TEVAR patients was slightly higher than FEVAR patients (Table 3.3). The mortality for elective FEVAR at 2.3% is comparable to open infra-renal AAA repair.

Table 3.2: Postoperative details of complex AAA repairs undertaken between January 2017 and December 2019

		Open repair (n=271)		Endovascular (n=2,306)	
Admitted to	Ward	1.8%		19.9%	
	Level 2	39.9%		62.1%	
	Level 3	56.5%		17.9%	
	Died in theatre	1.8%		0.1%	
		Median	IQR	Median	IQR
Days in critical care:	Level 2	3	2 to 5	2	1 to 3
	Level 3	4	2 to 6	2	1 to 3
Hospital length of stay (days)		9	6 to 15	4	2 to 7
		Rate	95% CI	Rate	95% CI
In-hospital postoperative mortality		14.0	10.1 to 18.7	2.7	2.1 to 3.4
Readmission to critical care		6.0	3.5 to 9.6	2.6	2.0 to 3.4
Return to theatre		14.3	10.3 to 19.1	4.8	4.0 to 5.8
30 day readmission rate		7.8	4.5 to 12.3	9.1	7.8 to 10.6

Table 3.3: Postoperative details of complex TEVAR and FEVAR undertaken between January 2017 and December 2019

		TEVAR (n=469)		FEVAR (n=1,303)	
Admitted to	Ward	18.3%		15.8%	
	Level 2	60.1%		65.3%	
	Level 3	21.3%		18.8%	
	Died in theatre	0.2%		0.1%	
		Median	IQR	Median	IQR
Days in critical care:	Level 2	2	1 to 3	2	1 to 3
	Level 3	2	1 to 3	2	1 to 3
Hospital length of stay (days)		4	2 to 7	4	3 to 7
		Rate	95% CI	Rate	95% CI
In-hospital postoperative mortality		3.4	2.0 to 5.5	2.3	1.6 to 3.3
Readmission to critical care		2.8	1.5 to 4.7	2.8	1.9 to 3.8
Return to theatre		5.6	3.7 to 8.0	4.1	3.1 to 5.4
30 day readmission rate		12.9	9.5 to 17.0	7.6	6.1 to 9.4

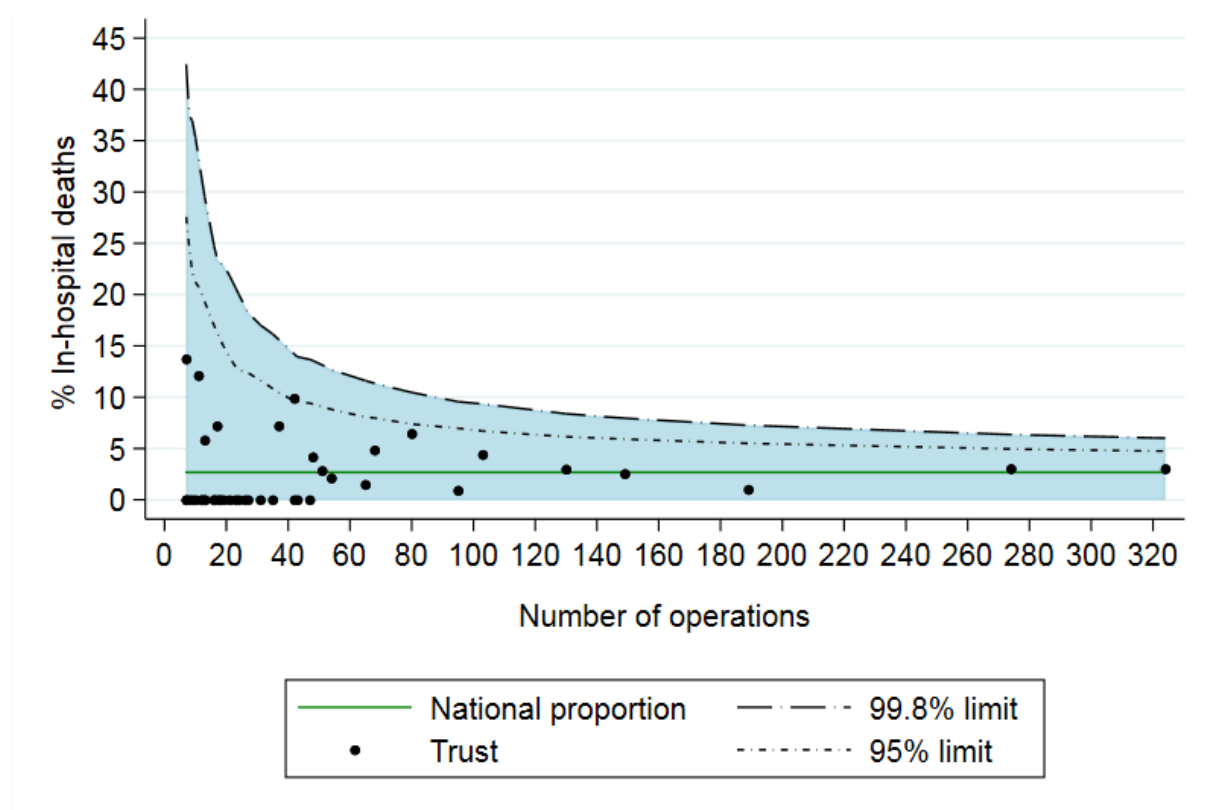
3.2 Postoperative in-hospital mortality for complex endovascular procedures

This section describes the in-hospital mortality rates for NHS organisations undertaking complex endovascular procedures during the period from 1 January 2017 to 31 December 2019.

The adjusted mortality rates for individual NHS Trusts are shown using a funnel plot in Figure 3.3. All 44 NHS Trusts had an in-

hospital mortality that fell within the expected range around the national average of 2.7%, given the number of procedures performed. The rates among the NHS Trusts ranged from 0 to 15% but this reflected the relatively low volumes used to calculate these rates.

Figure 3.3: In-hospital mortality after complex endovascular repairs between January 2017 and December 2019



3.3 Comment

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

intervention should be reviewed if units perform less than 10 procedures annually.

The area of endovascular repair continues to evolve, with new complex endovascular grafts being made available to vascular services. Changes to the NVR IT system in 2020 will enable vascular surgeons and interventional radiologists to enter device information for the first time, and this will help the NVR to capture the changing patterns of complex repair and support vascular services to monitor the safety of the various procedures.

4. Repair of ruptured abdominal aortic aneurysms

4.1 Surgical activity for ruptured AAA

Although there has been a steady decline in the incidence of ruptured abdominal aneurysms, it remains a common vascular emergency. In this chapter, the outcomes of emergency repairs among patients with a ruptured AAA are described for the period between 1 January 2017 and 31 December 2019. Details of 2,229 procedures were submitted to the NVR for these 3 years, giving an estimated case-ascertainment of approximately 93%.

Compared to patients who had an elective infra-renal AAA repair, patients who had surgery for a ruptured AAA were older on average, with just over 50% being over 75 years at the time of surgery. The average diameter of the aneurysm was also larger (see [Appendix 3](#)).

The proportion of patients having an EVAR procedure over this 3-year period was 31.5% (n=703). For patients undergoing EVAR, the basic characteristics of their anatomy were:

- 87.1% had a neck angle between 0-60 degrees; for 7.8%, it was 60-75 degrees
- the mean neck diameter was 23.8mm and the mean neck length was 24.9mm
- the aneurysm was extended into either the left / right iliac artery for 17.6% of procedures and was extended bilaterally for 6.2% of procedures
- the median aortic diameter was 7.55cm (IQR: 6.4 – 9.0).

For patients having open repair, 72.6% underwent tube grafts, 26.6% underwent a bifurcated graft and 5.5% had a groin incision.

The outcomes of the procedures for ruptured AAA are summarised in Table 4.1. Some notable differences in the postoperative care received by patients undergoing open and EVAR procedures were as follows:

- median postoperative length of stay was 15 days for open repair compared with 9 days for EVAR patients among patients discharged alive
- Over 80% of patients who had an open procedure required level 3 critical care after the procedure, with a median length of stay of 4 days.
- a greater proportion of patients who had open repair suffered from cardiac, renal and respiratory complications.

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

The in-hospital postoperative mortality rates for open and EVAR procedures were 41.1% (95% CI 38.6 to 43.6) and 20.2% (95% CI 17.3 to 23.4), respectively. This is likely to reflect the selection of more stable patients with better aortic anatomy for EVAR, and should be interpreted as indicating their relative effectiveness. The results of the IMPROVE trial reported 30-day mortality rates of 37.4% for open repair and 35.4% for EVAR among patients with ruptured AAA.

Table 4.1: Postoperative details of emergency repairs for ruptured AAAs undertaken between January 2017 and December 2019

		Open repair (n=1,526)		EVAR (n=703)	
Admitted to	Ward	0.5%		12.0%	
	Level 2	8.3%		39.5%	
	Level 3	84.5%		45.6%	
	Died in theatre	6.7%		3.0%	
		Median	IQR	Median	IQR
Days in critical care:	Level 2	4	2 to 6	2	1 to 3
	Level 3	4	2 to 8	3	1 to 5
Hospital length of stay (days)		10	3 to 19	8	4 to 15
Length of stay for patients discharged alive (days)		15	9 to 24.5	9	5 to 15
		Rate	95% CI	Rate	95% CI
In-hospital postoperative mortality		41.1	38.6 to 43.6	20.2	17.3 to 23.4
Defined complications					
	Cardiac	24.0	21.8 to 26.3	12.4	10.1 to 15.2
	Respiratory	31.3	28.9 to 33.8	18.6	15.7 to 21.7
	Stroke	2.3	1.6 to 3.2	1.2	0.5 to 2.3
	Haemorrhage	3.6	2.7 to 4.7	2.8	1.7 to 4.3
	Limb ischaemia	10.2	8.7 to 11.9	1.8	0.9 to 3.0
	Renal failure	29.0	26.7 to 31.5	13.3	10.9 to 16.1
	Ischaemic bowel	10.8	9.3 to 12.6	3.1	1.9 to 4.7
	None of the above	35.2	32.7 to 37.7	58.9	55.1 to 62.6
Return to theatre		20.0	17.9 to 22.2	9.2	7.1 to 11.6
Readmission within 30 days		7.7	5.9 to 9.7	10.0	7.6 to 13.0

4.2 Postoperative in-hospital mortality for ruptured AAA repair

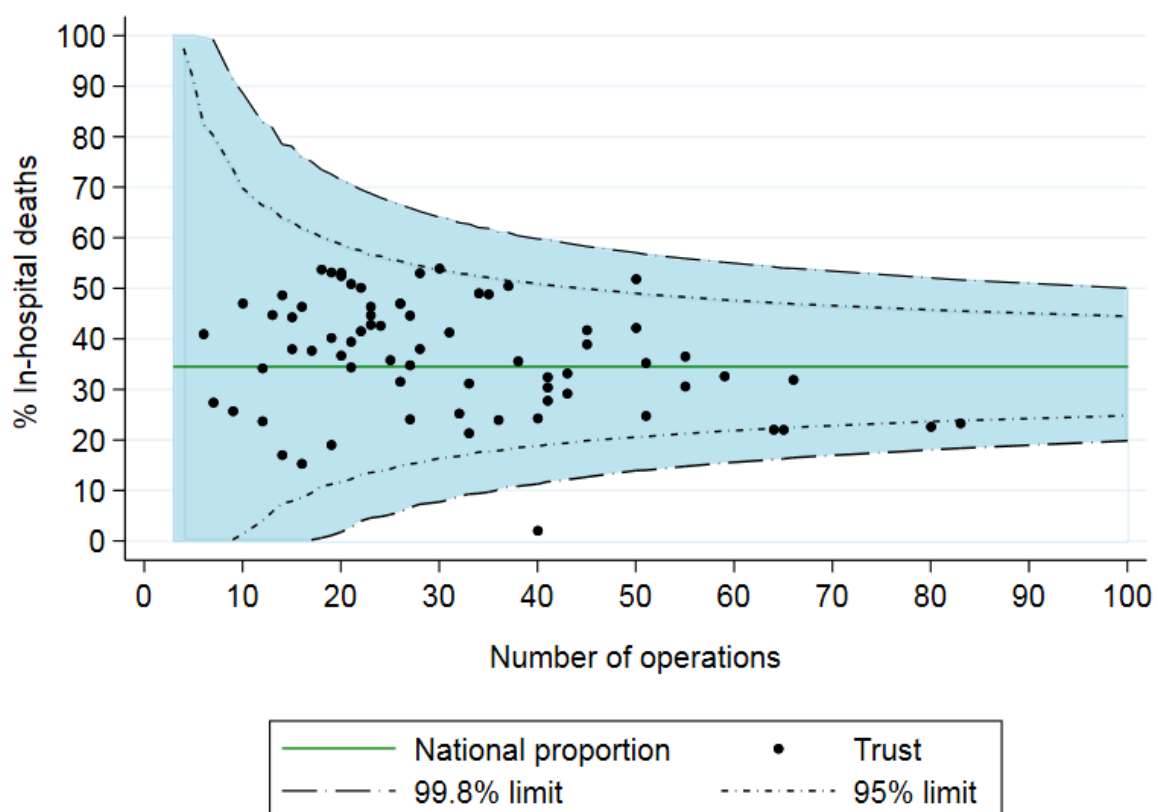
For NHS organisations undertaking repair of a ruptured AAA between 1 January 2017 and 31 December 2019, the risk-adjusted postoperative mortality rates are shown using a funnel plot in Figure 4.1.

All NHS Trusts had a risk-adjusted rate of in-hospital mortality that fell within the expected range around the national average of 34.5%, given the number of procedures performed. There was one NHS Trust that had a mortality rate that was lower than the 99.8% control limit.

The rates among the NHS Trusts typically ranged from 20-60%, which reflects the relatively low volumes used to calculate these rates. The online appendices spreadsheet gives the figures for each NHS Trust*.

Vascular units should evaluate how access to endovascular repair can be improved for emergency repair of ruptured aneurysms. This may require review of anaesthetic as well as surgical aspects of the care pathway.

Figure 4.1: Risk-adjusted in-hospital mortality for emergency repairs of ruptured AAAs between January 2017 and December 2019 by NHS Trust. The overall mortality rate was 34.5%.



* The online appendices spreadsheet can be found at <https://www.vsqip.org.uk/reports/2020-annual-report/>

5. Lower limb bypass for PAD

5.1 Introduction

Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower limb arteries [Peach et al 2012]. 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.

In March 2019, the VSGBI published its Quality Improvement Framework for PAD [VSGBI 2019]. This set out a series of best practice recommendations for vascular services on the management of PAD and, in particular, chronic limb-threatening ischaemia (CLTI), a severe form of PAD in which blood flow to the feet is severely restricted. Revascularisation is the primary treatment for patients with CLTI, with patients having either open bypass surgery or an endovascular intervention.

This chapter presents results on the processes and outcomes of lower limb bypass procedures, focusing on data from 18,090 procedures entered into the NVR during the three years between January 2017 and December 2019. Lower limb endovascular interventions are described in the next chapter.

It is estimated that the NVR has captured approximately 90% of the bypass procedures performed in the NHS between 2017 and 2019.

Table 5.1 summarises the characteristics of the lower limb bypass procedures. Patients admitted electively for surgery tended to have less severe disease compared with non-elective admissions, but chronic limb-threatening ischemia (Fontaine scores 3 and 4) accounted for the majority of procedures regardless of a patient's mode of admission. The prevalence of diabetes, hypertension and ischaemic heart disease was high among bypass patients, and only a small proportion of patients had no comorbid disease. Not surprisingly, most patients were on some form of cardiovascular/risk modification medication (see [Appendix 3](#)).

The most common elective and emergency procedures involved a bypass from a femoral artery to one above or below knee (53.0% and 60.2%, respectively). For elective procedures, an endarterectomy procedure was performed together with the bypass in 4,661 procedures (41.3%); for non-elective procedures, endarterectomy was performed in 2,461 bypass operations (36.2%).

The patient's own veins were used as the bypass grafts in 4,690 elective procedures (41.6%) and 3,461 non-elective procedures (50.8%).

Table 5.1: Characteristics of lower limb bypass procedures undertaken between January 2017 and December 2019

	Elective procedures (n=11,283)	%	Non-elective procedures (n=6,807)	%
Fontaine score ¹				
1 Asymptomatic	74	0.8	76	1.6
2 Intermittent claudication	3,960	40.8	186	3.9
3 Nocturnal &/or resting pain	3,007	31.0	1,129	23.7
4 Necrosis &/or gangrene	2,666	27.5	3,378	70.8
Bypass location				
Femoral – femoral	828	7.3	461	6.8
Femoral – popliteal / tibial	5,985	53.0	4,097	60.2
Aorta – femoral / iliac	917	8.1	259	3.8
Iliac – femoral	1,562	13.8	619	9.1
Femoral endarterectomy	276	2.4	97	1.4
Other bypass	2,763	24.5	1,668	24.5

¹The Fontaine score was missing for 1576 elective and 2038 non-elective procedures.

5.2 Time to revascularisation for patients with CLTI

VSGBI: PAD QIF

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

Early revascularisation for patients with CLTI is associated with a reduced risk of lower limb amputation. Rapid limb assessment and discussion with the lower limb multi-disciplinary team (MDT) are important aspects of care in evaluating the benefit of revascularisation and the risk of limb loss.

For CLTI patients admitted after a non-elective admission between 2017 and 2019, the overall median wait from admission to surgery was 6 days (IQR 2-9) and 49.9% of patients had their bypass within five days.

Figure 5.1 (overleaf) summarises the median (IQR) time from admission to surgery (right

panel) across 69 NHS Trusts that performed 10 or more bypasses for non-elective admissions between 2017 and 2019. The left panel shows the proportion of patients waiting inside 5 days (with 95% confidence intervals shown as grey lines). The red line indicates a recommended 80% target. In the right panel, the red vertical line indicates the 5-day standard defined by the VSGBI. In summary:

- at 37 vascular units, the pathway took more than five days for half of patients with CLTI
- at 23 vascular units, the pathway from admission to surgery took longer than 10 days for a quarter of patients
- 32 vascular units had more than half their patients operated on within 5 days.

Figure 5.1: Median (IQR) time from admission to surgery (days) for patients who had a non-elective bypass between January 2017 and December 2019 with chronic limb-threatening ischaemia

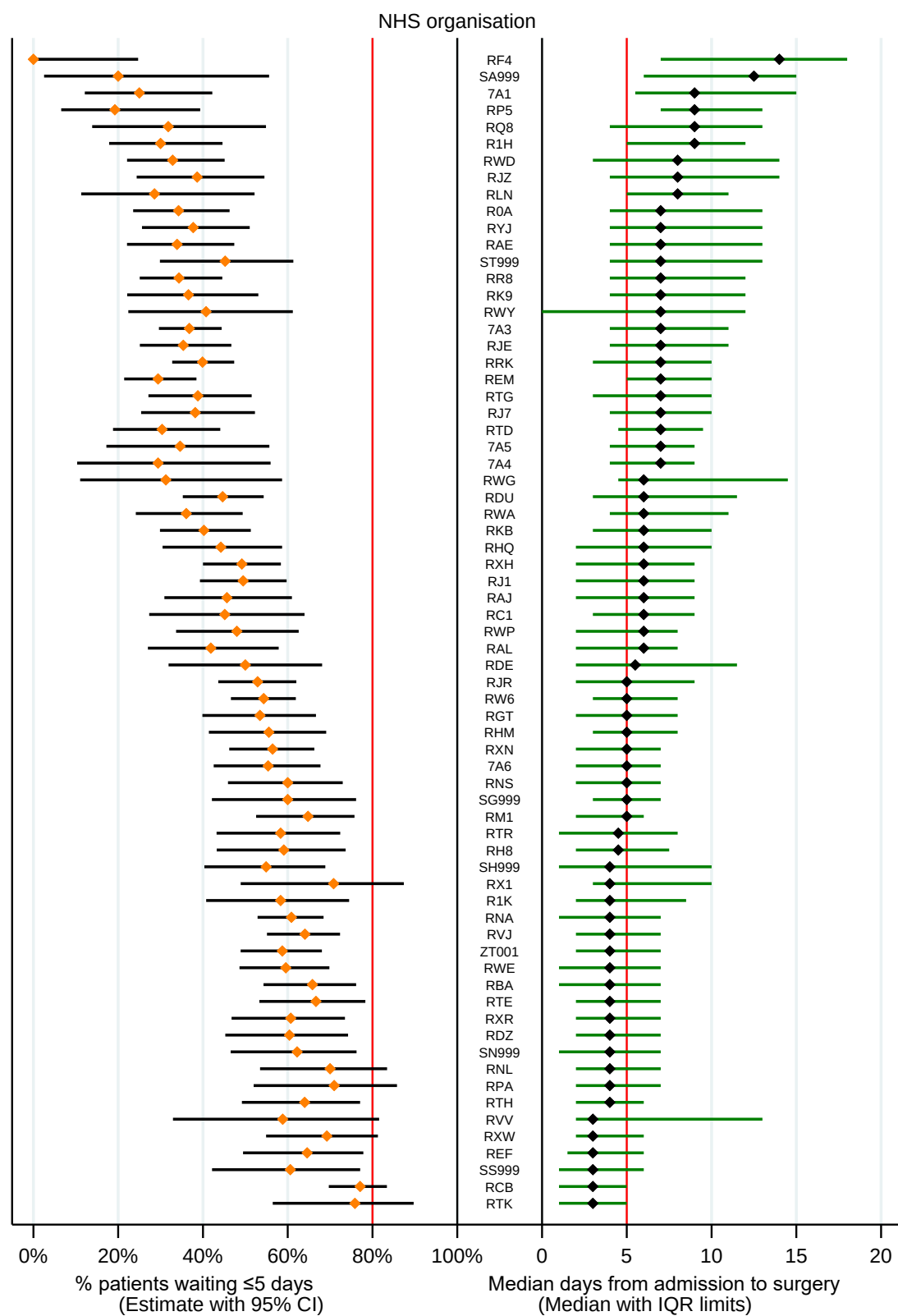


Table 5.2: Postoperative outcomes for patients undergoing elective and non-elective lower limb bypasses between January 2017 and December 2019

		Elective		Non-elective	
		No. of procs		No. of procs	
Total procedures		11,283		6,807	
Admitted to	Ward	8,089	71.7%	4,675	68.7%
	Level 2	2,607	23.1%	1,605	23.6%
	Level 3	579	5.1%	514	7.6%
	Day case unit	0	0.0%	0	0.0%
	Died in theatre	<5	<0.1%	7	0.1%
		Median	IQR	Median	IQR
Days in critical care:	Level 2	1	1 to 2	1	0 to 3
	Level 3	2	1 to 3	2	1 to 4
Admission to procedure (days)		0	0 to 1	4	1 to 8
Postoperative length of stay (days)		4	3 to 7	8	5 to 17
Overall length of stay (days)		5	3 to 8	14	9 to 25
		Rate	95% CI	Rate	95% CI
In-hospital mortality rates					
Overall mortality		1.0	0.9 to 1.2	4.8	4.3 to 5.3
Femoral – femoral		0.8	0.3 to 1.7	6.1	4.1 to 8.7
Femoral – popliteal / tibial		0.9	0.6 to 1.1	3.6	3.1 to 4.3
Aorta – femoral / iliac		3.4	2.3 to 4.8	9.3	6.0 to 13.5
Iliac – femoral		0.5	0.2 to 1.0	6.1	4.4 to 8.3
Femoral endarterectomy		0.4	0.0 to 2.0	4.1	1.1 to 10.2
Defined complications					
Cardiac		2.3	2.1 to 2.6	4.8	4.3 to 5.3
Respiratory		2.6	2.3 to 2.9	4.5	4.0 to 5.0
Haemorrhage		1.6	1.4 to 1.9	2.3	1.9 to 2.7
Limb ischaemia		2.7	2.4 to 3.0	5.7	5.2 to 6.3
Renal failure		1.0	0.8 to 1.2	2.2	1.8 to 2.6
Stroke		0.3	0.2 to 0.4	0.4	0.3 to 0.6
None of the above		87.4	86.8 to 88.0	79.7	78.8 to 80.7
Further unplanned lower limb procedure					
None		93.9	93.4 to 94.3	85.4	84.5 to 86.2
Angioplasty without stent		0.5	0.4 to 0.6	1.2	0.9 to 1.4
Angioplasty with stent		0.4	0.3 to 0.5	0.5	0.3 to 0.7
Lower limb bypass		1.4	1.2 to 1.6	2.5	2.2 to 2.9
Minor amputation		1.0	0.8 to 1.2	4.7	4.2 to 5.3
Major amputation		0.2	0.1 to 0.3	1.1	0.9 to 1.4
Other		3.2	2.8 to 3.4	5.6	5.1 to 6.2
Readmission to higher level care		2.1	1.8 to 2.3	2.9	2.5 to 3.3
Readmission within 30 days		10.2	9.6 to 10.8	15.1	14.2 to 16.0

5.3 Postoperative outcomes for lower limb bypasses

Table 5.2 summarises the outcomes of the elective and non-elective bypass procedures, which are consistent with the results in recent literature. Complications were relatively uncommon, with 94% of elective procedures and 85% of non-elective procedures not requiring a further unplanned intervention.

Outcomes for patients who had a non-elective procedure were slightly worse than elective procedures across a range of measures. For in-hospital postoperative mortality, the rates were 1.0% (95% CI 0.9 to 1.2) for elective patients, and 4.8% (95% CI 4.3 to 5.3) for non-elective patients overall. However, for procedures that involved the aorta, postoperative mortality was considerably higher than for other vessels, and reached 9.3% for non-elective cases.

However, the figures show that 10% of elective and 15% of non-elective patients

have an unplanned readmission within 30 days. The NVR does not have data on the reasons for readmission but local services should review their local rates to determine their cause.

The outcomes of the revascularisation procedures for patients with CLTI admitted non-electively are summarised in Table 5.3. There are some differences in outcomes according to whether patients met the 5-day target for the delay between assessment and surgery, 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 5.3: Postoperative outcomes following lower limb bypass, for patients undergoing non-elective revascularisation for CLTI, stratified by the preoperative length of stay (LOS) in hospital

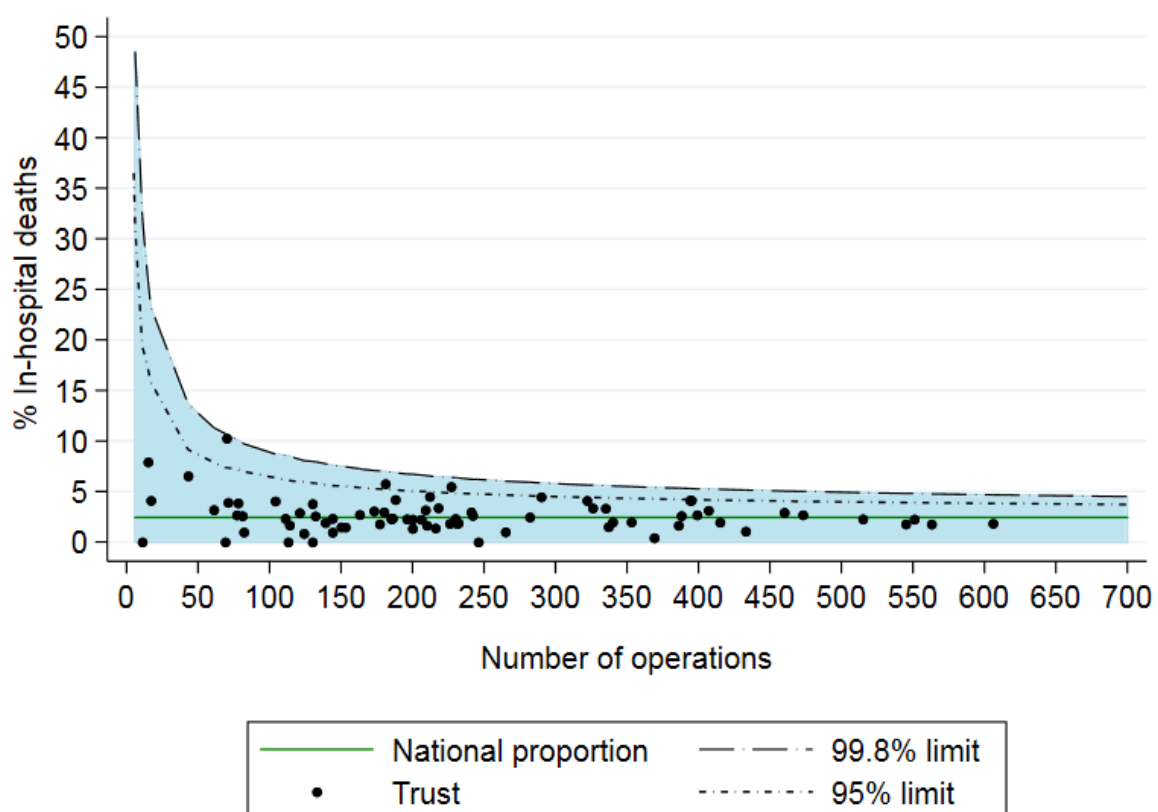
	Patients with preoperative LOS ≤5 days		Patients with preoperative LOS >5 days	
	No.		No.	
Procedures	2,243	49.9%	2,255	50.1%
	Median	IQR	Median	IQR
Days in critical care				
Level 2	1	0 to 2	1	0 to 3
Level 3	2	1 to 4	2	1 to 3
Overall LOS	10	7 to 17	21	15 to 34
Postoperative LOS	8	5 to 15	10	6 to 20
	Rate	95% CI	Rate	95% CI
In-hospital mortality	3.0	2.4 to 3.8	5.1	4.2 to 6.1
No predefined complication	83.6	82.0 to 85.1	79.7	77.9 to 81.3
Unplanned lower limb procedure				
None	87.0	85.5 to 88.3	84.3	82.8 to 85.8
Minor amputation	5.4	4.5 to 6.5	6.6	5.6 to 7.7

5.4 Rates of in-hospital death after lower limb bypass

Figure 5.2 shows the funnel plot of risk-adjusted mortality rates for each NHS Trust that performed bypass procedures between January 2017 and December 2019. The national average has slightly improved over time, decreasing from 2.8% (for 2014 to 2016) to 2.4% (for 2017 to 2019). All NHS trusts had a risk-adjusted rate of in-hospital death that fell within the expected range.

The rates of in-hospital death for lower limb bypasses were adjusted to take account of the differences in the characteristics of patients treated at the various organisations. The risk adjustment model took into account the following characteristics: age, sex, anatomy of procedure, Fontaine score, mode of admission, ASA grade, ischaemic heart disease, renal disease and chronic lung disease.

Figure 5.2: Funnel plot of risk-adjusted in-hospital deaths from lower limb bypass for NHS Trusts, shown for procedures performed between January 2017 and December 2019.



Patients who undergo a hybrid lower limb revascularisation procedures

Some patients that have a lower limb bypass also have an endovascular procedure. Between 2017 and 2019, the NVR received details of 2,548 (14.1%) such cases. Most of these patients were elective admissions (65.0%).

The overall in-hospital mortality rate for this patient group was 2.8% (95% CI 2.2 to 3.5), a little higher than non-hybrid procedures at 2.4% (95% CI 2.1 to 2.6) but this difference was not statistically significant ($p=0.218$).

- For elective hybrid cases, the postoperative mortality rate was 1.1% (95% CI 0.6 to 1.7) and was similar to non-hybrid procedures (1.0%; 95% CI 0.8 to 1.2%).
- For non-elective admissions, the rate was 5.9% (95% CI 4.5 to 7.7) which is marginally higher than non-hybrid procedures at 4.6% (95% CI 4.1 to 5.2, $p=0.078$).

Other outcomes for hybrid procedures were similar to non-hybrid bypass procedures (Table 5.4).

Table 5.4: Postoperative details of hybrid procedures undertaken between January 2017 and December 2019

		Elective		Emergency	
		No. of procs		No. of procs	
Total procedures		1,657		891	
Admitted to	Ward	1,244	75.1%	618	69.4%
	Level 2	368	22.2%	218	24.5%
	Level 3	45	2.7%	55	6.2%
	Day case unit	0	0.0%	0	0.0%
	Died in theatre	0	0.0%	0	0.0%
		Median	IQR	Median	IQR
Days in critical care:	Level 2	1	0 to 2	1	0 to 2
	Level 3	2	1 to 3	2	1 to 4
Admission to procedure (days)		0	0 to 1	4	2 to 8
Postoperative length of stay (days)		3	2 to 6	8	4 to 16
Overall length of stay (days)		4	2 to 7	14	8 to 24
		Rate	95% CI	Rate	95% CI
In-hospital postoperative mortality		1.1	0.6 to 1.7	5.9	4.5 to 7.7

6. Lower limb angioplasty/stent for peripheral arterial disease

6.1 Introduction

This chapter describes the processes and outcomes of care for patients who have a lower limb revascularisation performed as an endovascular procedure. The NVR has collected data on these procedures since 2014, to complement the information collected on lower limb bypass. Both are treatment options for patients suffering from peripheral arterial disease.

In this chapter, we report on 23,881 endovascular procedures performed between January 2017 and December 2019 that were the index procedure within an admission. In other words, the analysis focuses on the first procedure undergone by a patient during an admission; subsequent procedures are considered to be re-operations.

Over these three years, an additional 996 hybrid procedures (that combine bypass and endovascular components) were recorded in the NVR. This chapter focuses solely on lower limb endovascular procedures – information about hybrid procedures was included in the previous chapter).

Case-ascertainment has risen over time, from an estimated 38% in 2017 to 47% in 2019 (Table 6.1). Nonetheless, overall data submission remains comparatively low and there was considerable variation between NHS Trusts (Figure 6.1). Although some NHS Trusts achieved an estimated case-ascertainment of 90%, too many submitted less than half of all cases:

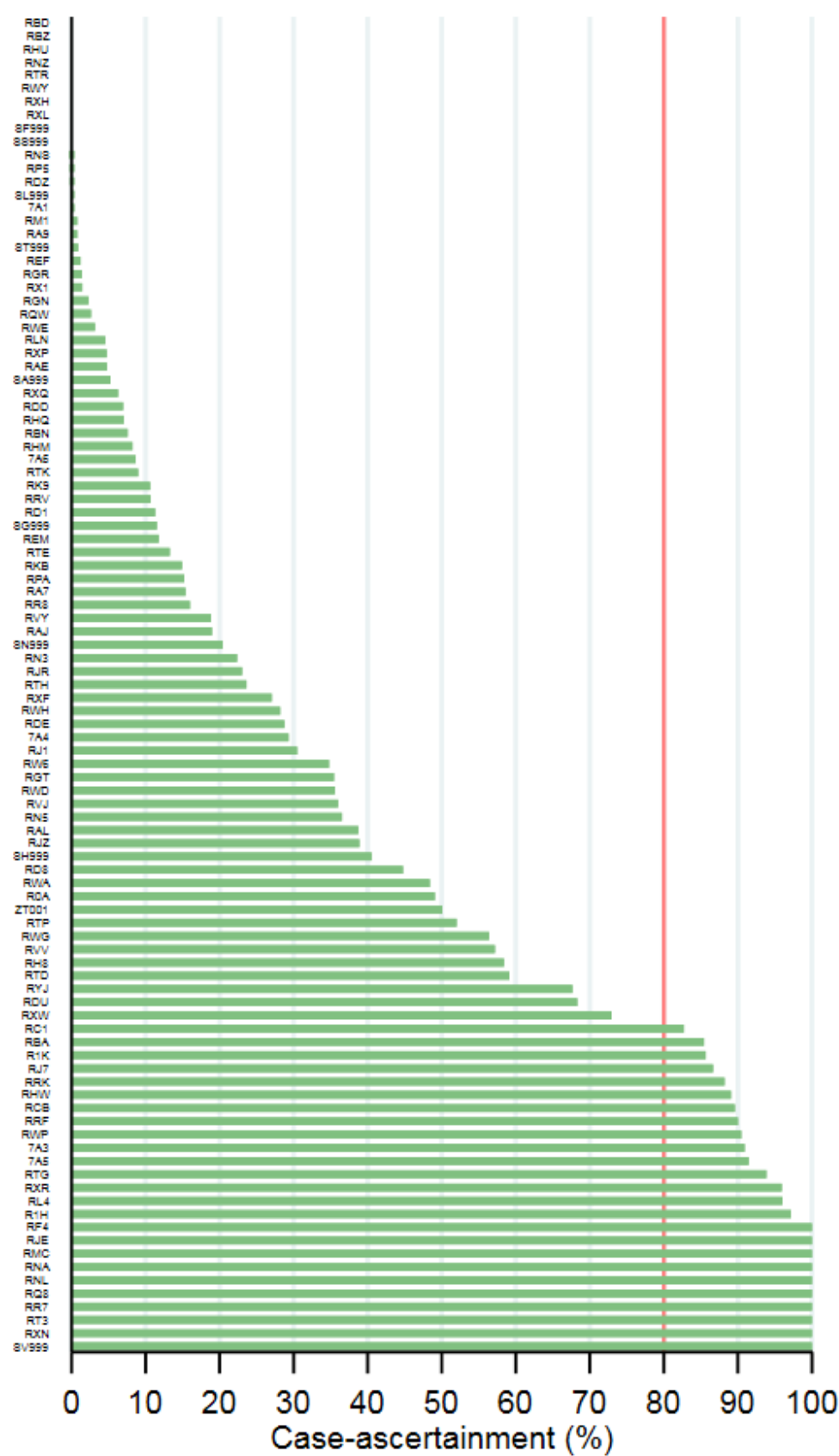
- 35 Trusts failed to submit 10% of the expected number of procedures
- 14 Trusts submitted less than 10 cases and were excluded from the Trust-level analysis
- 10 Trusts did not submit any cases.

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

	2017	2018	2019
NVR procedures	7,458	7,714	8,709
Expected procedures	19,658	19,230	18,481
Estimated case-ascertainment	38%	40%	47%

Figure 6.1: Case-ascertainment by NHS Trust



6.2 Procedure characteristics

Most patients (91%) underwent the procedure for chronic limb ischaemia, and of those 39% presented with intermittent claudication and 43% with gangrene. A third had undergone a previous procedure on the same limb (33%).

Two-thirds of patients undergoing endovascular procedures were men (67%), and about a quarter of patients were aged 80 years or older (23%). The prevalence of ischaemic heart disease, hypertension and diabetes was high and most patients were on antihypertensive and antiplatelet medication (see [Appendix 3](#) for details).

Characteristics of the lower-limb endovascular procedures are summarised in Table 6.2. The procedures involved interventions in 38,619 vessels. There were similar numbers of right (43%) and left-sided (46%) interventions, and 11% of the procedures were bilateral.

Half of the endovascular procedures involved treatment of a single vessel (55%), with 32% treating two, 10% treating 3 and 3% treating 4 or more vessels. The most common site was the superficial femoral artery, followed by the popliteal (18% of vessels, 28% of cases), common iliac (17% of vessels, 22% of cases) and tibial/pedal arteries (15% of vessels, 23% of cases). Plain balloon angioplasty alone was the most common type of intervention (29,035 vessels, 75%); a stent alone was used in 3,476 (9%) vessels and 6,108 (16%) 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 6.2: Characteristics of lower limb endovascular procedures by anatomical location

	Vessels treated	%	Angioplasty only	%	Stenosis/aneurysm¹	%	Procedure success²	%
Aorta	284	0.7	117	41.2	-	-	-	-
Common iliac	6,703	17.4	2,757	41.1	4,856	72.5	6,351	94.9
External iliac	4,977	12.9	2,955	59.4	3,793	77.2	4,690	95.4
Superficial femoral	11,869	30.7	9,723	81.9	6,674	56.8	10,828	92.1
CFA, PFA	1,309	3.4	1,143	87.3	952	72.9	1,132	86.7
Popliteal	6,791	17.6	5,870	86.4	4,178	61.8	6,152	91.1
Tibial/pedal	5,599	14.5	5,442	97.2	2,965	53.0	4,582	81.9
Within graft	1,087	2.8	1,028	94.6	973	89.5	990	91.1

¹The other indication for intervention was occlusion. 215 vessels and aorta missing lesion codes.

²The other outcomes were residual stenosis and failure. 229 vessels and aorta missing outcome codes.

VSGBI: PAD QIF

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

Among the index endovascular procedures, 17,276 (72.3%) were elective and 6,605 (27.7%) were non-elective procedures. Overall, 97.4% (n=23,080) of the endovascular revascularisations were recorded as being performed between 8am and 6pm, which were taken as indicating they had been on planned operating lists. The percentage of procedures performed between 8am and 6pm were more than 85% for all NHS Trusts that submitted more than 10 procedures in the NVR, suggesting that most Trusts met the QIF target during the 2017-19 audit period.

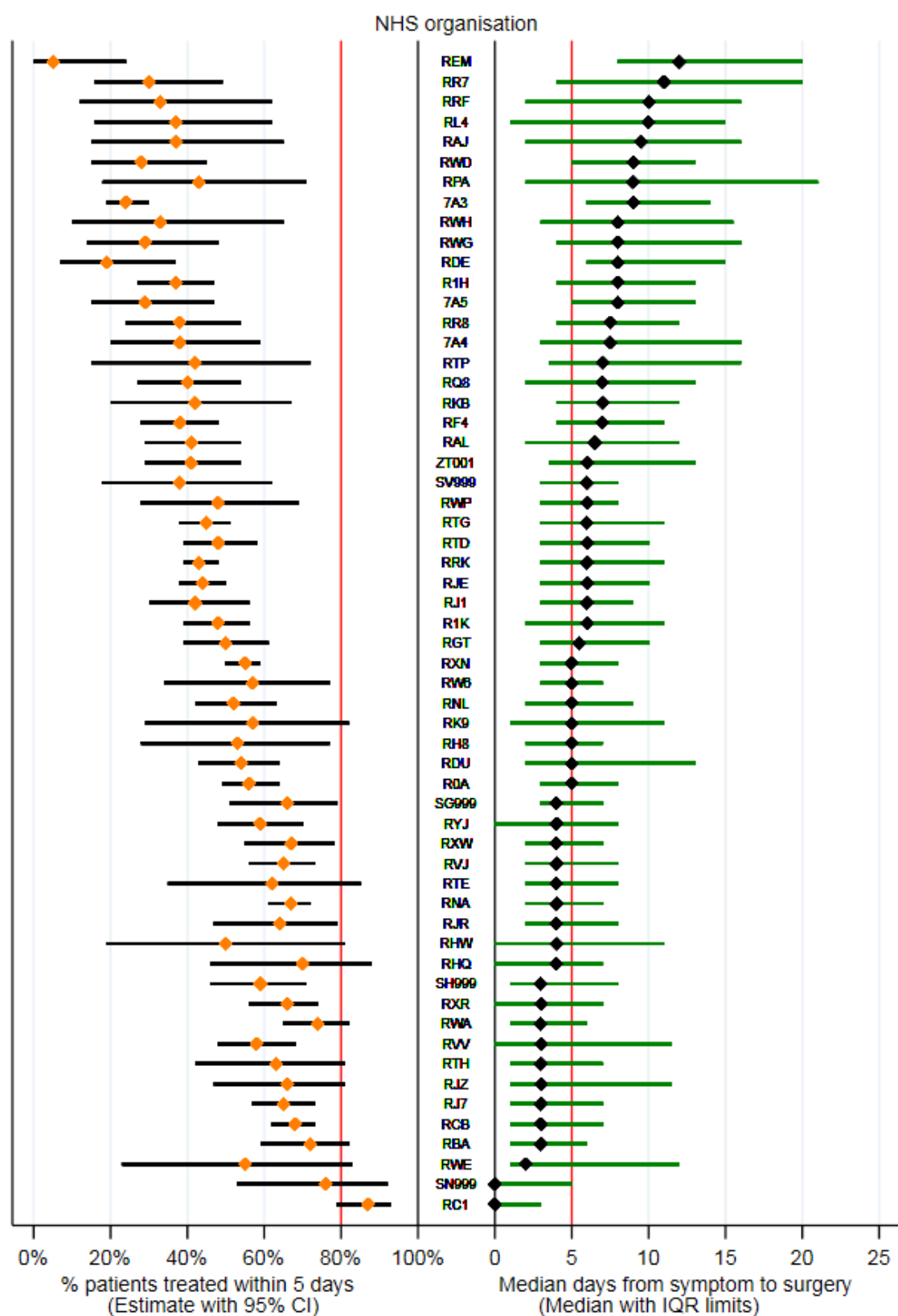
VSGBI: PAD QIF

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

There were 5,174 patients presenting with CLTI who underwent non-elective endovascular revascularisation during the 2017-19 audit period. Among these, 48% waited for longer than 5 days, and the median time from admission to intervention was 5 days (IQR: 2-10 days). Figure 6.2 depicts the percentage of non-elective procedures for CLTI performed within 5 days (left panel) and the median (IQR) time from admission to intervention (right panel) for the 58 active NHS Trusts with at least 10 non-elective CLTI cases.

The figure shows considerable variation between NHS trusts in times from admission to revascularisation for the 2017-19 audit period. Moreover, at 30 NHS Trusts, a quarter of patients waited more than 10 days for their procedure.

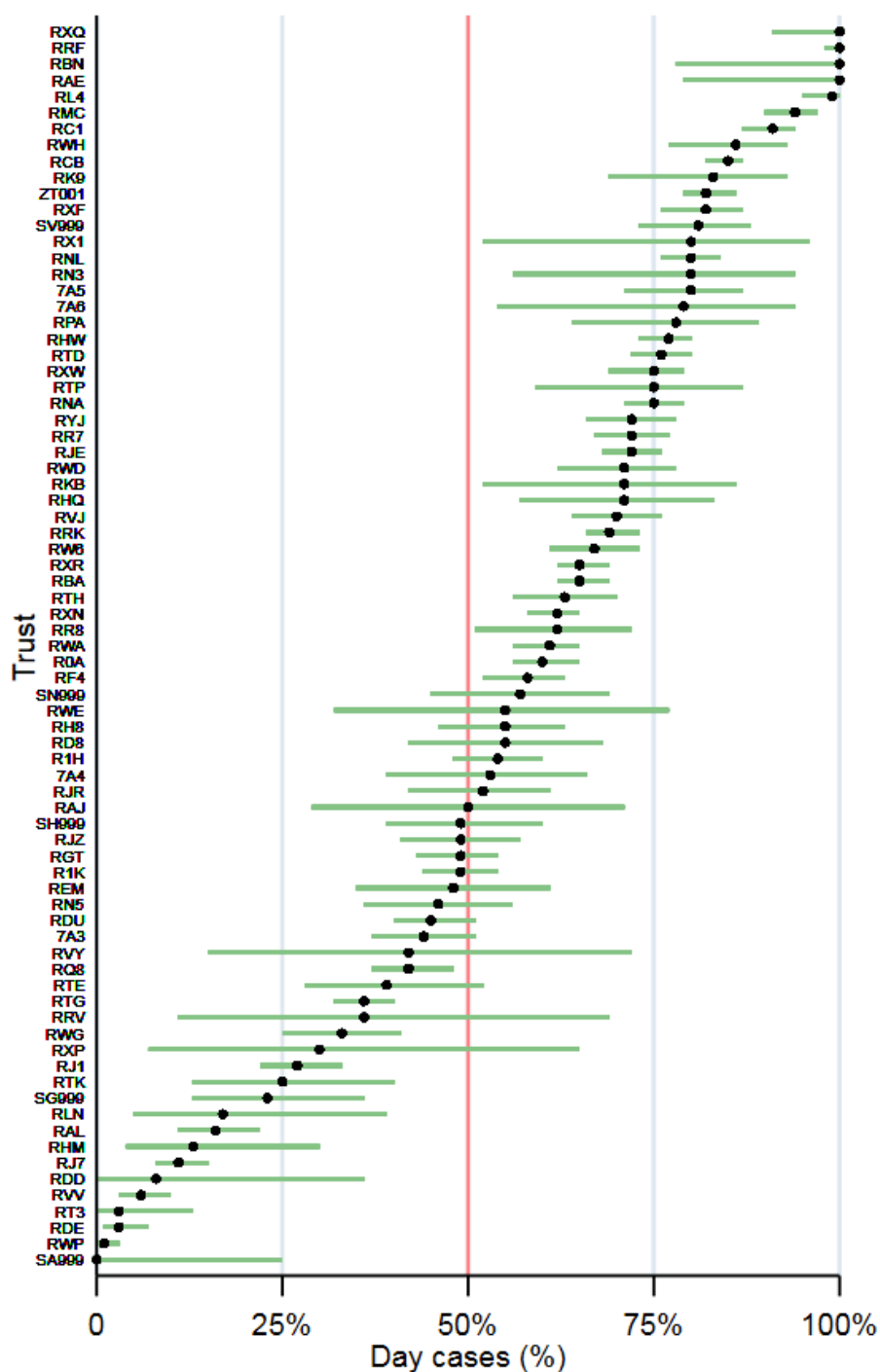
Figure 6.2 Proportion of non-elective CLTI patients who were revascularised within 5 days and time from admission to procedure by active NHS Trust with a volume of ≥ 10 non-elective CLTI cases



The 2018 GIRFT report on vascular services emphasised the potential gains in efficiency that could stem from a greater number of endovascular revascularisation procedures being performed on a same-day basis [Horrocks 2018].

The NVR data for the audit period 2017-19 reveal wide variation in the proportion of elective procedures done as day cases (Figure 6.3). While the low levels of case-ascertainment limit the interpretation of these figures, it suggests some NHS Trusts could make greater use of same-day facilities.

Figure 6.3: Proportion of elective endovascular procedures performed as day cases, by active NHS Trust with a volume of ≥ 10 elective cases



6.3 Outcomes of lower limb angioplasty/stents

The proportions of successful procedures, by individual NHS Trusts, are shown in Figure 6.4. Encouragingly, over 80% of the procedures

were reported as successful in most NHS Trusts.

Figure 6.4: Success rate of endovascular lower limb procedures (defined as successful by the operator), by active NHS Trust with a volume of more than 10 cases.

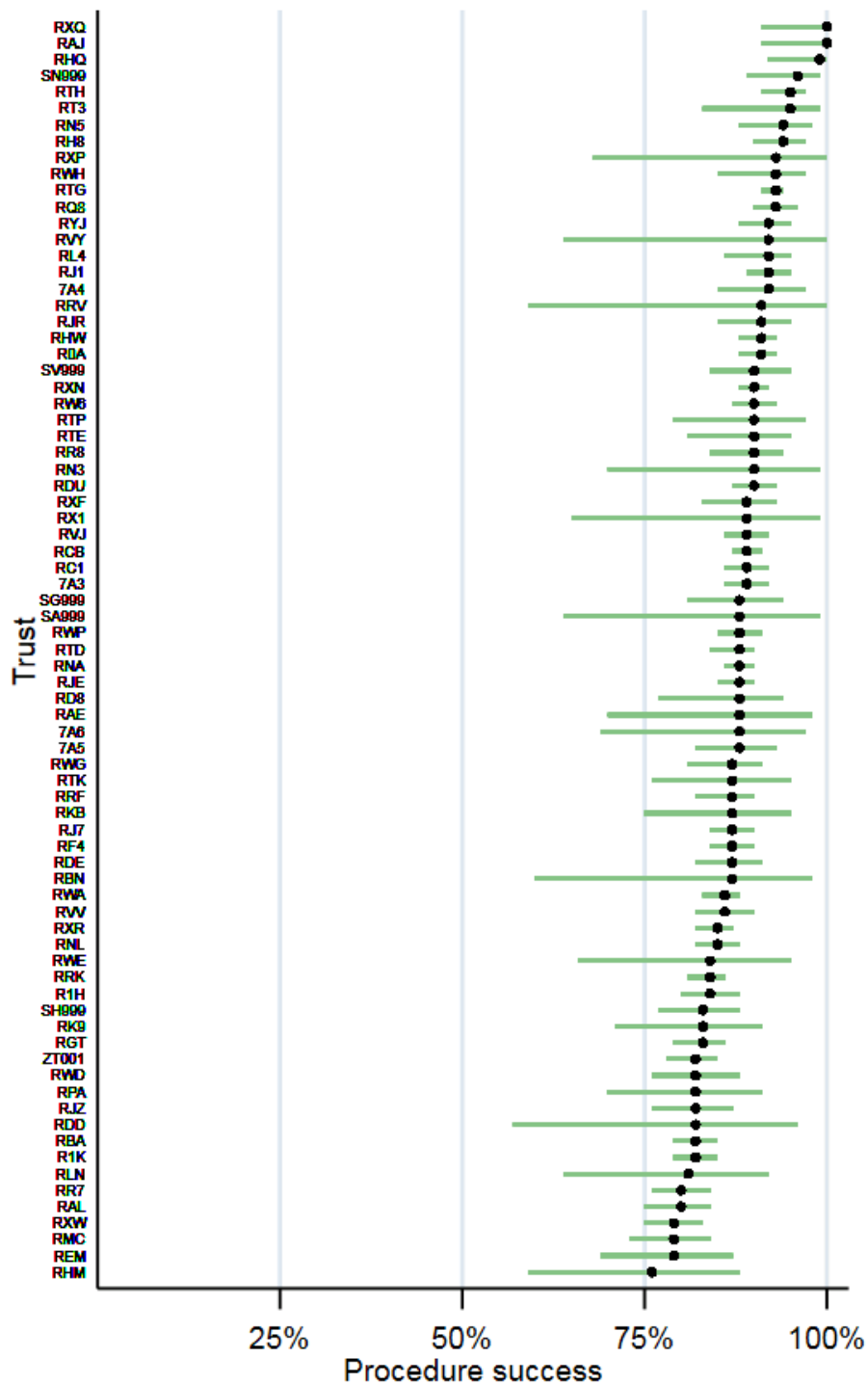


Table 6.3 describes specific outcomes for lower limb endovascular procedures, by mode of admission. As expected, patients undergoing endovascular revascularisation as non-elective admissions generally had worse outcomes than those undergoing elective

procedures. Patients undergoing endovascular procedures for acute limb ischaemia also had worse outcomes than CLTI, with in-hospital mortality rate of 1.2 (95%CI 0.6-2.2) for elective and 5.5 (95%CI 4.0-7.2) for non-elective admissions.

Table 6.3: Postoperative outcomes after endovascular lower limb revascularisation (2017-19), by mode of admission

	Elective		Non-elective	
Procedures	17,276	72.3%	6,605	27.7%
Post-op destination¹				
Ward	8,242	48.0%	6,043	92.8%
Level 2 (HDU/PACU)	335	2.0%	230	3.5%
Level 3 (ICU)	29	0.2%	71	1.1%
Died in theatre	<5	<0.1%	<5	<0.1%
Day-case unit	8,571	49.9%	166	2.5%
Defined complications²	Rate	95% CI	Rate	95% CI
None	95.3	95 to 95.6	87.9	87.0 to 88.6
Cardiac	0.3	0.3 to 0.4	1.7	1.4 to 2.0
Respiratory	0.3	0.2 to 0.3	2.3	2.0 to 2.7
Limb ischaemia	0.5	0.4 to 0.6	3.3	2.9 to 3.7
Renal failure	0.2	0.1 to 0.2	1.5	1.2 to 1.8
Haematoma	1.8	1.6 to 2.0	1.6	1.3 to 1.9
Distal embolus	0.7	0.5 to 0.8	1.0	0.7 to 1.2
Other	1.5	1.3 to 1.7	4.0	3.5 to 4.4
Further unplanned procedures				
None	96.4	96.1 to 96.7	82.3	81.4 to 83.2
Angioplasty/stent	1.0	0.9 to 1.2	3.7	3.2 to 4.1
Bypass	0.5	0.4 to 0.6	2.4	2.0 to 2.8
Minor amputation	0.6	0.5 to 0.8	6.2	5.7 to 6.9
Major amputation	0.4	0.3 to 0.5	4.9	4.4 to 5.4
Other	1.3	1.2 to 1.6	3.7	3.3 to 4.2
In-hospital mortality	0.4	0.3 to 0.5	4.6	4.1 to 5.2
Re-admission to higher level of care	0.8	0.7 to 0.9	2.7	2.3 to 3.1
Re-admission within 30 days	7.5	7.1 to 8.0	17.9	16.9 to 18.9
	Median	IQR	Median	IQR
Overall length of stay (days)	0	0 to 1	12	6 to 26
Preoperative length of stay (days)	0	0 to 1	5	2 to 9
Postoperative length of stay (days)	0	0 to 1	6	2 to 16

¹Post-op destination was missing for 99 elective and 94 non-elective procedures.

²Rates of haemorrhage, stroke, postoperative confusion, false aneurysm, vessel perforation and flow-limiting dissection were all below 1% for both elective and non-elective procedures.

Outcomes for patients with CLTI undergoing non-elective endovascular procedures are summarised in Table 6.4, by preoperative length of stay. In-hospital mortality and the risk of a complication were slightly higher for patients who waited for longer than 5 days for the procedure than for those who waited 5 days or less, and as with bypass procedure, the preoperative time in hospitals contributed most to the overall hospital stay.

Again, we caution against the over-interpretation of these figures. Further work is required to determine the degree to which the differences in the various outcome measures were due to the additional time from admission to surgery. Differences may also arise because patients who waited longer had more severe disease, for which outcomes would be expected to be worse on average.

Table 6.4: Postoperative outcomes following endovascular lower limb revascularisation, for patients with CLTI undergoing non-elective revascularisation¹, by preoperative length of hospital stay

	Patients with preoperative LOS ≤5 days		Patients with preoperative LOS >5 days	
	No.		No.	
Procedures	2,661	51.8%	2,475	48.2%
	Median	IQR	Median	IQR
Overall length of stay (LOS)	7	4 to 15	21	13 to 36
Postoperative LOS	5	1 to 13	8	3 to 21
Complications	Rate	95% CI	Rate	95% CI
None	90.0	88.8 to 91.1	85.4	83.9 to 86.7
Cardiac	1.3	0.9 to 1.8	2.4	1.8 to 3.1
Respiratory	1.4	0.9 to 1.9	3.7	3.0 to 4.5
Limb ischaemia	2.3	1.8 to 2.9	3.9	3.2 to 4.7
Renal	1.3	0.9 to 1.8	1.8	1.3 to 2.4
Haematoma	1.5	1.1 to 2.1	1.5	1.1 to 2.1
Distal embolus	1.1	0.8 to 1.6	0.9	0.6 to 1.4
Other	3.4	2.7 to 4.1	4.5	3.7 to 5.4
Further unplanned procedures				
None	83.8	82.3 to 85.1	81.3	79.7 to 82.8
Angioplasty/stent	3.2	2.6 to 4.0	3.2	2.5 to 3.9
Bypass	2.3	1.8 to 3.0	2.3	1.8 to 3.0
Minor amputation	6.5	5.6 to 7.5	7.8	6.8 to 9.0
Major amputation	4.4	3.7 to 5.3	5.3	4.5 to 6.3
Other	2.9	2.3 to 3.6	3.8	3.1 to 4.6
In-hospital mortality	3.5	2.9 to 4.3	5.6	4.7 to 6.6
Re-admission to higher level of care	1.9	1.4 to 2.5	3.3	2.6 to 4.1
Re-admission within 30 days	16.5	15.0 to 18.1	20.5	18.8 to 22.3

¹ Fontaine score 3 or 4

6.4 Risk-adjusted in-hospital deaths

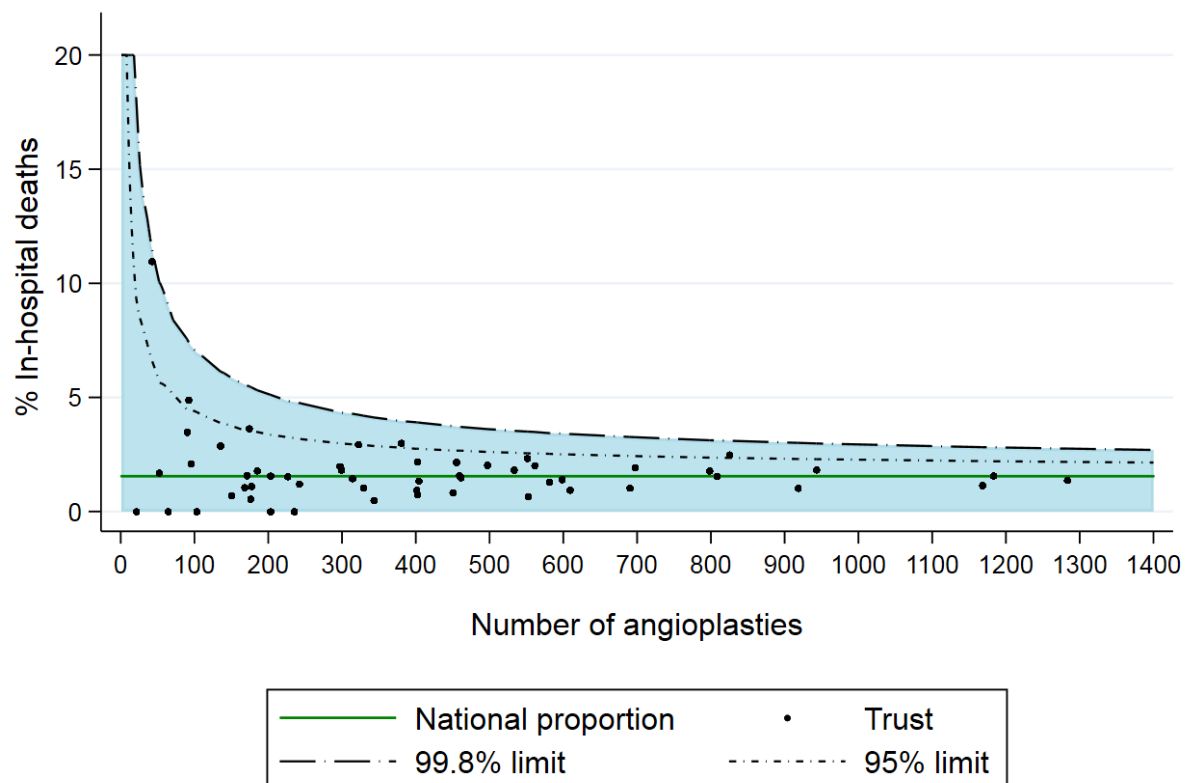
The risk-adjusted mortality rates for each NHS Trust that performed an adequate number of endovascular revascularisations between January 2017 and December 2019 are shown in Figure 6.5. This was defined as the NHS Trusts having more than 10 procedures and an estimated case-ascertainment at least 20%.

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 1.6% (95% CI: 1.4 to 1.7).

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, gender, chronic lung disease, chronic renal disease, chronic heart failure and smoking status.

Figure 6.5: Risk-adjusted in-hospital deaths following lower limb angioplasty, shown in comparison to the national average of 1.6%



Note: This figure is based on data from NHS Trusts that continue to offer endovascular revascularisation, with more than 10 procedures in the NVR and a case-ascertainment of at least 20%.

7. Major lower limb amputation

7.1 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 2017 to December 2019.

During this period, 10,022 major unilateral amputations were recorded in the NVR, which consisted of 5,204 (51.9%) below the knee amputations (BKAs) and 4,818 (48.1%) above the knee amputations (AKAs). Through knee amputations (TKAs) have been analysed as part of the BKA group. TKAs accounted for 3.4% of all major amputations recorded on the NVR during the three-year analysis period.

In addition, NHS hospitals submitted information on 3,335 (23.5%) minor

amputations, 256 (1.8%) bilateral amputations, 137 (1.0%) amputations due to trauma and 527 (3.7%) associated with a bypass. As the chapter focuses on major unilateral lower limb amputations, these records were not included in the analysis.

Table 7.1 gives the estimates of case-ascertainment for major unilateral lower limb amputations. The overall level of case-ascertainment is close to 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 7.1: Estimated case-ascertainment for major lower limb vascular amputations by year

Case-ascertainment	2017	2018	2019
Audit procedures	3,386	3,588	3,551
Expected procedures	4,359	4,362	4,381
Estimated case-ascertainment	78%	82%	81%

7.2 Care pathways

Tissue loss was the most common presenting problem for both below knee and above knee procedures (41% in BKA group and 37% AKA group). Furthermore, over half of patients had undergone a previous ipsilateral lower limb procedure (66% in BKA group and 58% AKA group), and 79% of patients were non-elective admissions.

Most patients undergoing a major lower limb amputation were men, with 75% in the BKA group and 68% in the AKA group. Over 90% of patients had one or more comorbid conditions, the most common being hypertension, diabetes and ischaemic heart disease. For more information, please refer to [Appendix 3](#).

VSGBI: Amputation QIF

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

NHS vascular units have to balance the urgency of surgery with the need to optimise the patients' condition before their operation. For patients being admitted non-electively for an amputation, the median time from vascular assessment to surgery was 7 days (IQR: 3 to 18 days). For patients undergoing amputations as elective procedures, the median time was 28 days (IQR: 8 to 74 days), probably reflecting the less severe nature of their condition. Overall the median delay was 9 days (IQR: 3 to 26 days).

Figure 7.1 describes the times from vascular assessment to amputation by NHS Trust for patients admitted non-electively, together with percentage of patients that had a wait exceeding 30 days. The graph shows some

variation across the NHS Trusts in the median wait, but among the 25% of patients who have the longest waits, there was considerably greater variation in the delay across NHS trusts. At 11 NHS Trusts, more than 25% of patients had a wait that exceeded 30 days, which is similar to the 2019 annual report. Several NHS Trusts had a wide range of time from vascular assessment to amputation.

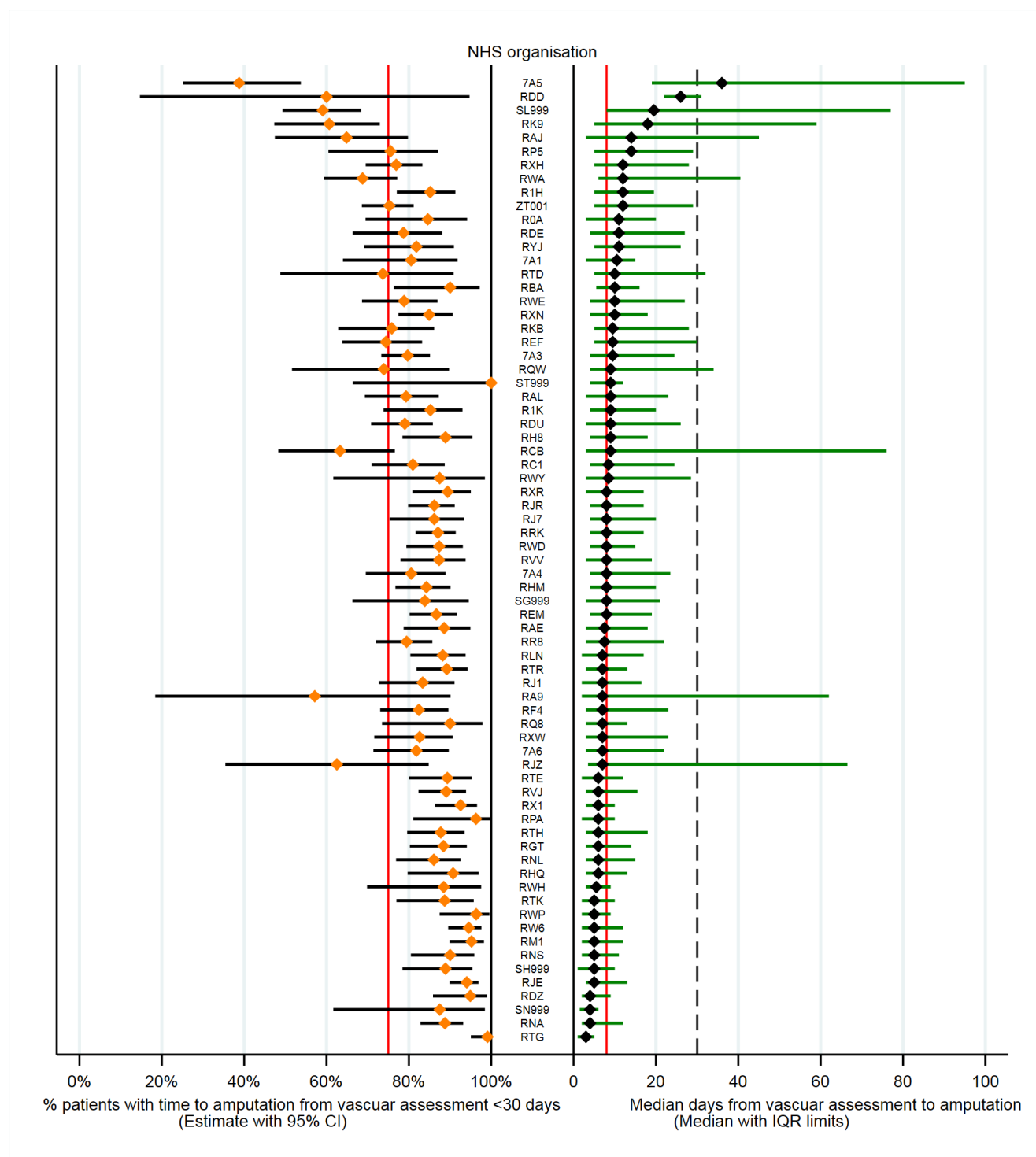
There are various reasons for patients to wait different times for an amputation. In some circumstances, it is necessary to wait for adjunctive procedures which prevent a high-level of amputation or which promote recovery. However, this is unlikely to explain the variation shown in Figure 7.1. Vascular 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.

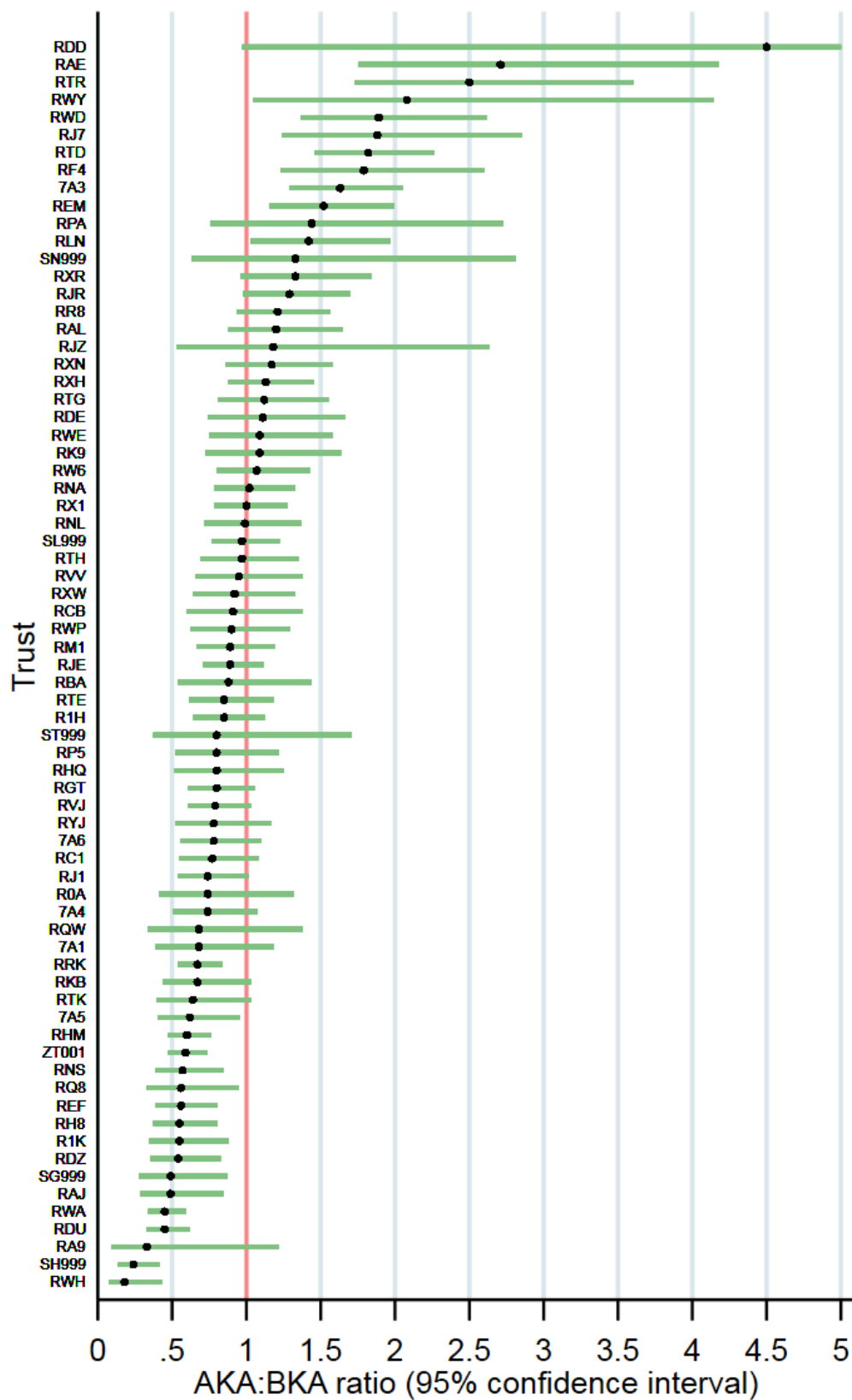
The AKA to BKA ratio by NHS Trust is shown in Figure 7.2. Nationally, over the three-year data collection period, the AKA:BKA ratio was 0.93 (95% CI: 0.89 to 0.96). Most of the NHS Trusts had a ratio of less than one, but 27 organisations had ratios that were above 1.0. 10 organisations had a ratio of more than 1.5 (i.e., with a 95% confidence interval that did not contain the recommended limit of 1). It is possible that the high ratios relate to some trusts treating more severely ill patients.

Figure 7.1: Median (IQR) time from vascular assessment to non-elective amputation for procedures performed between 2017 and 2019, by NHS Trust¹, together with percentage (95% CI) of patients with time to amputation from vascular assessment <30 days.



¹Figure presents NHS trusts reporting ≥10 major lower limb amputations over the audit period.

Figure 7.2: Ratio of above knee to below knee amputations for procedures performed between 2017 and 2019, by NHS Trust¹



¹Figure presents NHS trusts reporting ≥ 10 major lower limb amputations over the audit period.

**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.

- a consultant surgeon was present for just over three-quarters of the procedures
- prophylactic antibiotics and DVT medication were recorded for just over 60% of patients.

Whilst many NHS Trusts followed the recommendation that a consultant should be present in theatre during the audit period, there is some variation in practice across NHS organisations (Figure 7.3). Vascular units should investigate the reasons for this variation.

Table 7.2 summarises some key aspects of perioperative care for BKA and AKA patients. Performance against these standards was generally reasonable during the 2017-19 period but the figures suggest there is potential for improvement:

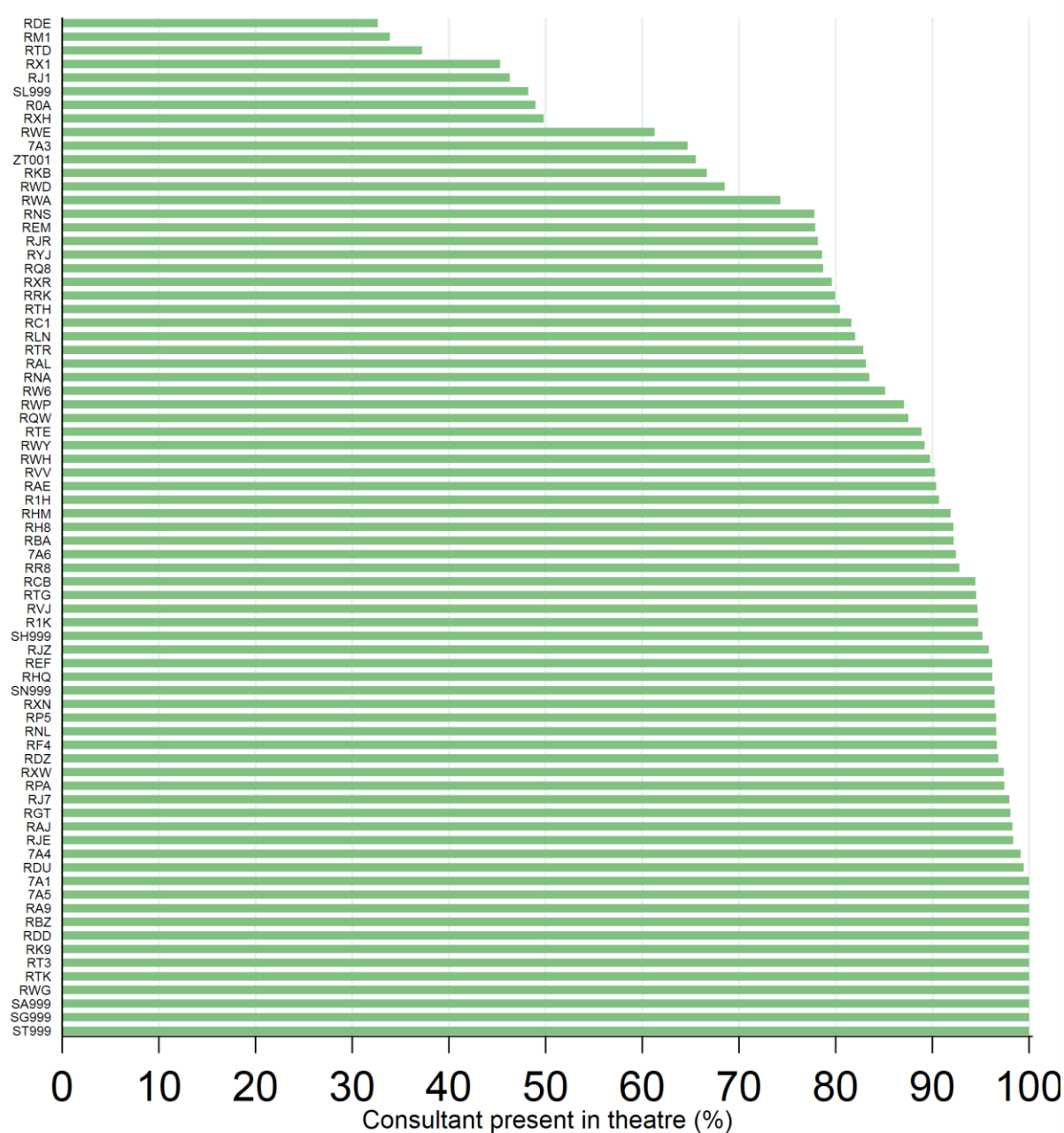
- over 80% of major amputations (BKAs and AKAs) were performed during the day

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

Table 7.2: Perioperative care of patients undergoing lower limb amputation during the 2017-19 period

	Below knee	%	Above knee	%
Procedures	5,204		4818	
Mode of admission				
Elective	1,274	24.5	830	17.2
Non-elective	3,930	75.5	3,988	82.8
Time procedure started				
8am to 6pm	4,573	87.9	4,084	84.8
6pm to midnight	555	10.7	619	12.9
Midnight to 8am	74	1.4	113	2.3
Consultant present in theatre	4,236	81.5	3,739	77.8
Prophylactic medication				
Antibiotic prophylaxis	3,620	69.6	3,296	68.4
DVT prophylaxis	3,436	66.0	3,072	63.8

Figure 7.3: Percentage of amputations where a consultant surgeon was present in theatre during the 2017-19 period, by NHS Trust



7.3 In-hospital outcomes following major amputation

Patient outcomes immediately following major lower limb amputation are summarised in Table 7.3.

The overall median length of hospital stay associated with major lower limb amputations was 23 days (IQR: 13 to 39 days). Most

patients were returned to the ward following amputation, although approximately 13% of BKA patients and 23% of AKA patients were admitted to critical care (level 2 or level 3).

Most patients were discharged alive, but around 5% of BKA patients and 10% of AKA

patients died in hospital. Over 20% of patients suffered more than one reported complication following major amputation:

- respiratory problems occurred in 6.4% of BKAs and 10.3% of AKAs
- cardiac complications were also common, occurring in 4.1% of BKA patients and 6.2% of AKA patients
- in 2019, 4.6% had surgical site infection for BKAs and 4.1% for AKAs, compared

with 2.1% of BKAs and 2.4% of AKAs in 2018

- 2.1% of BKAs and 3.5% of AKAs resulted in postoperative confusion in 2019, compared with 0.8% of BKAs and 1.3% AKAs in 2018.

Rates of return to theatre within the admission were 10.9% for BKA and 7.8% for AKA patients.

Table 7.3: Patient outcomes following major lower limb amputation, by amputation level

	Below knee		Above knee	
Procedures	5,204		4,818	
Post-op destination				
Ward	4,537	87.2%	3,697	76.7%
Level 2 (HDU/PACU)	513	9.9%	742	15.4%
Level 3 (ICU)	152	2.9%	376	7.8%
Died in theatre	0	0.0%	<5	<0.1%
	Median	IQR	Median	IQR
Days in level 2 critical care	2	1 to 4	2	1 to 4
Days in level 3 critical care	3	1 to 7	3	2 to 8
Overall length of stay (days)	23	14 to 38	22	13 to 39
Postoperative length of stay (days)	15	9 to 26	15	8 to 27
	Rate	95% CI	Rate	95% CI
Overall in-hospital mortality	4.9	4.3 to 5.6	10.4	9.5 to 11.3
30-day in-hospital mortality	2.4	2.0 to 2.9	7.2	6.4 to 8.0
Procedure complications				
Respiratory	6.4	5.8 to 7.1	10.3	9.4 to 11.2
Cardiac	4.1	3.6 to 4.7	6.2	5.6 to 7.0
Limb ischaemia	3.4	2.9 to 4.0	3.3	2.8 to 3.9
Renal failure	2.8	2.4 to 3.3	3.8	3.2 to 4.4
Surgical site infection	2.4	2.0 to 2.8	2.3	1.9 to 2.8
Postoperative confusion	1.0	0.7 to 1.3	1.7	1.4 to 2.1
Haemorrhage	0.6	0.4 to 0.9	0.6	0.4 to 0.9
Cerebral	0.6	0.4 to 0.8	0.7	0.5 to 1.0
No defined complications	80.0	78.7 to 80.9	75.6	74.3 to 76.8
Return to theatre	10.9	10.1 to 11.8	7.8	7.0 to 8.5
Re-admission to higher level care	2.5	2.1 to 2.9	2.4	2.0 to 2.9

Outcomes for patients undergoing major amputations are summarised in Table 7.4, by preoperative length of stay. Just over half of the patients (56%) underwent amputation within 5 days of being admitted. In comparison with the results for lower limb

bypass and endovascular revascularisation, the differences in outcomes were small between patients with comparatively short and long times from admission to surgery.

Table 7.4: Patient outcomes following major lower limb amputation, by time to surgery

	Patients with pre-operative LOS ≤5 days		Patients with pre-operative LOS >5 days	
	No.		No.	
Procedures	5,574		4,448	
	Median	IQR	Median	IQR
Days in critical care				
Level 2	2	1 to 4	2	1 to 5
Level 3	3	2 to 6	3	2 to 9
Overall length of stay (days)	15	10 to 26	33	22 to 52
Postoperative length of stay (days)	13	8 to 24	17	10 to 29
	Rate	95% CI	Rate	95% CI
Overall in-hospital mortality	7.0	6.3 to 7.7	8.2	7.4 to 9.1
30-day in-hospital mortality	5.6	5.0 to 6.3	3.4	2.9 to 4.0
No defined complications	79.1	78.0 to 80.2	76.1	74.8 to 77.4
Return to theatre	8.4	7.7 to 9.2	10.6	9.7 to 11.6
Re-admission to higher level care	2.4	2.0 to 2.8	2.5	2.1 to 3.0

Adjusted 30-day in-hospital mortality figures following major unilateral lower limb amputation for NHS Trusts are shown in Figure 7.4.

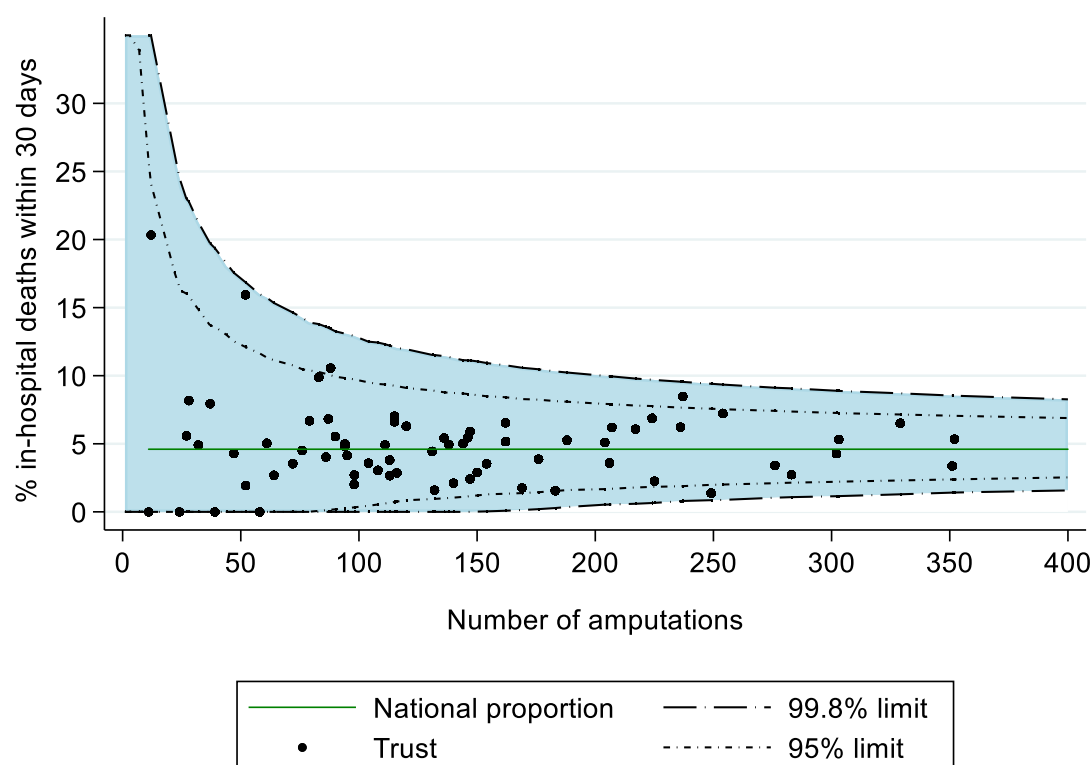
All NHS Trusts had an adjusted rate that fell within the 99.8% control limits, however three Trusts had an adjusted rate that fell outside the 95% upper control limit.

For elective cases, the rates were adjusted for age, sex, ASA grade (1-3 vs 4-5), level of amputation (below or above the knee) and

the presence of comorbid chronic renal disease and active/managed cancer. In addition for non-elective cases, the rates were also adjusted for the presence of comorbid chronic lung disease.

The overall rate of in-hospital death in AKA and BKA patients analysed together was 7.7% (95% CI: 7.2% to 8.2%) and the 30-day in-hospital mortality was 4.6% (95% CI: 4.2% to 5.0%; Figure 7.4).

Figure 7.4: Risk-adjusted 30-day in-hospital death rate following major amputation for the audit period 2017-19¹, shown in comparison to the overall national average of 4.6%



¹Figure presents NHS trusts reporting ≥ 10 major lower limb amputations over the audit period.

7.4 Discharge and follow-up

Discharge and follow-up of patients undergoing lower limb amputations, among patients discharged alive, are summarised in Table 7.5. Most patients' wounds had healed by 30 days. Around 84% of patients undergoing BKAs were referred to

rehabilitation units or limb fitting centres, compared with 71% of patients undergoing AKAs. Approximately 1 in 10 patients were readmitted to hospital within 30 days of the amputations and after discharge from hospital.

Table 7.5: Discharge and follow-up of patients undergoing lower limb amputations, among patients discharged alive

	Below knee	%	Above knee	%
Alive at discharge	4,947	95.1	4,310	89.5
Wound healed at 30 days ¹	1,734	78.8	1,495	87.1
Referred to rehabilitation/limb fitting ²	4,037	84.4	2,968	71.4
Re-admission within 30 days ¹	347	10.6	237	8.9

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

8. Carotid Endarterectomy

8.1 Background

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

The information in this report focuses on carotid procedures performed within NHS hospitals between 1 January 2019 and 31 December 2019. The NVR continues to achieve high levels of case-ascertainment (Table 8.1), with estimated case-ascertainment figures for the four nations in

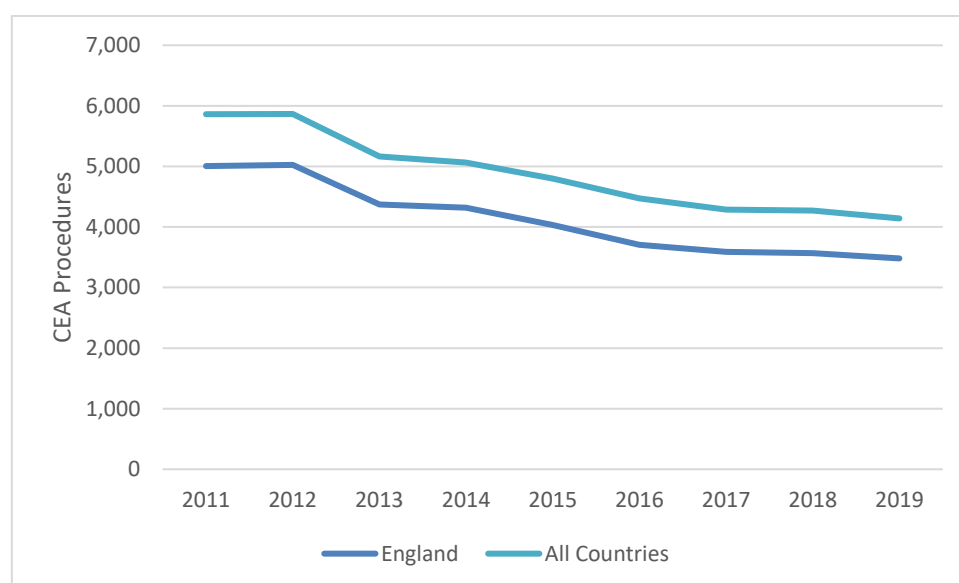
2019 being: 97% for England, 100% for Northern Ireland, 81% for Scotland and 100% for Wales.

The number of procedures reported to the NVR in 2020 was similar to the previous year (Figure 8.1) and follows a period of reducing activity, principally due to a decrease in the number of procedures undertaken in England. The patterns of change were explored in a separate study [Johal et al 2019] and we note that the decline occurred in both symptomatic and asymptomatic patients but these changes were not uniform across the regions within England. The causes contributing to these changes are currently unclear but it might reflect a change in the epidemiology of risk factors for stroke and better medical management of patients at risk.

Table 8.1: Estimated case-ascertainment of carotid endarterectomy in the UK

	2017	2018	2019	Total
Audit procedures	4,286	4,271	4,141	12,698
Expected procedures	4,456	4,359	4,279	12,822
Estimated case-ascertainment	96%	98%	97%	97%

Figure 8.1: Number of carotid endarterectomies performed within the NHS between 2011 and 2019



8.2 Treatment pathways

Patients may be referred for carotid endarterectomy from various medical practitioners. In 2019, the most common source of referral was the stroke physician (83.8%), followed by vascular surgeons (3.5%), neurologists (3.3%), and general practitioners (3.1%).

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

- Only 0.8% of patients had a previous ipsilateral treatment
- Medication for cardiovascular conditions was common among patients prior to surgery. Overall, 90.8% were on antiplatelet medication, while 83.3% were taking statins.
- There were 3,859 patients (93.2%) with symptomatic disease. TIA was the most common symptom (44.5%) followed by stroke (38.5%)
- Nearly three-quarters of patients had at least 70% stenosis in their ipsilateral carotid artery at the time of operation

VSGBI Provision of services

Vascular units are recommended to perform a minimum volume of 40 CEA per annum.

In 2019, there were 22 out of the 75 active vascular units that did not perform at least 40 CEA. This might be a consequence of the falling levels of activity. Assuming the trend is not going to reverse, further reconfiguration of vascular services may be required within regions. Alternatively, the minimum volume target may need to be revisited.

NICE guideline (NG128)

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

In the years from 2009 to 2012, the proportion of patients who were treated within the 14 days target rose from 37% to 56%. This figure has been relatively stable since then, with 60% of patients being treated within 14 days.

The median time from symptom onset to surgery for symptomatic patients in 2019 was 12 days (IQR 8-22). 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 0-4) from first medical referral to being seen by the vascular team, and
- 5 days (IQR 2-10) from being seen by the vascular team to undergoing CEA.

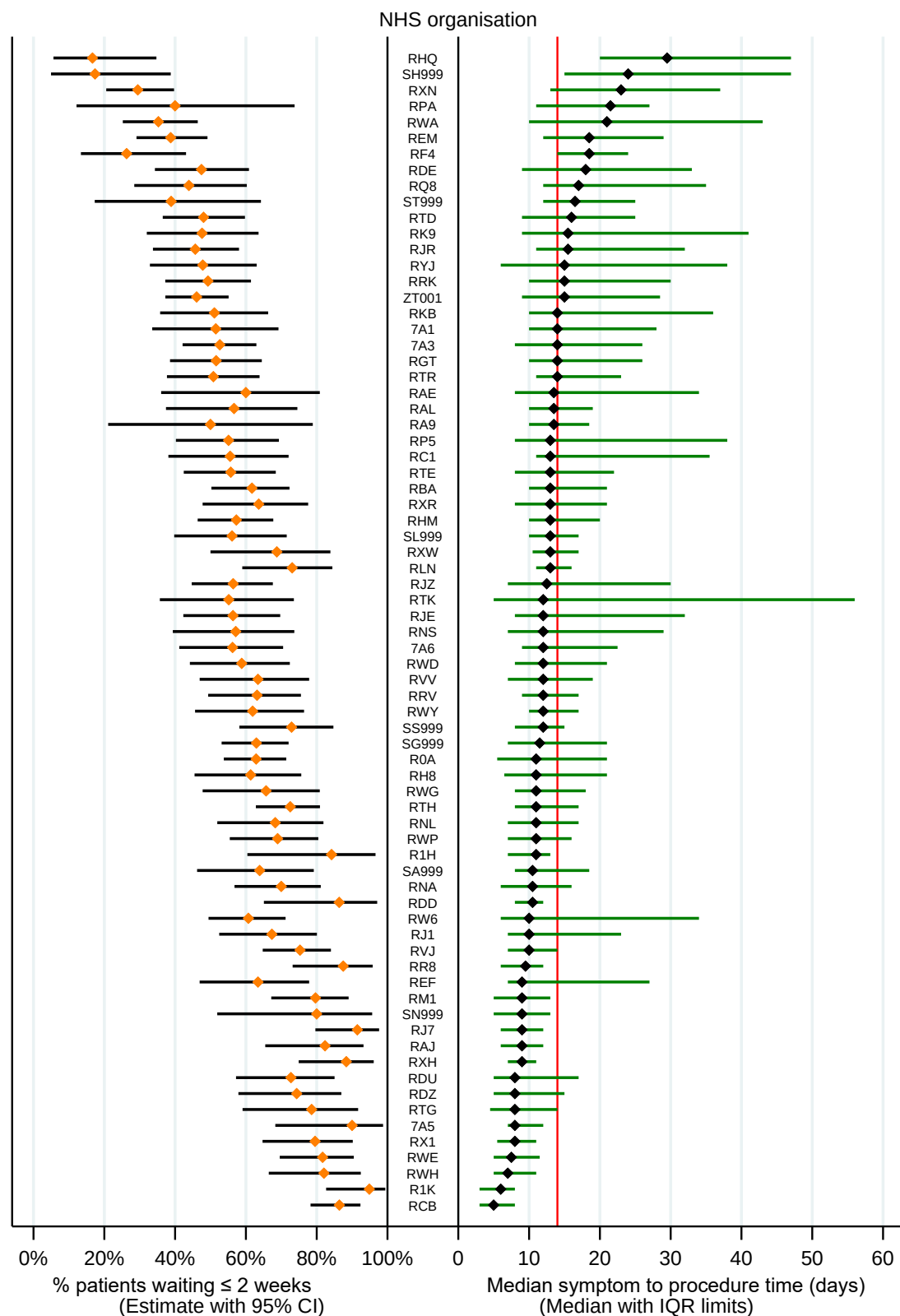
The distribution of symptom to operation times (right panel) and the proportion operated on within 14 days (left panel) for all NHS Trusts is summarised in Figure 8.2. The grey horizontal bars represent their 95% confidence intervals. The graph contains figures for all organisations that performed 10 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 2019 (right panel, Figure 8.2):

- 57 of the 73 NHS organisations had a median time of 14 days or less
- the median exceeded 20 days for just 5 vascular units, a considerable improvement from the 16 found in 2016
- 17 trusts had less than half of their patients operated on within 14 days.

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

Figure 8.2: Median time (and interquartile range) from symptom to procedure by NHS Trust for procedures performed between January and December 2019 (black diamonds) and proportion waiting less than 2 weeks following symptoms (orange diamonds)



8.3 Outcomes after carotid endarterectomy

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

The complication rates for the nearly 12,700 procedures performed in NHS hospitals between 2017 and 2019 are summarised in Table 8.2. The rates of the different

complications tended to be around 2% and have remained fairly consistent over the last few NVR annual reports.

Over this 3-year period:

- the median length of stay was 2 days (IQR: 2 to 5 days)
- rate of return to theatre was 2.8% (95% CI 2.5 to 3.1), and
- the rate of readmission within 30 days was 4.4% (95% CI 4.0 to 4.8).

Table 8.2: Postoperative outcomes following carotid endarterectomy

Complication	Procedures in 2017-2019	Complication rate (%)	95% confidence interval
Death and/or stroke within 30 days	12,698	1.9	1.7-2.2
Stroke within 30 days	12,698	1.7	1.5-1.9
Bleeding within admission	12,697	2.2	2.0-2.5
Myocardial Infarct within admission	12,697	1.1	1.0-1.3
Cranial nerve injury within admission	12,698	2.1	1.8-2.4

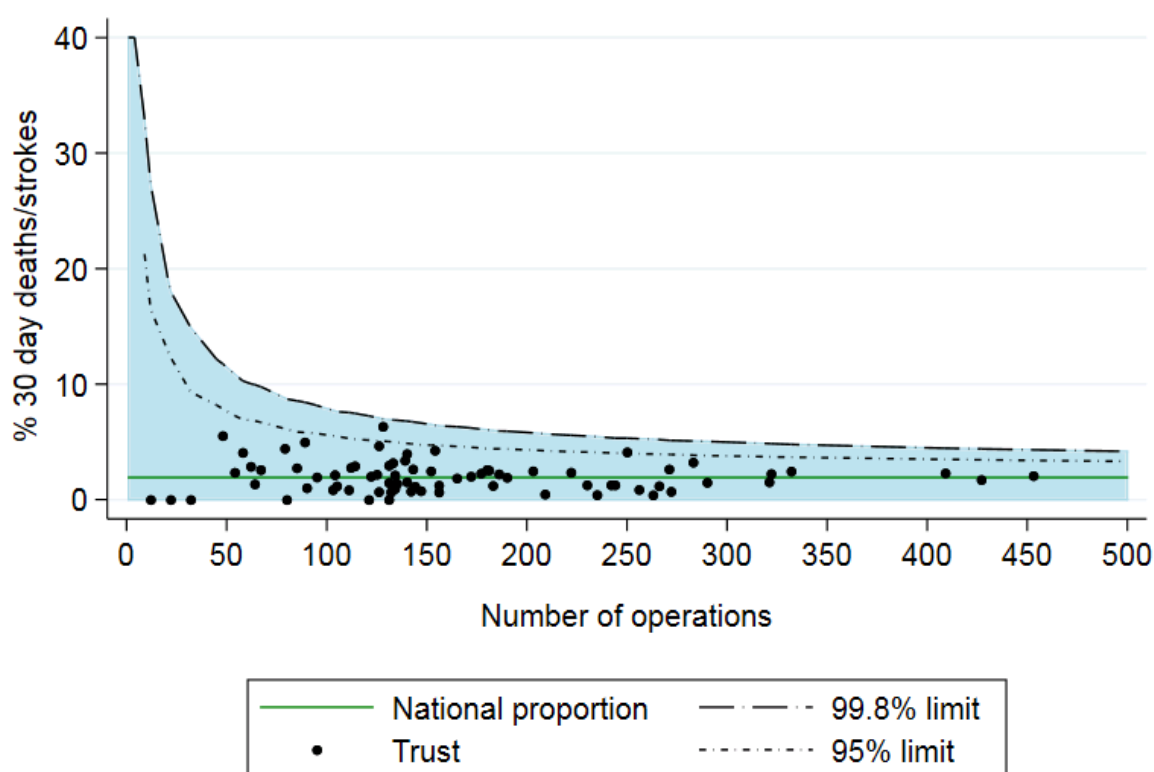
8.4 Rates of stroke/death within 30 days among NHS Trusts

The primary measure of safety after carotid endarterectomy is the rate of death or stroke within 30 days of the procedure. The risk-adjusted values for each NHS Trust for this outcome indicator are shown in the funnel plot in Figure 8.3.

The online appendices spreadsheet gives the figures for each organisation. The 30-day death/stroke rates were risk adjusted to account for differences in the characteristics of patients treated at the various organisations.

All NHS organisations were within the expected distance of the overall national average rate of 1.9% (i.e., they were within the 99.8% control limits).

Figure 8.3: Funnel plot of risk-adjusted rates of stroke/death within 30 days for NHS Trusts, for carotid endarterectomies between January 2017 and December 2019



The overall national average rate of stroke/death within 30 days = 1.9%

Appendix 1: NVR Governance structure

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

Members of Audit and Quality Improvement Committee of the Vascular Society

Mr J Boyle	Chair	VSGBI
Mr A Pherwani	Chair-Elect	VSGBI
Mr D Adam		VSGBI
Mr M Brooks		VSGBI
Ms L Wales		VSGBI
Mrs S Ward		Society for Vascular Nursing
Mr A Nasim		National AAA Screening Programme
Dr R O'Neill		British Society of Interventional Radiology
Dr A Papadopolou		British Society of Interventional Radiology
Dr R Mouton		Vascular Anaesthesia Society of GB & I
Mr A McLaren		Medicines and Healthcare products Regulatory Agency
Mr D Dunphy		Association of British HealthTech Industries

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

Members of Project Board

Prof I Loftus, Chair	VSGBI
Miss S Renton	VSGBI
Ms S Hewitt	HQIP
Ms S Harper	HQIP
Mr P Palmer	Northgate Public Services (UK) Limited
Mr R Armstrong	Northgate Public Services (UK) Limited

plus members of the project / delivery team: Mr Jon Boyle, Mr Arun Pherwani (Surgical Leads), Dr Richard O'Neill (IR Lead), Ms Panagiota Birmbili, Prof David Cromwell, Dr Amundeeep Johal, Dr Qiuju Li, and Mr Sam Waton

Appendix 2: NHS organisations that perform vascular surgery

Code	Organisation Name	CEA	AAA	Bypass	Angio	Amp
7A1	Betsi Cadwaladr University Health Board	Yes	Yes	Yes	Yes	Yes
7A3	Swansea Bay University Health Board	Yes	Yes	Yes	Yes	Yes
7A4	Cardiff and Vale University Health Board	Yes	Yes	Yes	Yes	Yes
7A5	Cwm Taf University Health Board	Yes	Yes	Yes	Yes	Yes
7A6	Aneurin Bevan University Health Board	Yes	Yes	Yes	Yes	Yes
ROA	Manchester University NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
R1H	Barts Health NHS Trust	Yes	Yes	Yes	Yes	Yes
R1K	London North West Healthcare NHS Trust	Yes	Yes	Yes	Yes	Yes
RA9	Torbay and South Devon NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RAE	Bradford Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RAJ	Southend University Hospital 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	No	Yes	No
RBN	St Helens & Knowsley Teaching Hospitals NHS Trust	No	No	No	Yes	No
RBZ	Northern Devon Healthcare NHS Trust	No	No	No	Yes	Yes
RC1	Bedford Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RCB	York Teaching Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RDD	Basildon and Thurrock University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
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
RDZ	Royal Bournemouth and Christchurch Hospitals 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	No	Yes	No
RGR	West Suffolk NHS Foundation Trust	No	No	No	Yes	No
RGT	Cambridge University Hospitals 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	CEA	AAA	Bypass	Angio	Amp
RHQ	Sheffield Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RHU	Portsmouth Hospitals NHS Trust	No	No	No	Yes	No
RHW	Royal Berkshire NHS Foundation Trust	No	No	No	Yes	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	No	Yes	No
RLN	City Hospitals Sunderland NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RM1	Norfolk and Norwich University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RMC	Bolton NHS Foundation Trust	No	No	No	Yes	No
RNA	The Dudley Group NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RNL	North Cumbria University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RNS	Northampton General Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RNZ	Salisbury NHS Foundation Trust	No	No	No	Yes	No
RP5	Doncaster and Bassetlaw Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RPA	Medway NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RQ8	Mid Essex Hospital Services NHS Trust	Yes	Yes	Yes	Yes	Yes
RQW	Princess Alexandra Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RR7	Gateshead Health NHS Foundation Trust	No	No	No	Yes	No
RR8	Leeds Teaching Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RRK	University Hospitals Birmingham NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RRV	University College London Hospitals NHS Foundation Trust	Yes	No	Yes	Yes	No
RT3	Royal Brompton & Harefield NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
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 Trust	Yes	Yes	Yes	Yes	Yes
RTK	Ashford And St Peter's Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
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	CEA	AAA	Bypass	Angio	Amp
RVV	East Kent Hospitals University NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RW6	Pennine Acute Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWA	Hull and East Yorkshire 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	Yes	Yes	Yes	Yes	Yes
RX1	Nottingham University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RXF	Mid Yorkshire Hospitals NHS Trust	No	No	No	Yes	No
RXH	Brighton and Sussex University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RXL	Blackpool Teaching Hospitals NHS Foundation Trust	No	No	No	Yes	No
RXN	Lancashire Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RXP	County Durham and Darlington NHS Foundation Trust	No	No	No	Yes	No
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
SA999	NHS Ayrshire & Arran	Yes	Yes	Yes	Yes	Yes
SF999	NHS Fife	No	No	No	Yes	No
SG999	NHS Greater Glasgow and Clyde	Yes	Yes	Yes	Yes	Yes
SH999	NHS Highland	Yes	Yes	Yes	Yes	Yes
SL999	NHS Lanarkshire	Yes	Yes	Yes	Yes	Yes
SN999	NHS Grampian	Yes	Yes	Yes	Yes	Yes
SS999	NHS Lothian	Yes	Yes	Yes	Yes	Yes
ST999	NHS Tayside	Yes	Yes	Yes	Yes	Yes
SV999	NHS Forth Valley	No	No	No	Yes	No
ZT001	Belfast Health and Social Care Trust	Yes	Yes	Yes	Yes	Yes

Key

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

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



For interactive version, please visit:

<https://batchgeo.com/map/84810d35d57465b318df86c46b21b428>

Appendix 3: Summary of procedures and patient characteristics

Elective repair of infra-renal AAAs

The characteristics of patients who underwent an elective repair of an infra-renal AAA during 2019 are summarised in Table A3.1.

Table A3.1: Characteristics of patients who had elective infra-renal AAA repair between January and December 2019

		Open repair	%	EVAR	%	Total
Total procedures		1,355		2,090		3,445
Age group (years)	Under 66	292	21.6	166	8.0	458
	66 to 75	720	53.2	760	36.5	1,480
	76 to 85	333	24.6	987	47.4	1,320
	86 and over	8	0.6	168	8.1	176
Male		1,218	89.9	1,887	90.3	3,105
Female		137	10.1	203	9.7	340
Current smoker		362	26.7	360	17.2	722
Previous AAA surgery		134	9.9	272	13.0	406
Indication	Screen detected	597	44.1	682	32.7	1,279
	Non-screen	615	45.5	1,096	52.5	1,711
	Other	141	10.4	309	14.8	450
AAA diameter (cm)	Under 4.5	51	3.8	112	5.4	163
	4.5 to 5.4	68	5.0	119	5.7	187
	5.5 to 6.4	956	70.6	1,392	66.7	2,348
	6.5 to 7.4	162	12.0	304	14.6	466
	7.5 and over	117	8.6	159	7.6	276
ASA fitness grade	1,2	424	31.3	418	20.0	842
	3	886	65.5	1,562	74.7	2,448
	4,5	43	3.2	110	5.3	153
Comorbidities	Hypertension	903	66.6	1,470	70.3	2,373
	Ischemic heart disease	365	26.9	831	39.8	1,196
	Chronic heart failure	26	1.9	119	5.7	145
	Stroke	78	5.8	157	7.5	235
	Diabetes	158	11.7	360	17.2	518
	Chronic renal failure	148	10.9	309	14.8	457
	Chronic lung disease	283	20.9	603	28.9	886

Repair of ruptured abdominal aortic aneurysms

Compared to patients who had an elective repair of an infra-renal AAA, the patients who had surgery for a ruptured AAA were older on average, with most aged over 76 years at the time of surgery and tended to have a larger

diameter of the aneurysm (Table A3.2). In comparison to patients undergoing an open repair, patients having EVAR had a smaller AAA diameter, on average, and a greater proportion had also undergone AAA surgery previously.

Table A3.2: Characteristics of patients who had a repair of a ruptured AAA between January 2017 and December 2019

		Open repair	%	EVAR	%	Total
Total procedures		1,526		703		2,229
Age group (years)	Under 66	217	14.3	63	9.0	280
	66 to 75	522	34.3	202	28.8	724
	76 to 85	684	45.0	334	47.6	1,018
	86 and over	97	6.4	103	14.7	200
Male		1,255	82.2	571	81.2	1,826
Female		271	17.8	132	18.8	403
Previous AAA surgery		145	9.5	165	23.5	310
AAA diameter (cm)	<4.5	21	1.4	47	6.8	68
	4.5 to 5.4	63	4.2	47	6.8	110
	5.5 to 6.4	243	16.0	141	20.4	384
	6.5 to 7.4	309	20.4	156	22.6	465
	7.5 and over	879	58.0	300	43.4	1,179
ASA fitness grade	1 or 2	62	4.1	33	4.7	95
	3	132	8.7	94	13.4	226
	4	943	61.8	464	66.0	1,407
	5	389	25.5	112	15.9	501

Lower limb bypass

Table A3.3: Characteristics of patients undergoing lower limb bypass between January 2017 and December 2019

	Bypass			
	Elective		Non-elective	
	No. of procs	%	No. of procs	%
Total procedures	11,283		6,807	
Age group (years)				
Under 60	2,383	21.2	1,240	18.3
60 to 64	1,618	14.4	895	13.2
65 to 69	1,959	17.4	1,054	15.5
70 to 74	2,152	19.1	1,215	17.9
75 to 79	1,638	14.6	1,084	16.0
80 and over	1,505	13.4	1,298	19.1
Men	8,496	75.3	4,817	70.8
Women	2,787	24.7	1,990	29.2
Smoking				
Current smoker	3,500	31.0	2,700	39.7
Ex-smoker	6,611	58.6	3,311	48.7
Never smoked	1,167	10.3	789	11.6
Fontaine score				
1 Asymptomatic	74	0.8	76	1.6
2 Intermittent claudication	3,960	40.8	186	3.9
3 Nocturnal &/or resting pain	3,007	31.0	1,129	23.7
4 Necrosis &/or gangrene	2,666	27.5	3,378	70.8
Comorbidities				
None	1,394	12.4	814	12.0
Hypertension	7,897	70.0	4,542	66.7
Ischaemic heart disease	3,797	33.7	2,520	37.0
Diabetes	3,653	32.4	2,690	39.5
Stroke	790	7.0	638	9.4
Chronic lung disease	2,728	24.2	1,711	25.1
Chronic renal disease	1,041	9.2	821	12.1
Chronic heart failure	579	5.1	532	7.8
Medication				
None	120	1.1	188	2.8
Anti-platelet	9,637	85.4	5,152	75.7
Statin	9,456	83.8	5,175	76.1
Beta blocker	2,810	24.9	1,730	25.4
ACE inhibitor/ARB	4,459	39.5	2,436	35.8

Table A3.4: Length of stay of patients undergoing lower limb bypass between January 2017 and December 2019 by type of procedure and anatomical location

	Bypass			
	Elective		Non-elective	
Total procedures	11,283		6,807	
Length of stay (days)	<i>Median</i>	<i>IQR</i>	<i>Median</i>	<i>IQR</i>
Bypass only	6	4 to 9	15	9 to 25
Adjunct to bypass	4	3 to 7	14	8 to 25
Endartectomy alone	4	2 to 6	13	8 to 23
Femoral - femoral	4	3 to 7	12	7 to 22
Femoral – abk/bk/tibial	5	3 to 8	15	9 to 25
Aorta – femoral/iliac/profunda	8	6 to 11	16	11 to 26
Iliac-femoral	4	2 to 6	12	7 to 22
Femoral endartectomy	3	2 to 5	10	6 to 18

Lower limb angioplasty / stenting

Table A3.5 Characteristics of patients undergoing endovascular lower limb revascularisation

	No. of procedures	%
Total procedures	23,881	
Age group (years)		
Under 60	4,041	17.0
60 to 69	6,551	27.6
70 to 79	7,768	32.7
80 and over	5,411	22.8
Sex		
Men	16,089	67.4
Women	7,792	32.6
Smoking		
Current smoker	6,029	25.5
Ex-smoker	12,974	54.9
Never smoked	4,630	19.6
Previous ipsilateral limb procedure	7,404	33.4
Mode of admission		
Elective	17,276	72.3
Non-elective	6,605	27.7
Fontaine score*		
No symptoms	791	3.7
Intermittent claudication	8,461	39.1
Nocturnal and/or resting pain	3,025	14.0
Necrosis and/or gangrene	9,378	43.3
Presenting problem		
Acute limb ischaemia	1,652	6.9
Chronic limb ischaemia	21,843	91.5
Aneurysm	343	1.4
Trauma	42	0.2
Comorbidities		
None	2,931	12.3
Diabetes	11,179	46.8
Hypertension	14,962	62.7
Chronic lung disease	3,953	16.6
Ischaemic heart disease	7,798	32.7
Chronic heart failure	1,863	7.8
Chronic renal disease	3,599	15.1
Stroke	2,096	8.8
Active/managed cancer	465	1.9
Medication		
None	1,239	5.2
Anti-platelet	18,497	77.5
Statin	17,388	72.8
Beta-blocker	6,354	26.6
ACE inhibitor/ARB	8,356	35.0
Antibiotic	3,718	15.6
DVT	5,433	22.8
Oral anticoagulant	1,439	6.0

*Fontaine score is calculated for patients with chronic limb ischaemia and non-missing values (n=21,655).

110 missing values for age

Lower limb major amputation

Characteristics of patients undergoing major unilateral amputations are summarised in Table A3.6, separately for above knee amputations (AKAs) and below knee amputations (BKAs). Overall, BKAs were more common in patients under 60 years and AKAs more common in patients older than 80 years. Most patients in both amputation groups were men and many were either current or ex-smokers.

The most common presenting problem for BKAs as well as AKAs was tissue loss. Among

the BKA patients, the second most common presenting problem was uncontrolled infection. For AKA patients, acute or chronic limb-threatening ischaemia were also common. Over a half of the patients had undergone a previous ipsilateral limb procedure. This may be because with the frailest, older patients, angioplasty (as a less invasive procedure) has been attempted prior to amputation. However, due to current poor case-ascertainment for angioplasty (see Chapter 6) this cannot be explored further.

Table A3.6: Characteristics of patients undergoing major unilateral lower limb amputation

	Below knee	%	Above knee	%
Total procedures	5,204		4,818	
Age group (years)				
Under 60	1,528	29.5	875	18.2
60 to 64	722	13.9	538	11.2
65 to 69	719	13.9	662	13.8
70 to 74	780	15.0	780	16.2
75 to 79	611	11.8	766	15.9
80 and over	825	15.9	1,185	24.7
Sex				
Men	3,900	74.9	3,262	67.7
Women	1,304	25.1	1,556	32.3
Smoking				
Current smoker	1,409	27.2	1,681	35.0
Ex-smoker	2,607	50.4	2,347	48.9
Never smoked	1,156	22.4	772	16.1
Presenting problem				
Acute limb ischemia	483	9.4	1,011	21.3
Chronic limb ischemia	976	18.9	1,025	21.6
Neuropathy	107	2.1	60	1.3
Tissue loss	2,117	41.0	1,766	37.3
Uncontrolled infection	1,468	28.4	823	17.4
Aneurysm	9	0.2	51	1.1
Previous ipsilateral limb procedure	3,101	65.5	2,503	57.6

Preoperative risk factors are summarised in Table A3.7. The majority of patients had one or more comorbid conditions. The most common comorbidities in both BKA and AKA groups were hypertension, diabetes and ischaemic heart disease. A large majority of patients in both groups were taking

antiplatelet medication or statins, and about a quarter to a third of the patients were on beta blockers, ACE inhibitors or Angiotensin II receptor blockers (ARBs).

Table A3.7: Preoperative risk factors among patients undergoing lower limb amputation

	Below knee	%	Above knee	%
Total procedures	5,204		4,818	
Pre-op ASA grade				
Normal	26	0.5	16	0.3
Mild disease	350	6.7	200	4.2
Severe, not life-threatening disease	3,731	71.8	2,821	58.7
Severe, life-threatening disease, or moribund patient	1,090	21.0	1,772	36.8
Comorbidities				
None	376	7.2	521	10.8
Diabetes	3,571	68.6	2,091	43.4
Hypertension	3,121	60.0	2,962	61.5
Chronic lung disease	979	18.8	1,345	27.9
Ischaemic heart disease	1,933	37.1	1,959	40.7
Chronic heart failure	522	10.0	643	13.3
Chronic renal disease	1,183	22.7	953	19.8
Stroke	463	8.9	625	13.0
Active/managed cancer	100	1.9	162	3.4
Medication				
None	186	3.6	202	4.2
Anti-platelet	3,597	69.1	3,205	66.5
Statin	3,730	71.7	3,153	65.4
Beta-blocker	1,469	28.2	1,442	29.9
ACE inhibitor/ARB	1,840	35.4	1,568	32.5
Antibiotic prophylaxis	3,620	69.6	3,296	68.4
DVT prophylaxis	3,436	66.0	3,072	63.8
Oral anticoagulant ¹	322	18.2	308	18.1

¹based on patients undergoing amputations in 2019 as answer option added to datasets in January 2019.

Carotid endarterectomy

Table A3.8: Characteristics of patients who had carotid endarterectomy between 1 Jan 2019 and 31 Dec 2019, compared with characteristics from previous two years

Patient characteristics	No. of procedures	2019 %	2018 %	2017 %
Total procedures	4,141			
Age (years), (n=4,136)				
Under 66	1,108	26.8	24.9	24.9
66 to 75	1,478	35.7	36.2	36.4
76 to 85	1,342	32.4	33.5	33.4
86 and over	208	5.0	5.4	5.3
Male	2,871	69.3	67.7	65.8
Female	1,270	30.7	32.3	34.2
Patients symptomatic for carotid disease				
Index symptom if symptomatic: (n=3,859)				
Stroke	1,486	38.5	38.6	36.4
TIA	1,716	44.5	45.4	46.5
Amaurosis fugax	598	15.5	14.5	15.1
None of the three above	59	1.5	1.6	2.0
Grade of ipsilateral carotid stenosis* (n=4,140)				
<50%	37	0.9	1.5	1.4
50-69%	1,077	26.0	27.2	26.1
70-89%	1,695	40.9	40.8	42.3
90-99%	1,325	32.0	30.2	30.0
Occluded	6	0.1	0.2	0.2
Rankin score prior to surgery				
0-2	3,803	91.8	90.5	91.1
3	290	7.0	8.2	7.7
4-5	48	1.2	1.3	1.2
Co-morbidities (n=4,140)				
Diagnosed diabetic	996	24.1	24.1	23.9
Current symptoms / treatment	1,191	28.8	30.8	31.2
Ischaemic heart disease				

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

Table A3.9: Operative details of unilateral carotid endarterectomies performed during 2019

Operation details		Procedures (n=4,137)	(%)
Anaesthetic	General only	2,337	56.5
	Local only	487	11.8
	General + local only	284	6.9
	General + superficial cervical	262	6.3
	Superficial cervical only	229	5.5
	Other	538	13.0
Type of Endarterectomy	Standard	340	8.2
	Standard + patch	3,550	85.8
	Eversion	247	6.0
Carotid shunt used		2,443	59.1
Ipsilateral patency check		2,756	68.1

Appendix 4: Audit methodology

Method of data collection

The data on these vascular procedures were collected using the National Vascular Registry IT system, which is hosted by Northgate Public Services (UK) Limited. The NVR IT system is a secure web-based data collection system used by vascular surgeons and other members of the vascular team to enter clinical data on each patient undergoing a major vascular procedure.

The data used in this report were extracted from the IT system in July 2020. In the preceding months, the Registry had undertaken several rounds of communication with vascular surgical units, asking them to validate the data, ensuring that all eligible patients were entered, and that their data was complete and accurate.

Data collected on patients, their surgery and outcomes

The NVR used datasets that are tailored to each of the various procedures within the scope of the audit, although these share a similar structure and some common data items. In particular, each dataset includes features to capture information about:

- the demographics of a patient (their age, sex, and region of residence)
- where and when the patient was admitted to hospital
- the indications for surgery, the severity of a patient's vascular disease, and other co-existing conditions
- the type and timing of surgery received, and
- the care received after surgery before the patient is discharged from hospital.

For AAA repairs, the NVR uses OPCS codes to describe the type of surgery that a patient has undergone:

- open repairs are described using OPCS codes L19.4, .5, .6, .8
- EVAR procedures are described using OPCS codes L27.1, .5, .6, .8, .9 and L28.1, .5, .6, .8, .9.

For the other procedures, the details of the operation are captured using distinct data items.

Analysis

In this report, we present summary information on patient characteristics and hospital activity, for the NHS as a whole and for individual NHS Trusts / Health Boards. Results are typically presented as totals and/or percentages, medians and interquartile ranges (IQR), with numerators and denominators stated where appropriate. 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. Measures of outcome are presented with 95% confidence intervals to describe the level of uncertainty associated with the estimates value. Stata 15 (StataCorp LP, College Station, TX, USA) was used for all statistical calculations.

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 the contributors and the total number of cases that meet the inclusion criteria for each analysis.

Activity figures from national routine datasets (e.g., HES for England, PEDW for Wales) were used to estimate case-ascertainment for the time periods included in the analysis. These were created by identifying the relevant OPCS procedure codes and ICD10 diagnosis codes in the HES procedure fields. Further information on these codes is available from the NVR team.

Multivariable logistic regression was used to derive the unit-level risk-adjusted mortality rates, and take into account differences in the patient case-mix across the NHS organisations. The regression models were used to produce the risk of death for each individual patient. The risk-adjusted mortality rates were then produced by dividing the observed number of deaths at each organisation with the predicted number and multiplying this ratio with the national mortality rate.

Not all patient records contained complete information on these risk factors. Multiple imputation by chained equations was used to address missing values on these case-mix variables when modelling postoperative complication rates for NHS organisations [White et al 2011].

Graphical presentation

A funnel plot was 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 [Spiegelhalter, 2005]. In these plots, each dot represents an NHS organisation. The solid horizontal line is the national average. The vertical axis indicates the outcome with dots higher up the axis showing trusts with a higher stroke and/or death rate. The horizontal axis shows NHS Trust activity with dots further to the right showing the trusts that perform more operations. The benefit of a funnel plot is that it shows whether the outcomes of NHS Trusts differ from the national average by more than would be expected from random fluctuations. Random variation will always affect outcome information like mortality rates, and its influence is greater among small samples. This is shown by the funnel-shaped dotted lines. These lines define the region within which we would expect the outcomes of NHS Trusts to fall if their outcomes only differed from the national rate because of random variation.

If the risk-adjusted mortality rate fell outside the outer control limits of the funnel plot, the organisation would be flagged as an outlier. If this occurred, there could be a systematic reason for the higher or lower rate, and they would be flagged for further investigation. In this report, outliers are managed according to the outlier policy of the Vascular Society, drawn up using guidance from the Department of Health. This policy can be found on the www.vsqip.org.uk website.

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Glossary

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

Confidence Interval (CI)	A statistical term used to describe the range of values that we are confident the metric lies within.
Endovascular Aneurysm Repair (EVAR)	A method of repairing an abdominal aortic aneurysm by placing a graft within the aneurysm from a small cut in the groin.
Fontaine Score	An internationally recognised scoring system or classification of the severity of peripheral arterial disease.
Hospital Episode Statistics (HES)	HES is the national statistical data warehouse for England regarding the care provided by NHS hospitals and for NHS hospital patients treated elsewhere. There are equivalent agencies in Northern Ireland, Scotland and Wales but in this report, the term HES is used generically to describe data that are collected by any of these national agencies.
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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