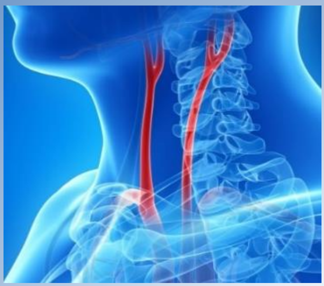

NATIONAL VASCULAR REGISTRY

2019 Annual Report

December 2019

Royal College of Surgeons
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.

The RCS managed the publication of the 2019 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.

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.

Commissioned by

The National Vascular Registry is commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP). HQIP is led by a consortium of the Academy of Medical Royal Colleges, the Royal College of Nursing, and National Voices. Its aim is to promote quality improvement, and in particular to increase the impact that clinical audit has on healthcare quality in England and Wales. HQIP holds the contract to commission, manage and develop the NCAPOP, comprising more than 30 clinical audits and clinical outcome review programmes that cover care provided to people with a wide range of medical, surgical, and mental health conditions. The programme is funded by NHS England, the Welsh Government and, with some individual audits, also funded by the Health Department of the Scottish government and the Northern Ireland Department of Health.

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Acknowledgements

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

We would also like to thank:

- VSGBI Audit and Quality Improvement Committee
- 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 to this, the 2019 NVR Annual Report. I have observed first hand the evolution of the report, and how it has documented the significant improvements in NHS vascular services since 2013. This report is especially important given the scrutiny of our activity from the Getting it Right First Time (GIRFT) project, and the interpretation of historical clinical trial data alongside contemporary outcomes used by NICE.

In early 2019, the Vascular Society, in collaboration with other stakeholders, published a Quality Improvement Framework (QIF) for peripheral arterial disease, and with support from the Royal College of Surgeons of England, has also launched a Quality Improvement Programme. This NVR report provides some initial benchmarking figures to support the vascular community implement the QIF, especially for patients with limb threatening ischaemia. I feel sure that the QIF will lead to real benefits for this important patient group.

The outcomes from aneurysm repair continue to improve. In 2018, the mortality from elective endovascular aneurysm repair was 0.4%, with a median length of stay of 2 days. This is dramatically better than the results from the randomised trials. It is also worth remembering the 2011 Vascunet report, which reported the mortality risk was four-times higher in the UK that other European countries. We should be very proud of these outcomes, during a period of uncertainty for the future of endovascular AAA repair.

Our outcomes from other major arterial surgery also remain excellent. A 1.1% mortality from elective lower limb bypass, and 2% major stroke / death rate from carotid endarterectomy are other figures to be proud of. There are very limited opportunities to reduce these rates without the inappropriate denial of therapy to higher risk patients.

There are also areas for improvement. We continue to observe significant variation in waiting times for surgery, which demands attention. It is also important to consider the completeness of the submitted data. For aneurysm repair, carotid endarterectomy and lower limb bypass, case ascertainment rates of over 90% year on year reflects the commitment of the vascular surgical community to thorough audit and transparent governance. However, the case ascertainment rates for amputation and lower limb angioplasty are a cause for concern and need a concerted effort to improve. The Vascular Society and British Society for Interventional Radiology have committed to a collaboration across all aspects of clinical audit and Registry based data collection.

In summary, this 2019 NVR report provides vital information on activity and outcomes from interventions in patients with vascular disease. It should be used individually to support appraisals and revalidation, within units and networks for clinical governance, and by national bodies including GIRFT and specialist commissioning to advise on the broader provision of services. More importantly, it continues to provide a basis for improvements in the pathways of care and clinical outcomes for our patients.

Prof Ian Loftus
President of the Vascular Society of Great Britain and Ireland

Executive Summary

The National Vascular Registry (NVR) was established to provide NHS vascular units with information on their performance and support their quality improvement initiatives. All NHS hospitals undertaking vascular procedures in England, Wales, Scotland and Northern Ireland are encouraged to participate in it.

This 2019 Annual contains information on the process and outcomes of care for: (i) patients undergoing a revascularisation procedure (angioplasty/stent or bypass) or major amputation for lower limb peripheral arterial disease (PAD), (ii) patients undergoing carotid endarterectomy, and (iii) patients undergoing abdominal aortic aneurysm (AAA) repair.

The performance indicators used by the NVR are related to key recommendations within various national guidelines including the National Institute for Health and Care Excellence (NICE) guidelines on stroke and peripheral arterial disease, and the Quality Improvement Frameworks (QIF) published by the Vascular Society of Great Britain and Ireland (VSGBI). In particular, this report provides some initial figures to support the implementation of the 2019 QIF for peripheral arterial disease.

Lower Limb Interventions for Peripheral Arterial Disease

Peripheral arterial disease of the lower limb causes a range of symptoms ranging from lifestyle restrictions due to intermittent pain to potential limb loss due to limited blood flow in the lower limb arteries (critical limb ischaemia).

1) Lower limb bypass surgery

Between January 2016 and December 2018, NHS Trusts submitted 17,295 bypass procedures to the NVR, with an estimated case-ascertainment rate of 90%. Among these patients, 69.8% were admitted with critical limb ischaemia (CLI).

VSGBI: PAD QIF

Patients admitted in an emergency with critical limb ischaemia should have a revascularisation procedure within five days.

In 2016-2018, 58.4% of patients admitted in an emergency with CLI had their bypass within five days. The proportion of patients treated within the five day standard varied among the 75 NHS Trusts that performed 10 or more bypasses for CLI. At 14 vascular units, the pathway from admission to surgery took longer than 10 days for 25% of patients.

Surgical outcomes for bypass procedures remained very good. The in-hospital postoperative mortality rate was 1.1% (95% CI 0.9 to 1.3) for elective admissions and 5.3% (95% CI 4.7 to 5.8) for emergency admissions. Over 80% of patients had no reported complications, and a subsequent procedure after the initial operation was required in 6.1% of elective admissions and 13.9% of emergency admissions. All NHS Trusts had an adjusted rate of postoperative in-hospital death 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 6,714 in 2016 to 7,674 in 2018. However, while a few NHS Trusts achieved 90% ascertainment rates, the overall case-ascertainment remains low at 36% for 2018. Therefore, the results for these procedures should be interpreted with appropriate caution. Continued local efforts must be made to improve the completeness of data collection.

VSGBI: PAD QIF

Patients admitted in an emergency with critical limb ischaemia (CLI) should have a revascularisation procedure within five days.

Among the patients having endovascular interventions during the 2016-18 audit period, there were 5,197 with critical limb ischaemia who were admitted as an emergency admission. Overall, 46% waited for longer than 5 days for revascularisation. The proportion of patients treated within the five day standard varied across the 54 NHS Trusts that performed 10 or more procedures. At 23 NHS Trusts, the pathway took longer than 10 days for 25% of their patients.

Outcomes after lower limb angioplasty / stents were good. The in-hospital postoperative mortality rate was 0.4% (95% CI 0.3 to 0.5) for elective admissions and 5.0% (95% CI 4.4 to 5.6) for emergency admissions. However, there were large variations between NHS Trusts in the treatment of patients on a day case basis, which highlights issues around the efficient delivery of care.

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.

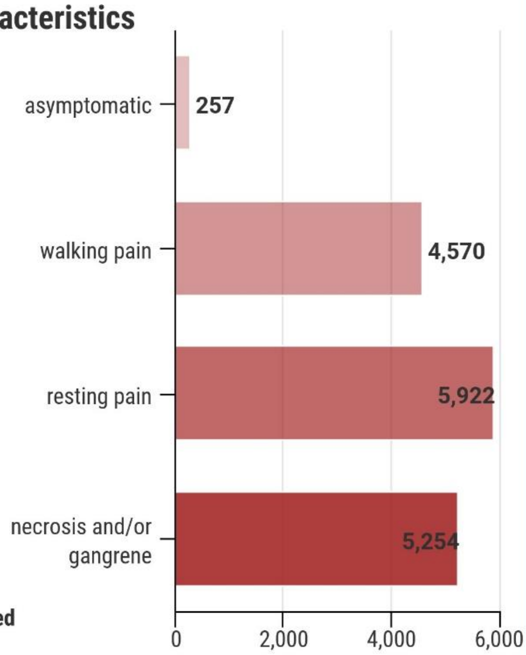
17,295 lower limb bypass procedures carried out in 2016-2018

10,878 were admitted electively

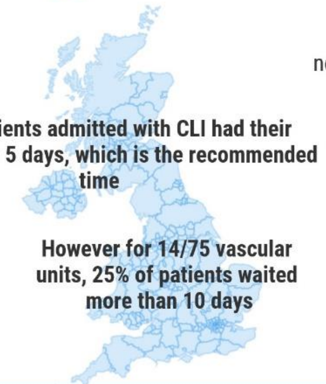
6,417 were admitted in an emergency

Patient characteristics

- **74%** were male
- **65%** were older than 65 years
- **34%** were diabetic
- **89%** were current or ex-smokers

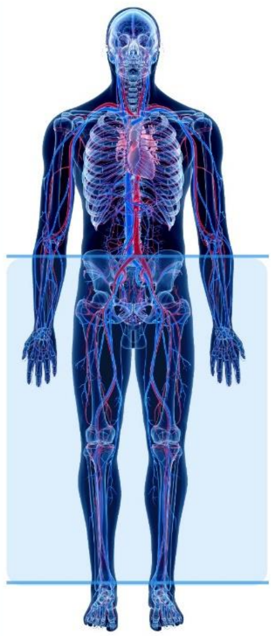


In the NVR data, CLI is defined as patients admitted in an emergency with either resting pain or necrosis and/or gangrene.



58% of patients admitted with CLI had their bypass within 5 days, which is the recommended time

However for 14/75 vascular units, 25% of patients waited more than 10 days



Glossary

The average is the median; "typically between" is the interquartile range.

Critical limb ischaemia (CLI) is the most severe form of PAD, where the blood flow to the legs becomes severely restricted.

Patient outcomes post bypass

Elective

- 1.1% died in hospital
- 9.7% were readmitted within 30 days
- 5 days (3-8 days) average length of stay (typical range)

Emergency

- 5.3% died in hospital
- 15.0% were readmitted within 30 days
- 14 days (8-25 days) average length of stay (typical range)

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.

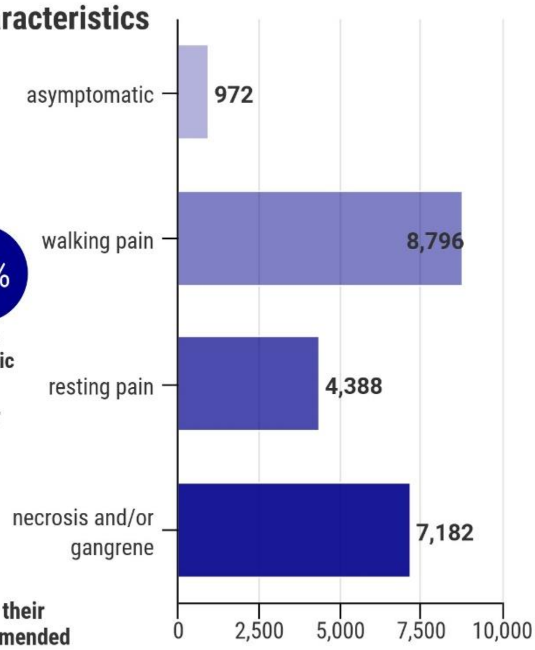
22,109 lower limb angioplasty/stent procedures carried out in 2016-2018

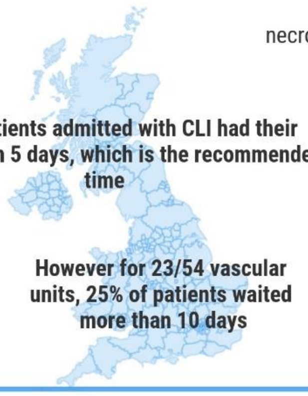
15,999 were admitted electively

6,110 were admitted in an emergency

Patient characteristics

- **68%** were male
- **72%** were older than 65 years
- **44%** were diabetic
- **81%** were current or ex-smokers

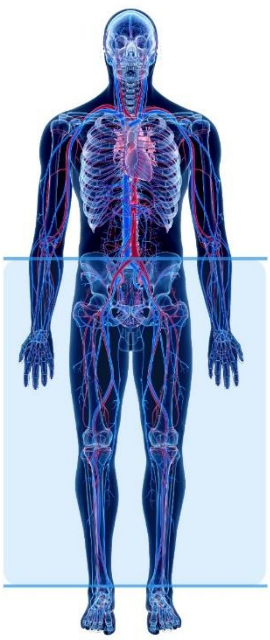




54% of patients admitted with CLI had their bypass within 5 days, which is the recommended time

However for 23/54 vascular units, 25% of patients waited more than 10 days

In the NVR data, CLI is defined as patients admitted in an emergency with either resting pain or necrosis and/or gangrene.



Glossary

The average is the median; "typically between" is the interquartile range.

Critical limb ischaemia (CLI) is the most severe form of PAD, where the blood flow to the legs becomes severely restricted.

Patient outcomes post procedure

Elective
- 0.4% died in hospital
- 7.6% readmitted within 30 days
- 0 days (0-1 days) average length of stay (typical range)

Emergency
- 5.0% died in hospital
- 17.8% readmitted within 30 days
- 13 days (6-27 days) average length of stay (typical range)

3) Major lower limb amputation

During the three-years from 2016 to 2018, the NVR received details of 9,508 major lower limb amputations, giving an estimated case-ascertainment of around 70%. Significant variations in the level of data ascertainment remain between NHS Trusts.

VSGBI: Amputation QIF

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

The overall median time from vascular assessment to amputation was 8 days (IQR: 3 to 26 days). Among patients undergoing amputations as elective procedures, the median time was 30 days (IQR: 8 to 82 days); for patients having emergency amputation, the median was 7 days (IQR: 2 to 18 days). Among patients admitted as an emergency, there were 11 NHS Trusts at which 25% of patients had a wait longer than 30 days.

VSGBI: Amputation QIF

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

Over the 2016-18 audit period, the overall AKA:BKA ratio was 0.91. Most of the NHS Trusts had a ratio of less than one, but 11 organisations had ratios 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.

Overall performance on the Amputation QIF / NCEPOD process measures was reasonable but requires improvement given that there was some 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 three-quarters of the procedures
- prophylactic antibiotics and DVT medication were used for only just over 60% of patients.

The overall rate of 30-day in-hospital death for major amputations was 4.8% (95% CI: 4.4 to 5.3), being slightly higher for AKA (7.6%; 95% CI: 6.8 to 8.4) than BKA (2.3%; 95% CI: 1.9 to 2.7). All NHS Trusts had an adjusted mortality rate that fell within the expected range of the overall 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.

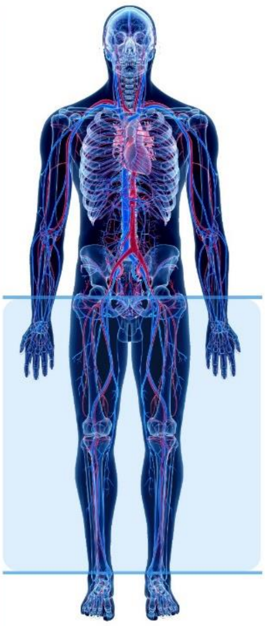
Despite open and endovascular revascularisation procedures, PAD can gradually progress in some patients to critical limb ischaemia. In these situations, patients will require amputation of the lower limb.

In 2016-2018 there were 9,508 major lower limb amputations submitted to the NVR.

9,508
amputations

4,525
above Knee

4,983
below Knee



Which people had surgery?

Above knee:

- 68% were male
- 71% were older than 65 years
- 43% were diabetic
- 83% were current or ex-smokers

Below knee:

- 74% were male
- 57% were older than 65 years
- 67% were diabetic
- 77% were current or ex-smokers

Glossary

The average is the median; "typically between" is the interquartile range.

Patient outcomes after surgery

Above Knee

- 11.0% died in hospital
- 8.3% were readmitted within 30 days
- 22 days (13-39 days) average length of stay (typical range)

Below Knee

- 4.7% died in hospital
- 10.8% were readmitted within 30 days
- 24 days (14-40 days) average length of stay (typical range)

Carotid endarterectomy

In 2018, there were a total of 4,178 carotid endarterectomies (CEAs). The number has decreased significantly since 2011 when nearly 6,000 CEAs were performed. Case-ascertainment remains high, being consistently over 90% since 2014.

VSGBI Provision of services

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

In 2018, there were 25 out of the 78 active vascular units that did not perform at least 40 CEAs.

NICE guideline CG68

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

Symptomatic patients made up 93.4% of the audit cohort. The median time from symptom to surgery remained stable in 2018 compared to 2017, at 12 days and 60% of patients were treated within 14 days. However, there remains significant variation between NHS Trusts. The median delay exceeded 20 days for seven vascular units, although this is less than half the number in 2016.

Patient outcomes after carotid surgery continue to be good. Among 12,925 patients undergoing carotid endarterectomy between 2016 and 2018, complication rates during the hospital admission remained low:

- 2.0% of patients died and/or had a stroke within 30 days (95% CI 1.8-2.3)
- 2.0% of patients had a cranial nerve injury during their admission (95% CI 1.8-2.3).

All NHS Trusts demonstrated adjusted 30 day rate of death / stroke after surgery within the expected range of the national average, given the number of procedures performed at that organisation.

Carotid artery surgery to prevent stroke

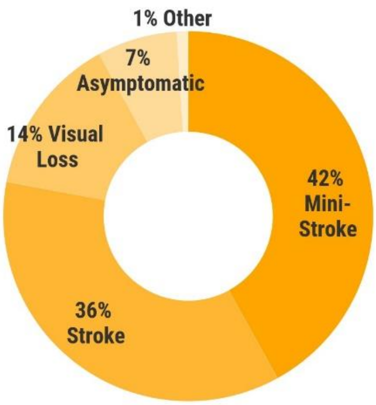
A procedure in which build-up of plaque is removed from the carotid artery in the neck is called a carotid endarterectomy (CEA).

There were 4,178 CEAs submitted to the NVR in 2018, which is approximately 96% of all procedures in the UK.

Which people had surgery?

- 68% were male
- 24% were diabetic
- 31% had heart disease
- 75% were older than 65 years

Reasons for surgery



Treatment times for symptomatic patients

Recommended time from symptom to surgery is within 14 days

average 12 days (7-23 days typical range)

Symptom → Referral → Seen by surgeon → Operation

- Symptom to Referral: average 4 days (1-9 days typical range)
- Referral to Seen by surgeon: average 1 day (0-5 days typical range)
- Seen by surgeon to Operation: average 5 days (2-10 days typical range)

Glossary

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

Visual loss, also know 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; "typically between" 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 42 days

Outcomes of surgery

CEA

- 2.0% died and/or had a stroke within 30 days of the procedure
- 4.4% were readmitted within 30 days
- 2 days (2-5 days) average length of stay (typical range)

Abdominal aortic aneurysms (AAA)

Aortic aneurysm repair represents a major aspect of vascular service provision. Aneurysms typically develop in the aorta below the arteries to the kidneys (infra-renal AAA) but can develop elsewhere along the Aorta and these require more complex types of repair. A national screening programme for AAA in men aged 65 years has run since 2009 to diagnose asymptomatic aneurysms.

1) Elective infra-renal AAA

The NVR received information on 3,708 elective infer-renal AAA repairs in 2018, of which 63% were endovascular repair (EVAR). Estimated case-ascertainment was 91%.

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.

The results for procedures performed in 2018 suggest that the majority of patients are receiving care that is consistent with the recommended pathway:

- 82.0% were discussed at MDT meetings
- 89.3% had pre-operative CT/MR angiography
- 95.4% of patients underwent a formal anaesthetic review
- 85.5% had documented formal fitness assessment tests.

National AAA Screening Programme (NAAASP)

The National Screening Programme recommends a target of 8 weeks from the date of referral from the NAAASP to the date of repair for the majority of patients.

Across the 72 vascular units performing AAA repair, the median delays from vascular assessment to AAA repair tended to fall between 60 and 90 days. However, at 16 vascular units, 25% of patients waited more than 140 days in 2018.

Patient outcomes after elective AAA repair improved dramatically following the VSGBI Quality Improvement Programme. In 2018, the in-hospital postoperative mortality was 3.2% after open repair and 0.4% after EVAR. Over the 3-year period from January 2016 to December 2018, the risk-adjusted in-hospital mortality rates for all NHS vascular units were within the expected range of the national average (1.4% for 2016-18).

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 3,708 elective infra-renal AAA repairs submitted to the NVR in 2018, which is approximately 91% of all procedures carried out in the UK.

Of these

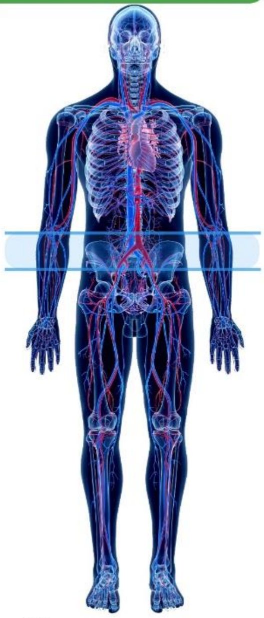
3,708

1,358 (37%) were open repair

- **91%** were male
- **75%** were older than 65 years
- **68%** had hypertension
- **85%** were a current or ex-smoker

2,350 (63%) were endovascular repair (EVAR)

- **89%** were male
- **93%** were older than 65 years
- **71%** had hypertension
- **85%** were a current or ex-smoker

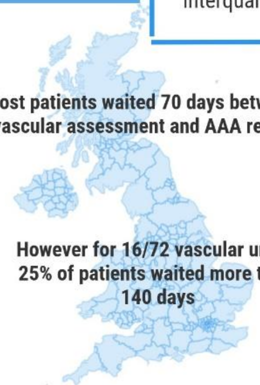


Glossary

The average is the median; "typically between" is the interquartile range.

How were patients assessed?

- **82%** discussed at multi-disciplinary team meeting
- **86%** had fitness measured
- **89%** had pre-operative angiography assessment
- **95%** had formal anaesthetic review
  - **91%** of these had review by consultant vascular anaesthetist



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

Patient outcomes after surgery

Open

- **3.2%** died in hospital
- **5.6%** were readmitted within 30 days
- **7 days (6-9 days)** average length of stay (typical range)

EVAR

- **0.4%** died in hospital
- **5.4%** were readmitted within 30 days
- **2 days (1-3 days)** average length of stay (typical range)

2) Complex aneurysm repair

Open repair was the traditional approach to repairing the complex aneurysms that occur above or around the arteries to the kidneys. In recent years, many vascular units have been using an endovascular technique. Between January 2016 and December 2018, there were 2,513 complex AAA repairs, of which 245 were open repairs and 2,268 were endovascular: 1,278 fenestrated repairs (FEVAR), 211 branched repairs (BEVAR) and 447 thoracic repairs (TEVAR). Cases were submitted to the NVR from 73 vascular units performing complex AAA repairs between 2016 and 2018; 52 units submitted fewer than 10 cases per year.

The median time from vascular assessment to surgery at these vascular units tended to fall within the range of 100 to 160 days. However, at nine vascular units, 25% of patients having complex AAA repair between 2016 and 2018 waited more than 220 days.

The outcomes remain favourable for endovascular repair compared with open repair of complex AAA, with in-hospital postoperative mortality rates of 2.4% and 14.7%, respectively.

3) Repair of ruptured AAA

Despite the national screening programme for the detection of aortic aneurysms, aneurysm ruptures still affect many people. The NVR recorded 2,474 cases from January 2016 to December 2018, which represents a case-ascertainment rate of approximately 92%.

The use of EVAR increased from 27.4% in the period 2014-16 to 30.0% during 2016-18. Patients undergoing EVAR for ruptured AAA had lower in-hospital postoperative mortality compared to open repair (22.6% and 40.9%, respectively). However, these figures for EVAR and open repair should not be directly compared because open procedures may represent the more complex cases. Further work is required to clarify which patients benefit most from the two approaches.

All NHS Trusts demonstrated in-hospital mortality rates after repair for ruptured AAA within the expected range around the overall national average (35.4%), 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 that the standard infra-renal repairs and will require specialist teams, often within a specialist hospital.

There were 2,513 repairs of elective complex AAAs carried out in 2016-2018.

Of these

2,513

245 (10%) were open repair

2,268 (90%) were endovascular repair (EVAR)

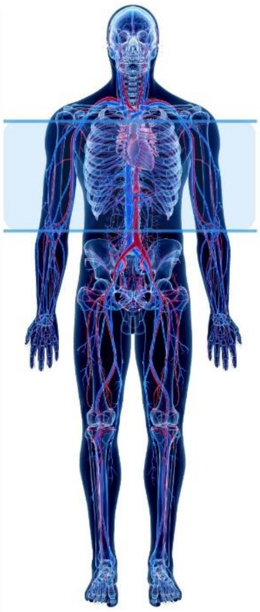
Which people had surgery?

Open repair

- 86% were male
- 80% were older than 65 years
- 76% had hypertension
- 82% were a current or ex-smoker

EVAR

- 82% were male
- 85% were older than 65 years
- 75% had hypertension
- 82% were a current or ex-smoker



Glossary

The average is the median; "typically between" is the interquartile range.

The most common complex EVAR 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

Open

- 14.7% died in hospital
- 10.5% were readmitted within 30 days
- 9 days (6-16 days) average length of stay (typical range)

EVAR

- 2.4% died in hospital
- 8.5% were readmitted within 30 days
- 4 days (3-7 days) average length of stay (typical range)

Recommendations

Recommendation	Where in report	Primary audience
1) Vascular units should ensure that all data on lower limb revascularisation and major amputation procedures are being uploaded to the NVR, including the provision of administrative support to allow this.	Page 30; Page 41	NHS Trusts and vascular specialists
2) Vascular units should review their pathways of care for patients with critical limb ischaemia (CLI), using the VSGBI Quality Improvement Frameworks (QIF) for peripheral arterial disease and amputation.	Pages 25-26; Page 35; Pages 42-43	NHS Trusts and vascular specialists
3) Vascular units should aim for patients admitted as emergency with CLI to have their lower limb bypass or endovascular revascularisation procedure within 5 days.	Pages 25-26; Page 35	NHS Trusts and vascular specialists
4) Vascular units should review local care pathways and patient outcomes for lower limb amputation using recommendations in the VSGBI QIF. Specifically: • 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 • below knee amputation should be undertaken whenever appropriate. Vascular units should aim to have an above knee to below knee ratio below one.	Page 45	NHS Trusts and vascular specialists
5) Vascular units should examine how to improve their performance against the shared NCEPOD and VSGBI QIF recommendations for amputation.	Pages 45-46	NHS Trusts
6) NHS Trusts at which patients are not having their carotid endarterectomy within 14 days of experiencing symptoms should review the referral pathways within their networks and implement improvements to reduce waiting times.	Pages 53-54	NHS Trusts
7) Vascular units should assess whether all AAA patients are discussed at the vascular MDT meeting and that this is documented in medical notes.	Page 58	NHS Trusts and vascular specialists
8) For non-complex aneurysms, vascular units should ensure the time patients take from referral for vascular assessment to elective AAA repair is less than 8 weeks for both screen and non-screen detected patients.	Page 59	NHS Trusts and vascular specialists
9) Vascular units should only be commissioned to perform complex AAA repair if they submit complete and accurate data on case activity and outcomes to the NVR to ensure the provision of safe and effective services for patients with complex aortic disease. Vascular units should consider how provision could be organised best within their regions.	Page 65	Commissioners
10) For patients requiring complex AAA repair, vascular units should also examine how the time from vascular assessment to surgery can be reduced, particularly, the process of requesting non-conventional devices for endovascular procedures.	Pages 66-67	NHS Trusts and vascular specialists
11) 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.	Pages 73-74	NHS Trusts and vascular specialists

1. Introduction

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

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

The NVR was designed as a procedure-based audit. Adult patients with vascular conditions who do not have surgery (including those referred to a vascular unit but not operated on) are outside the scope of the NVR.

The NVR is commissioned by the Healthcare Quality Improvement Partnership (HQIP) 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 2019 Annual Report

The aim of this report is to describe 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 vascular services are delivered within the NHS.

The outcome indictors 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, the introduction of new hybrid operating theatres, and reorganisations of services, which has resulted in arterial surgery and complex endovascular interventions 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 process measures are linked to standards of care that are drawn from various national guidelines. The focus on either particular aspects of care before and after the vascular intervention, or 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 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 (CG68) [NICE 2008]
- National Stroke Strategy [DH 2007] and its associated publication "Implementing the National Stroke Strategy – an imaging guide" [DH 2008].

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].

1.2 Publication of information on the VSQIP website

The Registry publishes a range of information on the **www.vsqip.org.uk** website for UK vascular services, patients and the public. The website provides access to:

- all Annual Reports, including this report
- 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.

In addition, as part of NHS England's "Everyone Counts: Planning for Patients 2013/4" initiative, the Registry publishes information on the outcomes of carotid endarterectomy and elective infra-renal AAA repair for individual consultants currently working at English NHS vascular units. 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. The information on English NHS organisations can be found on the MyNHS website (https://www.nhs.uk/Service-Search/performance/search).

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 2016 and 31 December 2018. As noted above, the scope of the NVR extends only to patients who underwent a procedure. Details of patients who were admitted to hospital with a vascular condition (e.g. a ruptured AAA) but were not operated upon, are not captured.

The data used in this report was extracted from the NVR IT system in June 2019. 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.

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 has 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.

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/

2. Lower limb bypass for PAD

2.1 Introduction

Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower limb arteries. Around 1 in 5 people over the age of 60 in the UK have the condition and it can severely affect a patient's quality of life [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, with a particular focus on critical limb ischaemia (CLI), a severe form of PAD in which blood flow to the feet is severely restricted. The 2018 report on Vascular Services from the GIRFT initiative reported that the delivery of revascularisation for patients with CLI was inconsistent across England, particularly in relation to the time patients could wait from initial presentation to treatment [Horrocks 2018].

This chapter presents results on the processes and outcomes of lower limb bypass procedures, focusing on data from 17,295 procedures entered into the NVR during the three years between January 2016 and December 2018. Open surgical interventions such as bypass, along with the endovascular interventions described in the next chapter, are the primary treatments for patients with critical limb ischemia.

It is estimated that the NVR has captured approximately 90% of the bypass procedures performed between 2016 and 2018 in the NHS.

Table 2.1 summarises the characteristics of lower limb bypass procedures by clinical urgency. Patients varied in the severity of their disease as highlighted by the Fontaine classification, with patients suffering from critical limb ischemia (Fontaine scores 3 and 4) accounting for the majority of procedures. The most common elective and emergency procedures involved a bypass from a femoral artery to one to one above or below knee (52.8% and 59.2%, respectively). For elective procedures, an endarterectomy procedure was performed together with the bypass in 4,468 procedures (41.1%); for emergency procedures, endarterectomy was performed in 2,321 bypass operations (36.2%).

The patient's own veins were used as the bypass grafts in 4,538 elective procedures (41.7%) and 3,302 emergency procedures (51.5%).

The prevalence of diabetes, hypertension and ischaemic heart disease was high, 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).

Table 2.1: Characteristics of lower limb bypass procedures undertaken between January 2016 and December 2018

	Elective procedures (n=10,878)	%	Emergency procedures (n=6,417)	%
Fontaine score[1]				
1 Asymptomatic	137	1.4	120	2.0
2 Intermittent claudication	4,269	43.1	301	4.9
3 Nocturnal &/or resting pain	3,392	34.2	2,530	41.5
4 Necrosis &/or gangrene	2,112	21.3	3,142	51.6
Bypass location				
Femoral – femoral	822	7.6	452	7.0
Femoral – popliteal / tibial	5,747	52.8	3,799	59.2
Aorta – femoral / iliac	874	8.0	243	3.8
Iliac – femoral	1,510	13.9	617	9.6
Femoral endarterectomy	224	2.1	83	1.3
Other bypass	2,686	24.7	1,599	24.9

[1]The Fontaine score was missing for 968 elective and 324 emergency procedures.

2.2 Time to revascularisation for patients with CLI

VSGBI: PAD QIF

Patients admitted in an emergency with critical limb ischaemia (CLI) should have a revascularisation procedure within five days.

Early revascularisation for patients with CLI 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 CLI patients admitted after an emergency admission between 2016 and 2018, the overall median wait from admission to surgery was 4 days (IQR 1-8) and 58.4% of patients had their bypass within five days.

Figure 2.1 (overleaf) summarises the median (IQR) time from admission to surgery across 75 NHS Trusts that performed 10 or more bypasses for emergency admissions between 2016 and 2018. The red line indicates the 5-day standard defined by the VSGBI. The graph shows that:

- at 23 vascular units, the pathway took more than five days for 50% of patients with CLI
- at 14 vascular units, the pathway from admission to surgery took longer than 10 days for 25% of patients.

Figure 2.1: Median (IQR) time from admission to surgery (days) for patients who had an emergency bypass between January 2016 and December 2018 with critical limb ischaemia

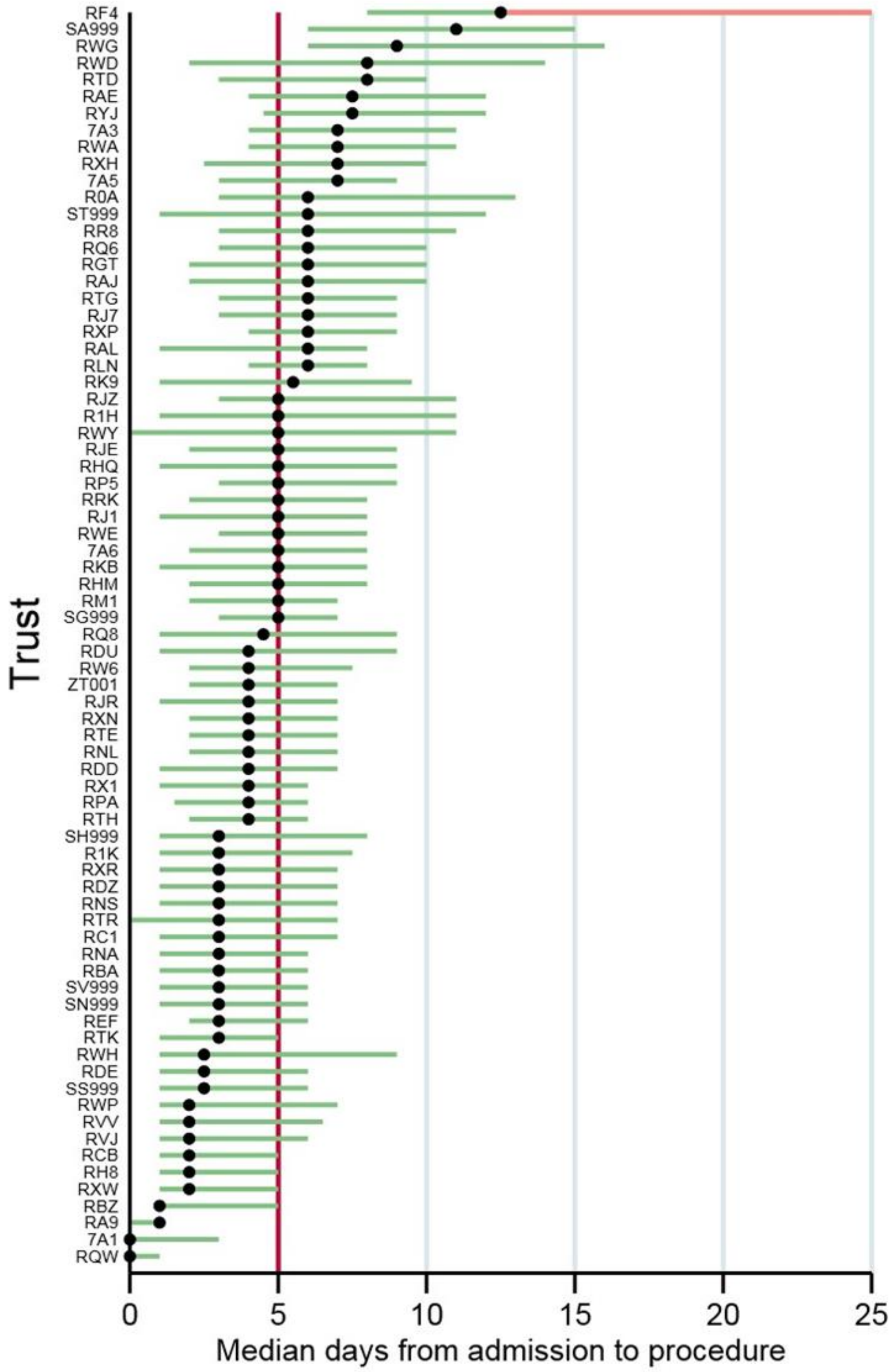


Table 2.2: Postoperative outcomes for patients undergoing elective and emergency lower limb bypasses between January 2016 and December 2018

		Elective		Emergency	
		No. of procs		No. of procs	
Total procedures		10,878		6,417	
Admitted to	Ward	7,849	72.2%	4,408	68.7%
	Level 2	2,493	22.9%	1,567	24.4%
	Level 3	528	4.9%	433	6.8%
	Day case unit	0	0.0%	0	0.0%
	Died in theatre	<5	<0.1%	5	0.1%
		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	1 to 8
Post-operative length of stay (days)		4	3 to 7	9	5 to 17
Overall length of stay (days)		5	3 to 8	14	8 to 25
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital mortality rates					
Overall mortality		1.1	0.9 to 1.3	5.3	4.7 to 5.8
Femoral – femoral		1.3	0.7 to 2.4	7.7	5.5 to 10.6
Femoral – popliteal / tibial		0.8	0.6 to 1.1	3.9	3.3 to 4.6
Aorta – femoral / iliac		2.7	1.8 to 4.1	10.3	6.8 to 14.8
Iliac – femoral		0.9	0.5 to 1.6	6.2	4.4 to 8.4
Femoral endarterectomy		0.4	0.0 to 2.5	3.6	0.8 to 10.2
Defined complications					
Cardiac		2.4	2.2 to 2.8	4.9	4.4 to 5.4
Respiratory		2.6	2.3 to 2.9	4.9	4.4 to 5.5
Haemorrhage		1.6	1.4 to 1.9	2.5	2.1 to 2.9
Limb ischaemia		2.9	2.6 to 3.2	6.0	5.4 to 6.6
Renal failure		0.9	0.7 to 1.1	2.3	2.0 to 2.7
Stroke		0.2	0.2 to 0.4	0.5	0.3 to 0.7
None of the above		90.8	90.3 to 91.4	82.9	81.9 to 83.8
Further unplanned lower limb procedure					
None		93.9	93.4 to 94.3	86.1	85.2 to 86.9
Angioplasty without stent		0.4	0.3 to 0.6	1.0	0.7 to 1.2
Angioplasty with stent		0.4	0.3 to 0.5	0.5	0.3 to 0.7
Lower limb bypass		1.6	1.3 to 1.8	2.5	2.2 to 2.9
Minor amputation		1.0	0.8 to 1.2	4.3	3.8 to 4.9
Major amputation		0.1	0.1 to 0.2	1.0	0.8 to 1.3
Readmission to higher level care		2.0	1.7 to 2.2	3.1	2.7 to 3.5
Readmission within 30 days		9.7	9.1 to 10.3	15.0	14.0 to 16.0

2.3 Postoperative outcomes for lower limb bypasses

The outcomes of the revascularisation procedures are summarised in Table 2.2 for elective and emergency procedures.

In relation to the in-hospital postoperative mortality, there was a clear difference between the two modes of admission, with the rates being:

- 1.1% (95% CI 0.9 to 1.3) for elective patients
- 5.3% (95% CI 4.7 to 5.8) for emergency patients.

For procedures where the bypass involved the aorta, the mortality was considerably higher for emergency cases at 10.3% (95% CI 6.8 to 14.8) compared to other locations.

The outcomes for lower limb bypass are in line with recent literature. Complications were relatively uncommon, with 94% of elective patients and 86% of emergency patients not requiring a further unplanned intervention. Approximately, 99 in 100 elective patients were discharged alive without having their limb amputated; for procedures after an emergency admission, the figure was 95 in 100 patients.

However, the figures show that 10% of elective and 15% of emergency 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 CLI admitted as an emergency are summarised in Table 2.3 by the preoperative length of stay. There are some differences in relation to the two patient groups, although we caution against the over-interpretation of these figures. Further work is required to identify the degree in which these differences arise from the time to surgery or from the patients having more severe disease, for which outcomes would be expected to be worse.

Table 2.3: Post-operative outcomes following lower limb bypass, for patients undergoing emergency revascularisation for CLI, stratified by the pre-operative length of stay in hospital

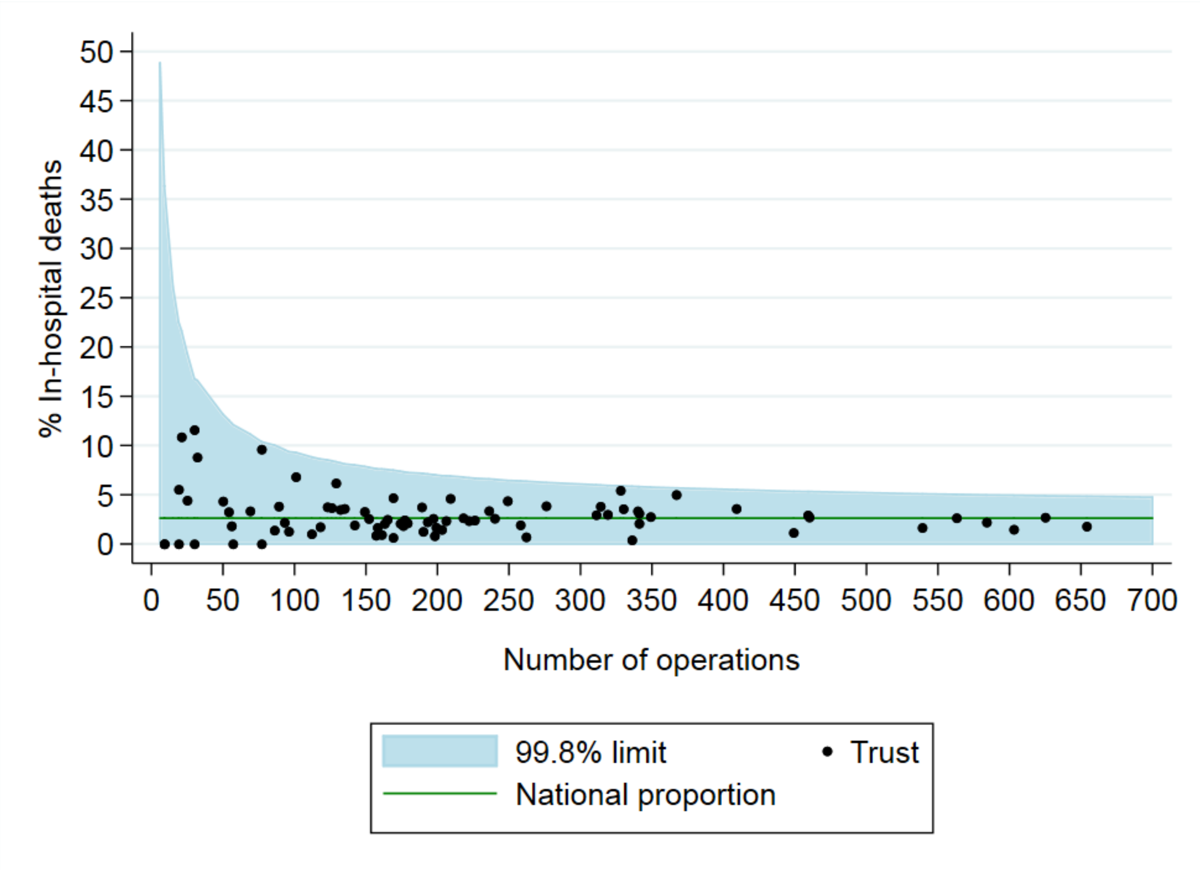
	Patients with LOS ≤5 days		**Patients with LOS >5 days**	
	No.		**No.**	
Procedures	3,310	58.4%	2,358	41.6%
	Median	**IQR**	**Median**	**IQR**
Days in critical care				
Level 2	1	0 to 2	1	0 to 2
Level 3	2	1 to 4	2	1 to 3
Overall LOS	10	7 to 17	22	15 to 35
Post-operative LOS	8	5 to 15	11	6 to 21
	Rate	**95% CI**	**Rate**	**95% CI**
In-hospital mortality	4.2	3.6 to 5.0	6.2	5.3 to 7.3
No predefined complication	82.7	81.4 to 84.0	81.2	79.5 to 82.7
Unplanned lower limb procedure				
None	86.8	85.5 to 87.9	84.6	83.1 to 86.1
Minor amputation	3.7	3.0 to 4.4	6.2	5.3 to 7.3

2.4 Rates of in-hospital death after lower limb bypass

Figure 2.2 shows the funnel plot of risk-adjusted mortality rates for each NHS Trust that performed bypass procedures between January 2016 and December 2018. The national average has slightly improved over time, decreasing from 2.8% (for 2014 to 2016) to 2.6% (for 2016 to 2018). 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, anatomy of procedure, Fontaine score, type of procedure, ASA grade, mode of admission, cardiac disease, renal disease and chronic lung disease.

Figure 2.2: Funnel plot of risk-adjusted in-hospital deaths from lower limb bypass for NHS Trusts, shown for procedures performed between January 2016 and December 2018.



3. Lower limb angioplasty/stent for peripheral arterial disease

3.1 Introduction

This chapter describes the processes and outcomes of care for patients who have a lower limb revascularisation performed as an endovascular procedure. This will either involve angioplasty and/or the insertion of a stent. Like bypass procedures, endovascular procedures are used to treat patients with a range of lower limb symptoms, with Fontaine scores ranging from asymptomatic to critical limb ischaemia with tissue loss.

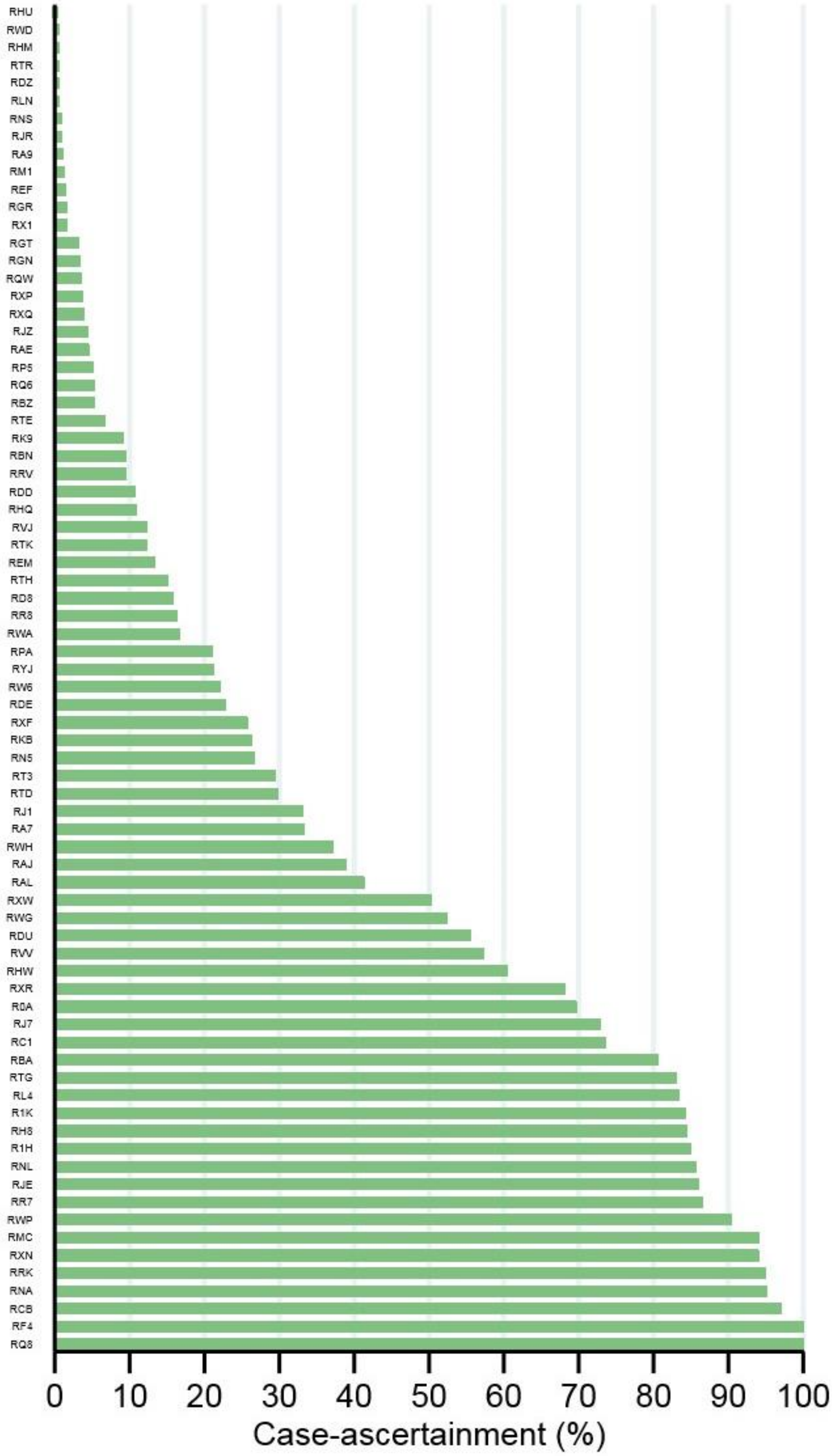
The NVR has collected data on endovascular revascularisation since 2014. In the present report, we provide data on 22,019 procedures performed between January 2016 and December 2018: 6,714 performed in 2016, 7,721 in 2017 and 7,674 in 2018.

The estimated case-ascertainment for this period was approximately 32% in 2016 to 36% in 2018. There has been some improvement in the figures for 2016 and 2017 compared with those reported in the 2018 Report, but overall data submission remains comparatively low. There was considerable variation between NHS Trusts (Figure 3.1), with some NHS Trusts achieving an estimated case-ascertainment of 90%. Nonetheless, too many trusts are submitting less than half of all cases, with 27 failing to submit 10% of procedures. In the 2018 GIRFT report on vascular services [Horrocks 2018], it was recommended that services should be achieving an estimated case-ascertainment rate in excess of 85%. NHS hospitals should ensure sufficient resources (including administrative support) to allow vascular services to respond to this expectation.

Table 3.1: Estimated case-ascertainment for lower limb endovascular procedures, by year

	2016	2017	2018
NVR procedures	6,714	7,721	7,674
Expected procedures	20,911	20,419	21,289
Estimated case-ascertainment	32%	38%	36%

Figure 3.1: Case-ascertainment by NHS Trust



3.2 Procedure characteristics

Characteristics of the lower-limb endovascular procedures are summarised in Table 3.2. Superficial femoral angioplasty was the most common procedure site, undertaken in nearly 48% of cases. Popliteal (28% of cases), common iliac (23%) and tibial/pedal angioplasties (21%) were also common sites. The majority of patients undergoing the procedure were men, and about a quarter of patients were aged 80 years or older. Just under a third had undergone a previous procedure on the same leg. The prevalence of ischaemic heart disease, hypertension and diabetes was high and most patients were on antihypertensive or antiplatelet medication (see Appendix 3 for details).

Angioplasty alone was the most common type of procedure (16,989, 76.8%); a stent alone was used in 2,550 (11.5%) procedures and 4,177 (18.9%) 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.

VSGBI: PAD QIF

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

Of all endovascular procedures, 15,999 (72.4%) were elective and 6,110 (27.6%) were emergency procedures. The proportions of procedures performed between 8am and 6pm, which were taken as representing those on planned operating lists, are shown, by NHS Trust, in Figure 3.2. Overall, 97.6% of the 21,133 endovascular revascularisations were recorded as being performed between 8am and 6pm, suggesting many NHS Trusts met the QIF target during the 2016-18 audit period.

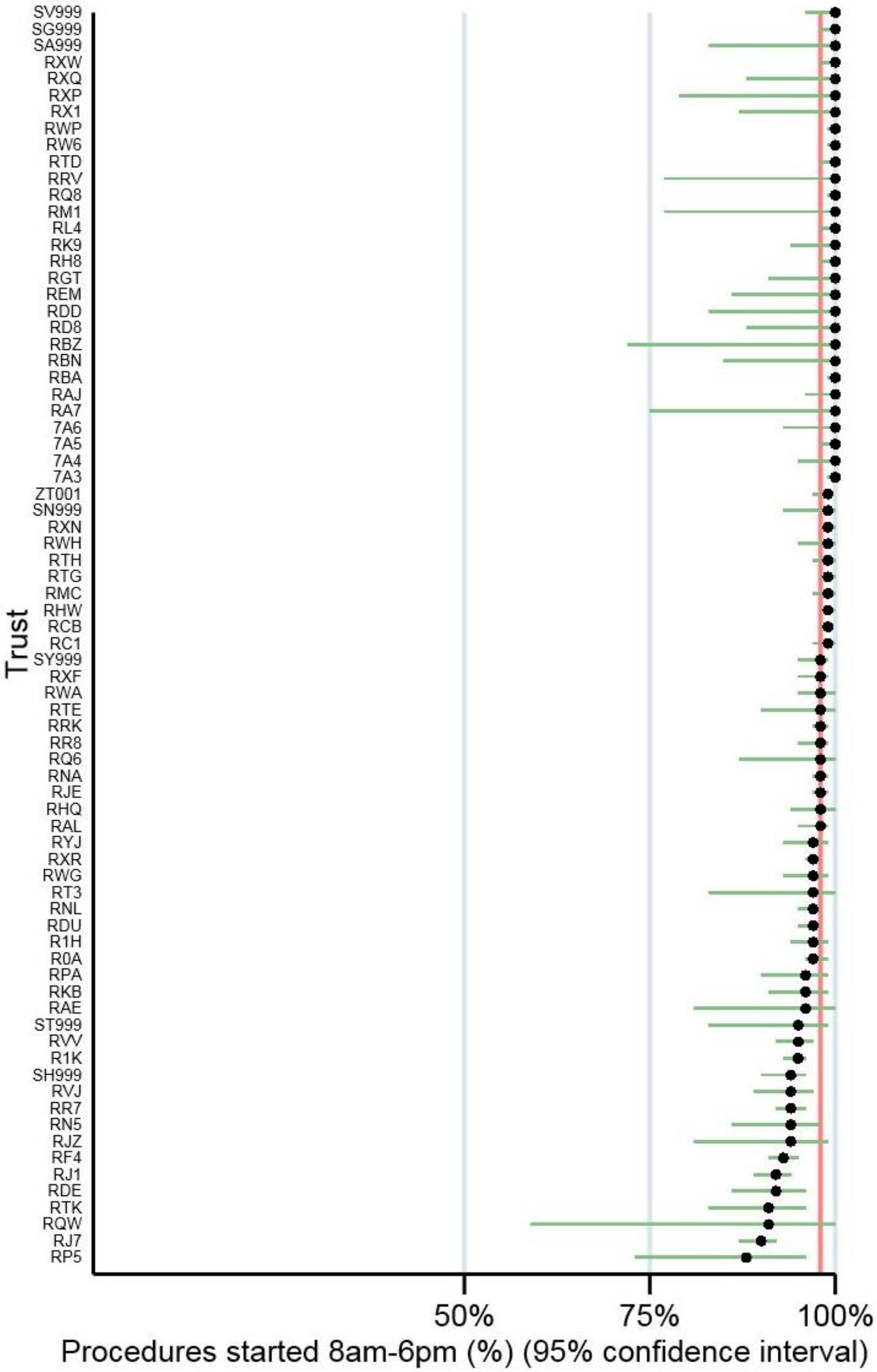
Table 3.2: Characteristics of lower limb endovascular procedures by anatomical location

	No. of procedures	%	ASA grade 4-5	%	Stenosis/ aneurysm[1]	%	Procedure success	%	Day cases	%	Admitted to critical care	%	LOS[2] Median	IQR
Common iliac	5,045	22.8	150	3.9	3,785	75.0	4,731	93.8	1,742	34.5	278	5.5	2	1 to 7
External iliac	4,350	19.7	155	4.9	3,185	75.3	3,971	93.9	1,389	32.8	241	5.7	2	1 to 8
Common-external iliac	1,891	8.6	78	5.4	1,448	76.6	1,784	94.3	590	31.2	134	7.1	2	1 to 8
Superficial femoral	10,551	47.7	368	4.8	5,714	55.4	9,173	89.0	3,401	33.0	335	3.2	3	1 to 13
Superficial femoral–popliteal	3,778	17.1	179	6.4	2,324	61.8	3,335	88.7	1,066	28.3	101	2.7	4	1 to 15
Popliteal	6,088	27.5	265	6.0	3,442	57.6	5,214	87.2	1,600	26.8	169	2.8	4	1 to 15
Popliteal -tibial/pedal	1,966	8.9	146	10.0	1,092	55.5	1,645	83.7	430	21.9	53	2.7	7	1 to 19
Tibial/pedal	4,596	20.8	292	8.5	2,423	52.7	3,743	81.5	984	21.4	103	2.2	8	1 to 21
Other	1,036	4.7	31	3.9	768	77.3	907	91.2	324	31.3	41	4.0	2	1 to 7

[1] The other indication for intervention was occlusion

[2] Length of Stay (LOS) among overnight admissions

Figure 3.2 Proportion of endovascular procedures on a planned list during 2016-18, by NHS Trust



VSGBI: PAD QIF

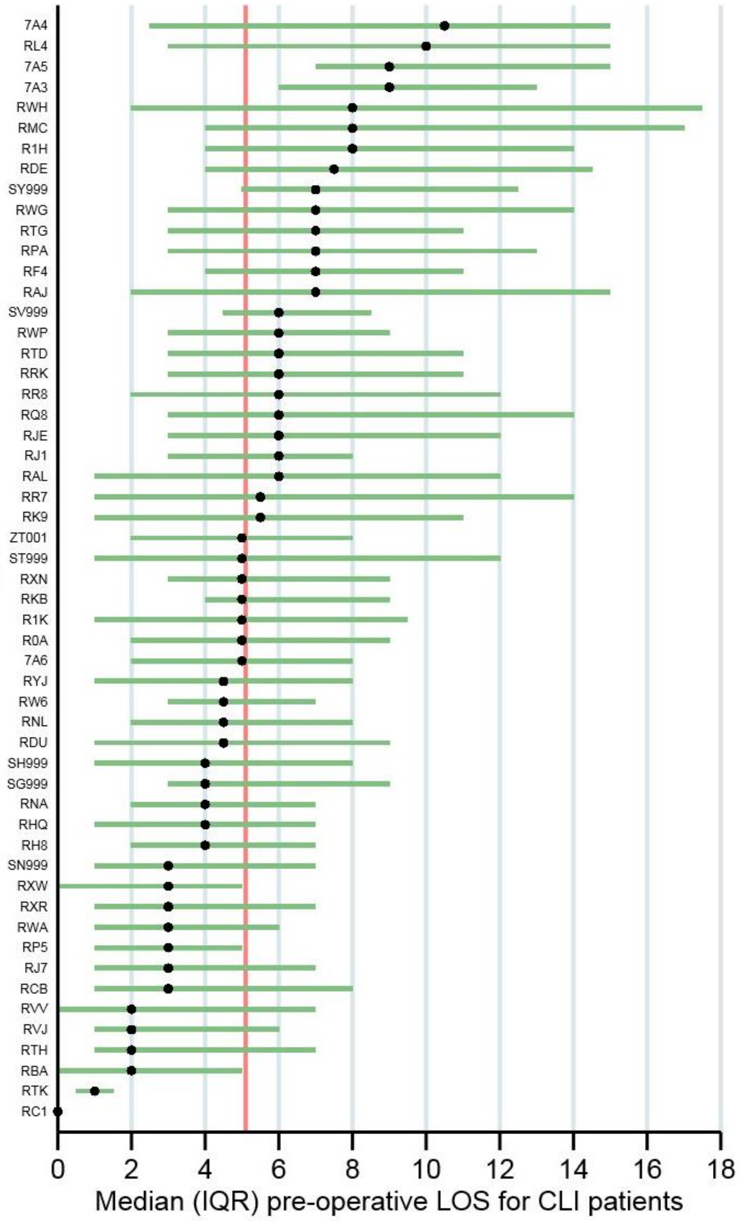
Patients admitted in an emergency with critical limb ischaemia (CLI) should have a revascularisation procedure within five days.

There were 5,197 patients presenting with CLI who underwent emergency endovascular revascularisation during the 2016-18 audit period. Among these, 46% waited for longer than 5 days.

Figure 3.3 summarises the median (IQR) time from admission to revascularisation across 54 NHS Trusts. The red line indicates the 5-day standard. The graph shows that:

- at 25 NHS Trusts, the pathway took more than five days for 50% of patients with CLI
- at 23 NHS Trusts, the pathway took longer than 10 days for 25% of patients.

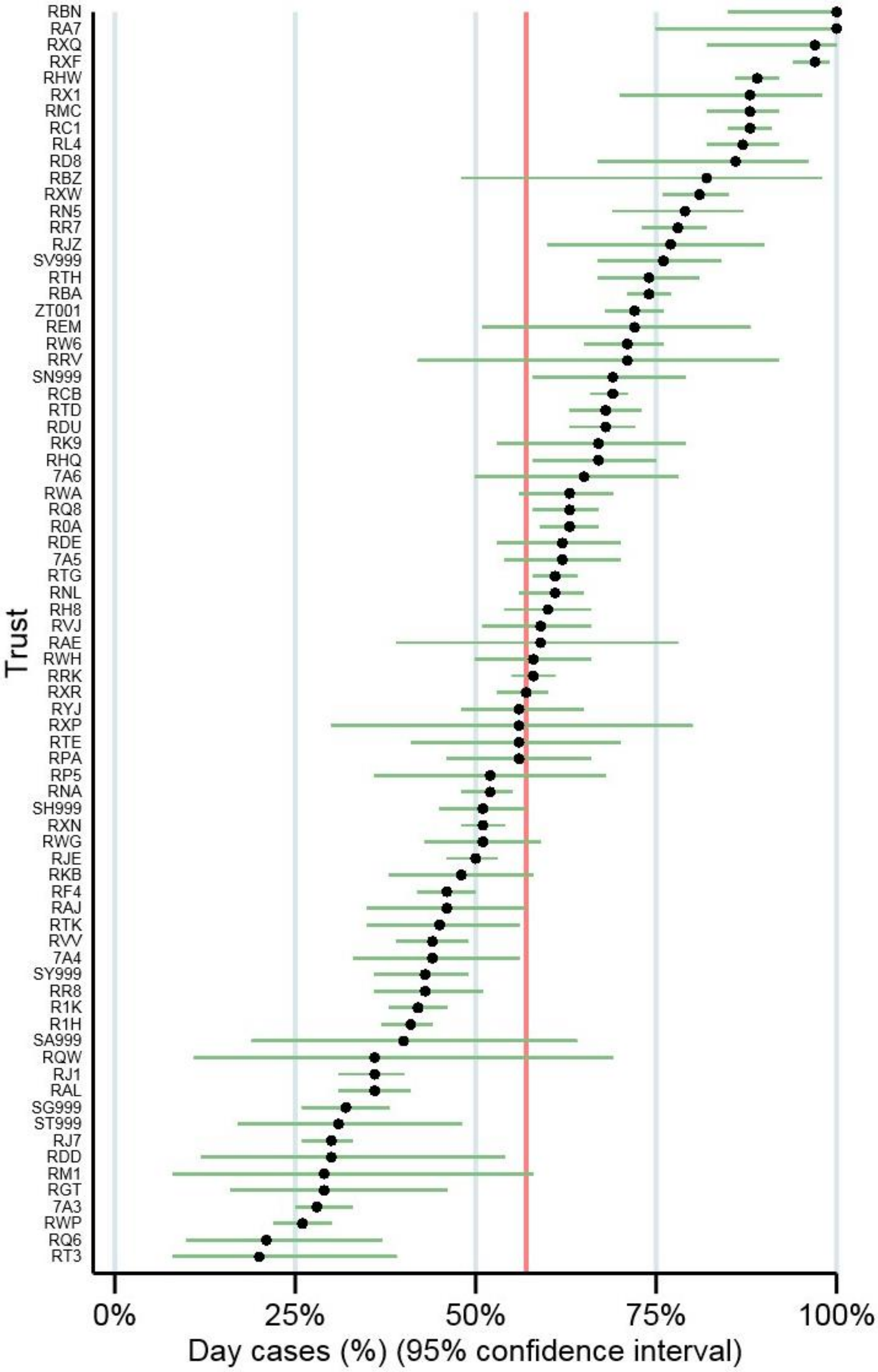
Figure 3.3: Median (IQR) waiting times for patients with CLI undergoing endovascular revascularisation during the 2016-18 audit period, by NHS Trust with a volume of ≥10 cases



The 2018 GIRFT report emphasised the potential improvements in efficiency that could arise if all vascular units were able to achieve a similar number of endovascular revascularisation procedures on a same day basis [Horrocks 2018].

The NVR data for the audit period 2016-18 reveal wide variation in the proportion of procedures done as day cases (Figure 3.4). While the low levels of case-ascertainment limits the interpretation of these figures, it suggests some NHS Trusts could make greater use of same day facilities.

Figure 3.4: Proportion of endovascular procedures performed as day cases, by NHS Trust



3.3 Outcomes of lower limb angioplasty/stents

The majority of endovascular procedures were recorded as successful by the operator. The proportions of successful procedures, by individual NHS Trusts, are shown in Figure 3.5. Encouragingly, over 80% of the procedures were reported as successful in most NHS Trusts.

Table 3.3 describes specific outcomes following endovascular procedures, by mode of admission. As expected, patients undergoing endovascular revascularisation as emergency admissions generally had worse outcomes than those undergoing elective procedures.

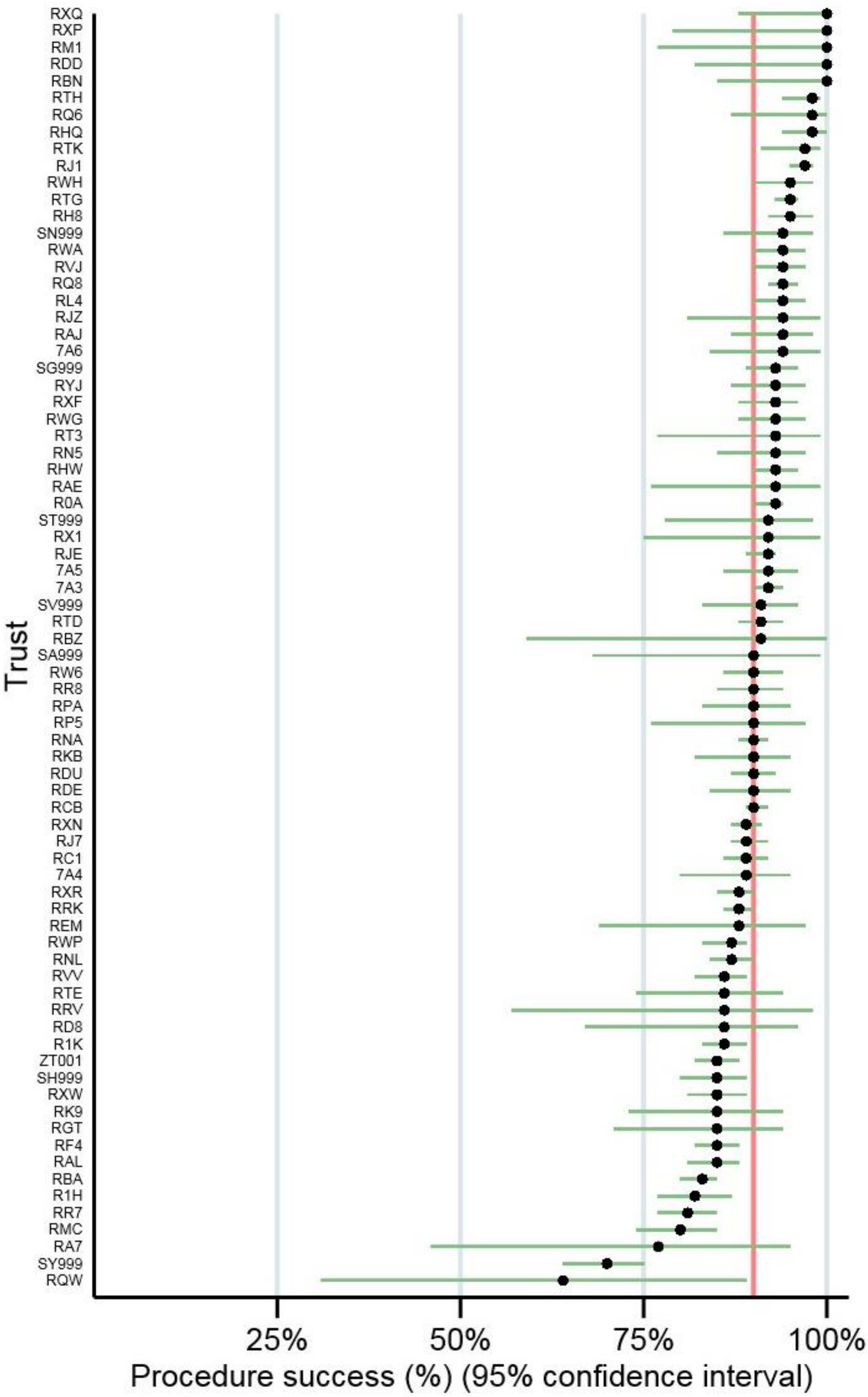
Table 3.3: Postoperative outcomes after endovascular lower limb revascularisation (2016-18), by mode of admission

	Elective		Emergency	
Procedures	15,999		6,110	
Post-op destination[1]				
Ward	8,697	55.1%	5,417	92.2%
Level 2 (HDU/PACU)	399	2.5%	276	4.7%
Level 3 (ICU)	41	0.3%	82	1.4%
Died in theatre	<5	<0.1%	<5	<0.1%
Day case unit	6,643	42.1%	101	1.7%
	Median	**IQR**	**Median**	**IQR**
Overall length of stay (days)	0	0 to 1	13	6 to 27
Pre-operative length of stay (days)	0	0 to 1	5	2 to 10
Post-operative length of stay (days)	0	0 to 1	6	2 to 17
	Rate	**95% CI**	**Rate**	**95% CI**
In-hospital mortality	0.4	0.3 to 0.5	5.0	4.4 to 5.6
Defined complications[1]				
Cardiac	0.5	0.4 to 0.6	2.2	1.8 to 2.6
Respiratory	0.4	0.3 to 0.5	2.5	2.1 to 2.9
Limb ischaemia	0.6	0.5 to 0.7	3.3	2.9 to 3.8
Renal failure	0.2	0.1 to 0.2	1.5	1.2 to 1.9
Haematoma[2]	1.7	1.5 to 1.9	1.3	1.0 to 1.6
None of the above	97.0	96.7 to 97.2	91.3	90.6 to 92.0
Further unplanned lower limb procedure				
None	95.7	95.4 to 96.0	81.0	80.0 to 81.9
Angioplasty without stent	0.8	0.6 to 0.9	3.1	2.7 to 3.6
Angioplasty with stent	0.8	0.6 to 0.9	1.6	1.3 to 2.0
Bypass	0.6	0.5 to 0.7	2.5	2.1 to 2.9
Amputation at any level	1.1	0.9 to 1.2	10.5	9.7 to 11.3
Re-admission to higher level of care	0.8	0.7 to 1.0	2.8	2.4 to 3.3
Re-admission within 30 days	7.6	7.2 to 8.1	17.8	16.7 to 18.8

[1]Post-op destination was missing for 219 elective procedures and 234 emergency procedures.

[2] Rates of haemorrhage, cerebral, false aneurysm, vessel perforation and distal embolus were all below 1% for both elective and emergency procedures.

Figure 3.5: Success rate of endovascular lower limb procedures (defined as successful by the operator), by NHS Trust



Outcomes for patients with CLI undergoing emergency endovascular procedures are summarised in Table 3.4, 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. Nonetheless, we again caution against the over-interpretation of these figures. Further work is required to identify whether the differences are due to the additional time from admission to surgery or from patients having more severe disease, for which outcomes would be expected to be worse on average.

Table 3.4: Post-operative outcomes following endovascular lower limb revascularisation, for patients with CLI undergoing emergency revascularisation[1], by pre-operative length of hospital stay

	Patients with LOS ≤5 days		Patients with LOS >5 days	
	No.		No.	
Total procedures	2,808	54.0%	2,389	46.0%
	Median	**IQR**	**Median**	**IQR**
Days in critical care				
Level 2	1	0 to 2	1	0 to 3
Level 3	2	1 to 3	2	1 to 4
Overall length of stay (LOS)	7	4 to 15	22	13 to 38
Post-operative LOS	5	1 to 13	8	3 to 22
	Rate	**95% CI**	**Rate**	**95% CI**
In-hospital mortality	3.8	3.1 to 4.5	6.6	5.6 to 7.7
No predefined complications	89.8	88.6 to 90.9	86.6	85.1 to 87.9
Further unplanned lower limb procedure				
None	81.9	80.4 to 83.3	80.3	78.7 to 81.9
Amputation at any level	10.1	9.1 to 11.3	12.9	11.6 to 14.3

[1] Fontaine score 3 or 4

3.4 Risk-adjusted in-hospital deaths

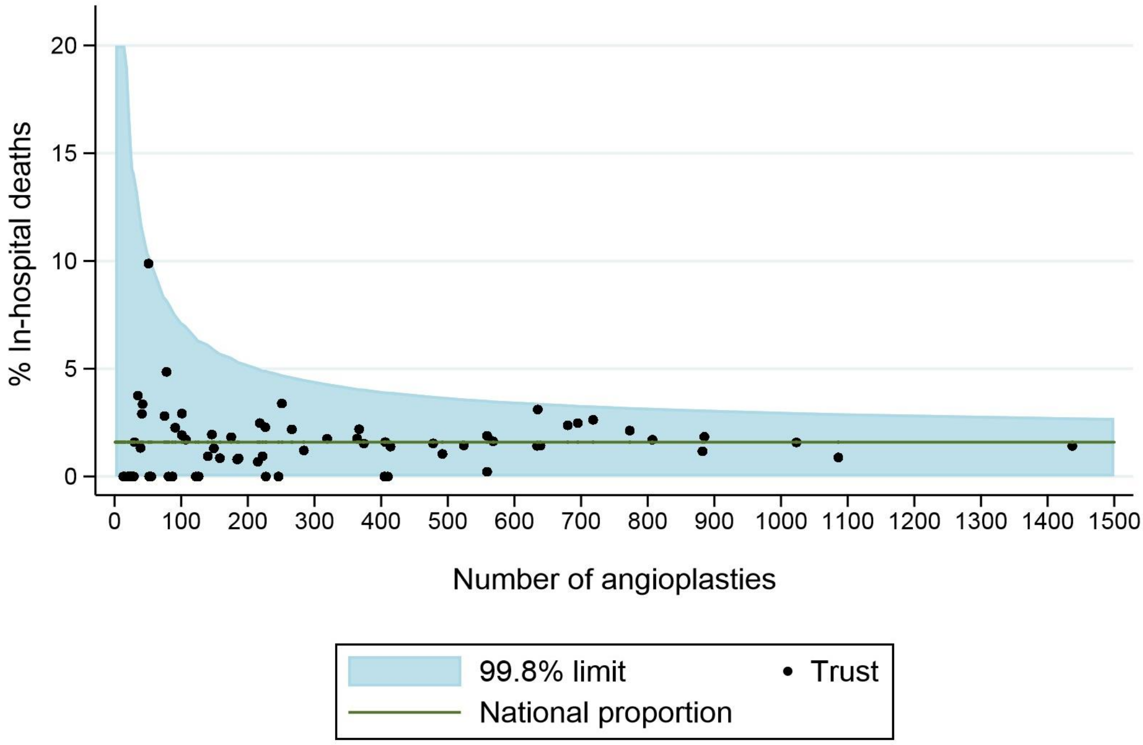
Figure 3.6 shows the funnel plot of risk-adjusted mortality rates for each NHS Trust that performed endovascular revascularisations between January 2016 and December 2018. As the numbers of procedures submitted by some organisations were small (and many NHS Trusts had low case-ascertainment), the rates are only shown for the NHS Trusts with at least 10 procedures and an estimated case-ascertainment of 20% or more.

All NHS Trusts had a risk-adjusted rate of in-hospital mortality that fell within the expected range of the overall national average of 1.6% (95% CI: 1.4 to 1.8)

The rates of in-hospital death after endovascular revascularisation were adjusted to take account of the differences in patient populations within each organisation. Separate risk adjustment models were used for elective and emergency cases. For emergency cases, the adjustment model included patient age, Fontaine score at admission (1-2 vs. 3-4), chronic heart failure and chronic renal disease as comorbidities.

The model for elective cases included patient age, Fontaine score at admission (1-2 vs. 3-4), chronic lung disease, chronic renal disease and chronic heart failure.

Figure 3.6: 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 endovacsular revascularisation, with at least 10 procedures in the NVR and a case-ascertaintment of at least 20%.

4. Major lower limb amputation

4.1 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 2016 to December 2018. Over these three-years, 9,508 major unilateral amputations were recorded in the NVR (Table 4.1). The recorded procedures comprised 4,983 (52.4%) below the knee amputations (BKAs) and 4,525 (47.6%) above the knee amputations (AKAs). In this chapter, through knee amputations (TKAs) have been analysed as part of the BKA group. TKAs accounted for approximately 4% of all major amputations recorded on the NVR during the three-year analysis period.

The chapter excludes the small number of major amputations due to trauma (n=140, 1.0% of all amputations within the NVR in 2016-2018). Bilateral amputations (n=253) and amputations associated with a bypass (n=496) have also been excluded from the main analyses.

Estimates of case-ascertainment for major lower limb amputations, based on comparisons with routinely collected hospital datasets, are show in Table 4.1. Overall levels of case-ascertainment are around 70% for the 2016-18 audit period, which is an improvement on levels reported in previous Annual Reports. Nonetheless, the level remains below the target figure of 85% recommended within the 2018 GIRFT vascular surgery report [Horrocks 2018] and many NHS Trusts are still failing to record a large proportion of their major lower limb amputations in the NVR.

Table 4.1: Estimated case-ascertainment for all vascular amputations by year

Case-ascertainment	**2016**	**2017**	**2018**
Audit procedures	3,198	3,185	3,125
Expected procedures	4,876	4,551	4,202
Estimated case-ascertainment	66%	70%	74%

4.2 Care pathways

Most patients undergoing a major lower limb amputation were men, with tissue loss being the most common presenting problem for both above-knee and below knee procedures (AKA = 36.0% / BKA = 38.7%). Over half of patients had undergone a previous ipsilateral lower limb procedure.

Few patients did not suffer from one or more comorbid conditions, the most common being 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).

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.

The overall median time from vascular assessment to amputation was 8 days (IQR: 3 to 26 days). Among patients undergoing amputations as elective procedures, the median time was 30 days (IQR: 8 to 82 days), whereas among patients having emergency amputation, the median was 7 days (IQR: 2 to 18 days).

Figure 4.2 describes the times from vascular assessment to amputation by NHS Trust for patients admitted as an emergency. The graph shows some variation across the NHS Trusts in the median wait but there was considerably greater variation across trusts in the 25% of patients who have the longest waits. At 11 NHS Trusts, 25% of patients had a wait that exceeded 30 days.

NHS vascular units have to balance the urgency of surgery with the need to optimise the patient's condition before surgery. This can lead to variation in the waiting times of individual patients. Nonetheless, vascular units should, as much as possible, attempt to reduce the longer times that patients wait for their operation.

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 4.3. Nationally, over the three-year data collection period, the AKA:BKA ratio was 0.91. Most of the NHS Trusts had a ratio of less than one, but 11 organisations had ratios that exceeded 1.5 (with a 95% confidence interval that did not contain the recommended limit of 1). It should be noted that the estimated ratios were not adjusted for differences case-mix at these NHS Trusts, so it is possible that the high ratios relate to some trusts treating more severely ill patients.

Figure 4.2: Median (IQR) time from vascular assessment to emergency amputation for procedures performed between 2016 and 2018, by NHS Trust

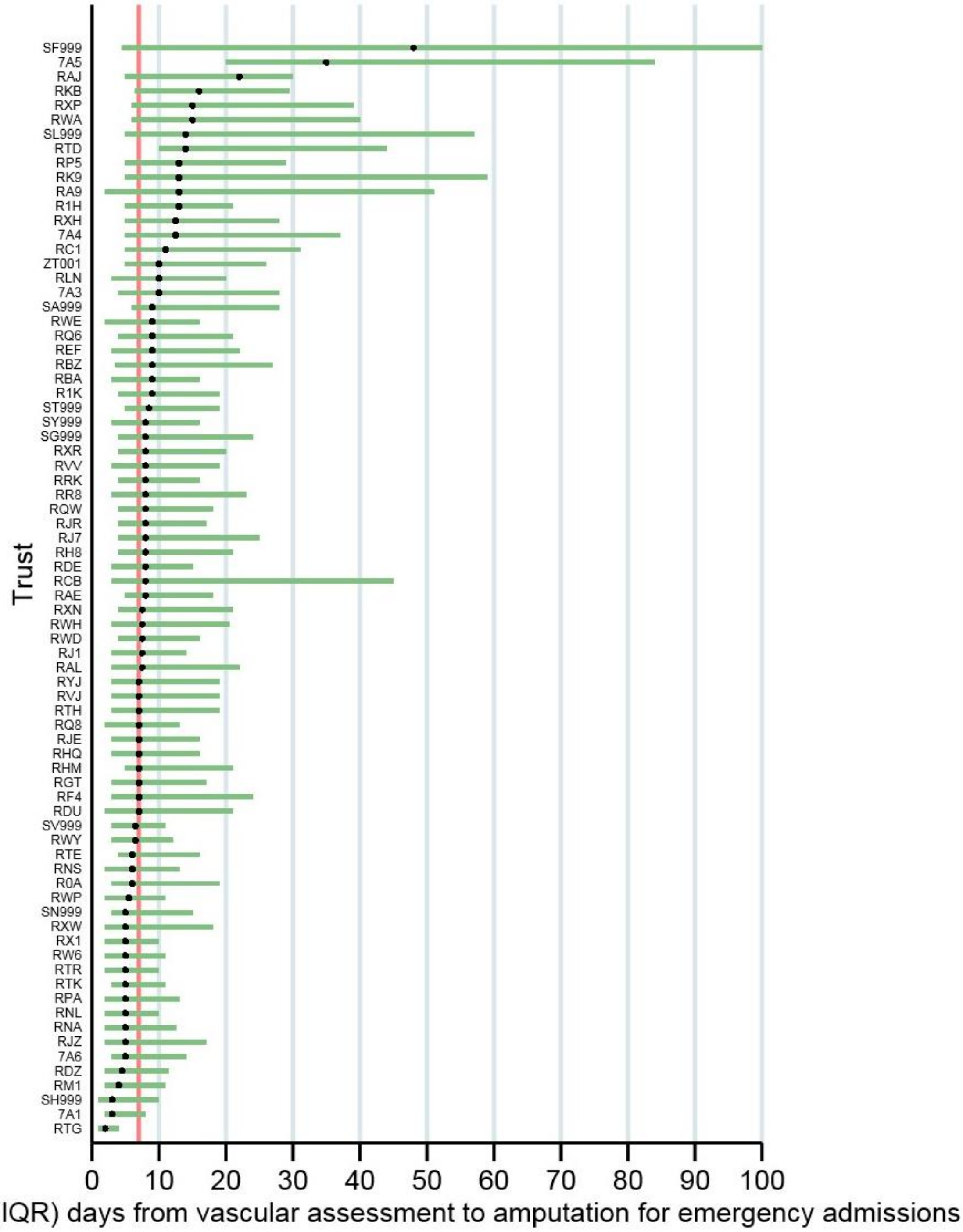
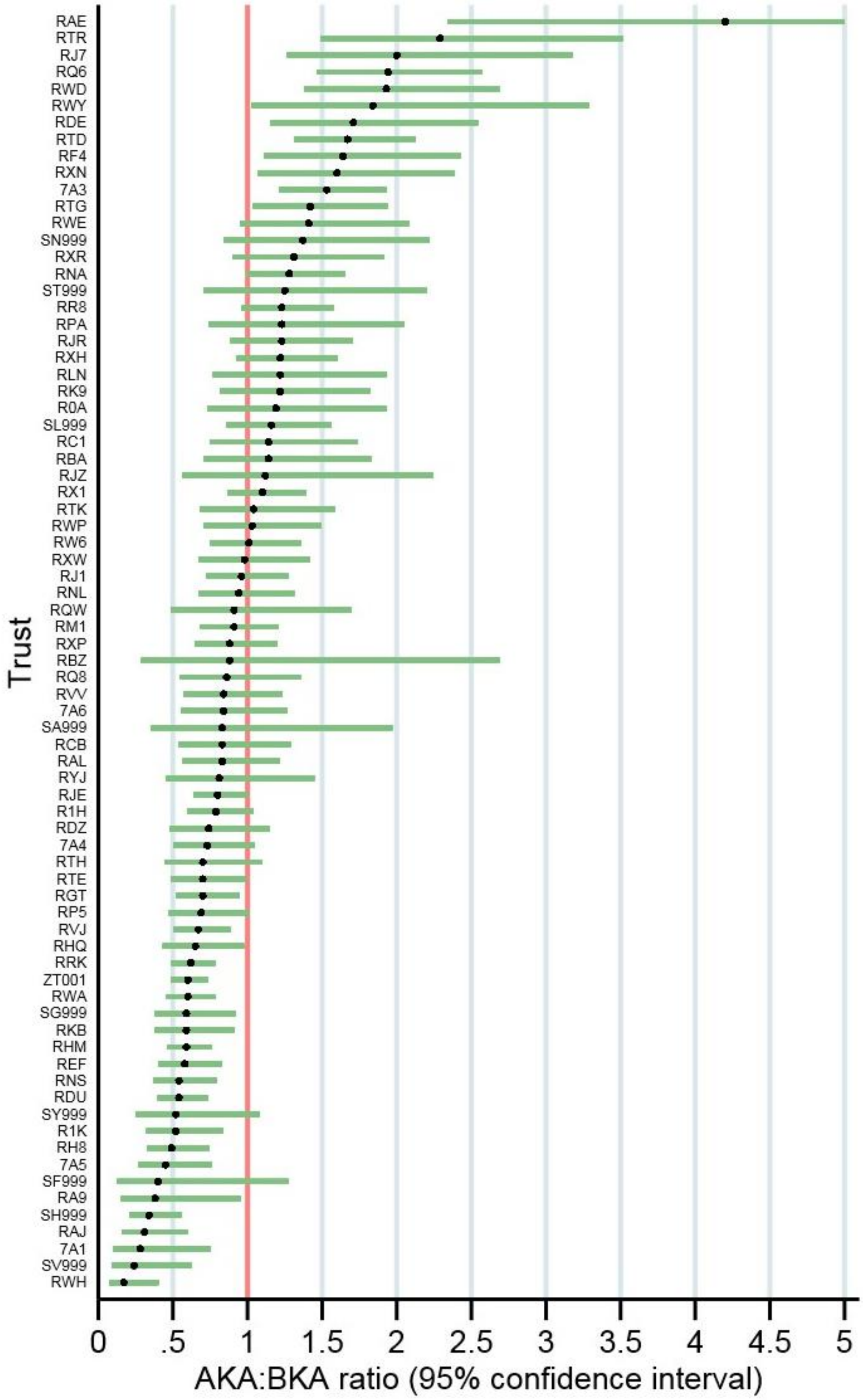


Figure 4.3: Ratio of above knee to below knee amputations for procedures performed between 2016 and 2018, by NHS Trust[1]



[1] These estimates based on data from NHS Trusts reporting at least 10 amputations over the study 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.

Table 4.2 provides an overview of how NHS vascular units are delivering perioperative care for BKA and AKA patients. The figures suggest that the above standards of care were not always met during the 2016-18 period:

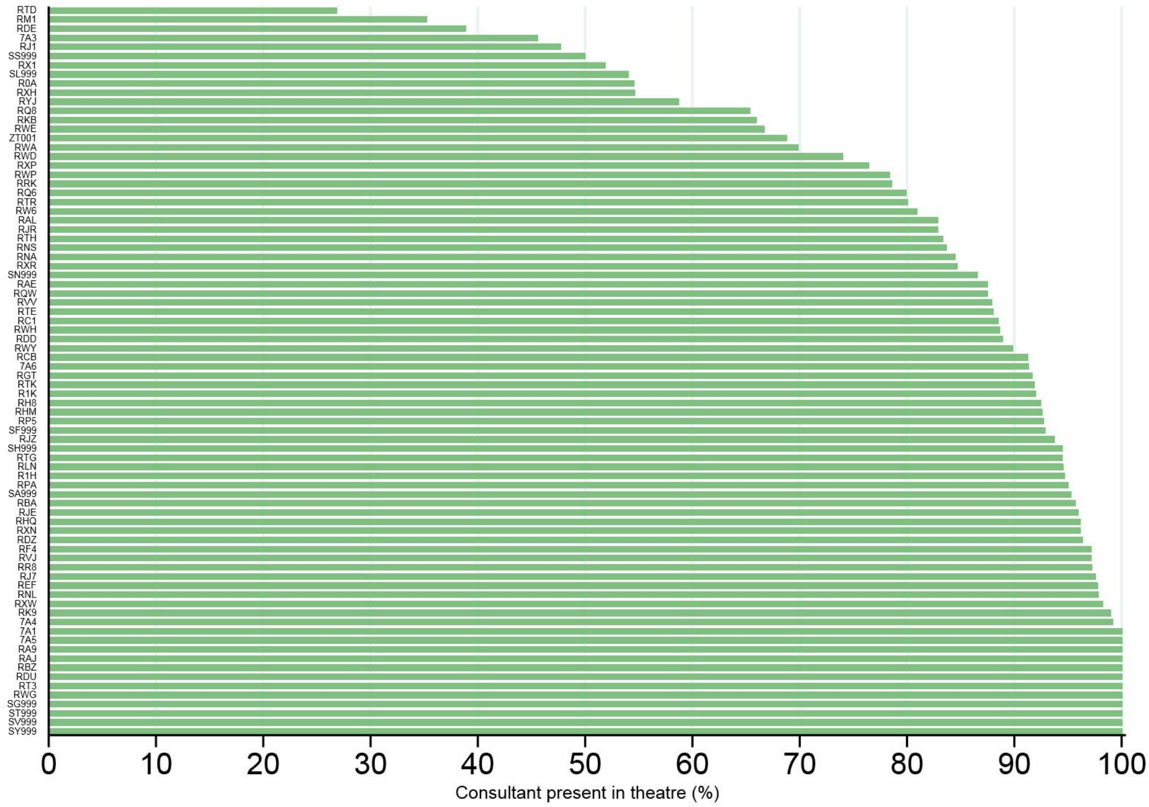
- a large proportion of amputations were performed as emergency rather than elective procedures
- over 80% of major amputations (BKAs and AKAs) were performed during the day
- a consultant surgeon was present for three-quarters of the procedures
- prophylactic antibiotics and DVT medication were used for only 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 4.4). Vascular units should investigate the reasons for this variation.

Table 4.2: Perioperative care of patients undergoing lower limb amputation during the 2016-18 period

	Below knee	%	Above knee	%
Procedures	4,983		4,525	
Mode of admission				
Elective	1,275	25.6	797	17.6
Emergency	3,708	74.4	3,728	82.4
Time procedure started				
8am to 6pm	4,337	87.1	3,775	83.5
6pm to midnight	556	11.2	616	13.6
Midnight to 8am	84	1.7	130	2.9
Consultant present in theatre	4,078	81.9	3,476	77.0
Prophylactic medication				
Antibiotic prophylaxis	3,367	67.6	3,048	67.4
DVT prophylaxis	3,299	66.2	2,892	63.9

Figure 4.4: Percentage of amputations where a consultant surgeon was present in theatre during the 2016-18 period, by NHS Trust



In addition, it seems doubtful that 40% of patients did not receive antibiotic prophylaxis and we recommend that units ensure the information on prophylaxis is accurately recorded in the NVR.

Curiously, the observed variation in perioperative care was not obviously related to the severity of the patient's disease. For example, the proportion of procedures where a consultant was present in theatre was not related to the ASA severity assessment (consultant presence = 79% for ASA grades 1-3 and 81% for ASA grades 4-5).

4.3 In-hospital outcomes following major amputation

Patient outcomes immediately following major lower limb amputation are summarised in Table 4.3.

Overall, most patients were returned to the ward following amputation, although approximately 13% of BKA patients and 24% of AKA patients were admitted to critical care (level 2 or level 3). The overall median length of hospital stay associated with major amputations was 22 days (IQR: 13 to 39 days).

Around 1 in 5 patients suffered a complication after major amputation:

- respiratory problems occurred in 5.9% of BKAs and 10.7% of AKAs
- cardiac complications were also common, occurring in 3.8% of BKA patients and 6.6% of AKA patients
- for 2018, 0.8% of BKAs and 1.3% of AKAs resulted in post-operative confusion
- 1.8% had surgical site infection for BKAs and 2.0% for AKAs in 2018.

Rates of return to theatre within the admission were 10.7% for BKA and 7.6% for AKA patients. Most patients were discharged alive, but 4.7% of BKA patients and 11.0% of AKA patients died in hospital.

Table 4.3: Patient outcomes following major lower limb amputation, by amputation level

	Below knee		Above knee	
Procedures	4,983		4,525	
Post-op destination				
Ward	4,370	87.7%	3,483	77.0%
Level 2 (HDU/PACU)	486	9.8%	710	15.7%
Level 3 (ICU)	126	2.5%	330	7.3%
	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	2 to 7	3	2 to 7
Overall length of stay (days)	23	14 to 40	22	13 to 39
Post-operative length of stay (days)	15	9 to 27	15	8 to 27
	Rate	**95% CI**	**Rate**	**95% CI**
Overall in-hospital mortality	4.7	4.1 to 5.3	11.0	10.1 to 12.0
30-day in-hospital mortality	2.3	1.9 to 2.7	7.6	6.8 to 8.4
Procedure complications				
Cardiac	3.8	3.3 to 4.3	6.6	5.9 to 7.4
Respiratory	5.9	5.3 to 6.6	10.7	9.8 to 11.6
Haemorrhage	0.6	0.4 to 0.9	0.7	0.5 to 1.0
Limb ischaemia	3.9	3.4 to 4.4	3.3	2.8 to 3.8
Renal failure	3.1	2.6 to 3.6	4.2	3.6 to 4.8
Cerebral	0.6	0.4 to 0.8	0.7	0.5 to 1.0
None of the above	85.3	84.3 to 86.3	80.4	79.2 to 81.6
Return to theatre	10.7	9.8 to 11.7	7.6	6.8 to 8.5
Re-admission to higher level care	2.9	2.4 to 3.4	3.1	2.6 to 3.6

Table 4.4 summarises immediate patient outcomes following major lower limb amputation, by the time spent waiting in hospital for the procedure. 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 4.4: Patient outcomes following major lower limb amputation, by time to surgery

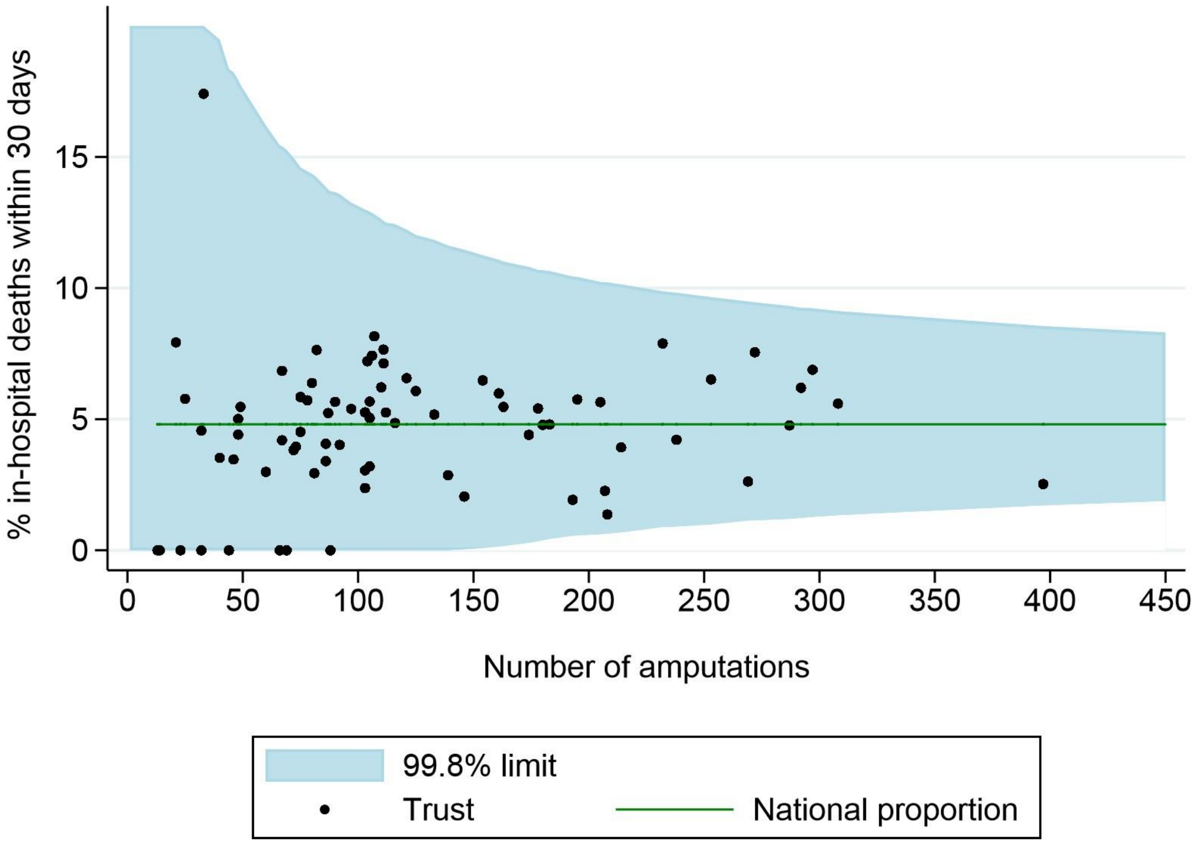
	Patients with LOS ≤5 days		**Patients with LOS >5 days**	
	No.		**No.**	
Procedures	5,353		4,155	
	Median	**IQR**	**Median**	**IQR**
Days in critical care				
Level 2	2	1 to 4	2	1 to 4
Level 3	3	2 to 6	4	2 to 10
Overall length of stay (days)	15	10 to 26	34	22 to 52
Post-operative length of stay (days)	13	8 to 24	17	10 to 30
	Rate	**95% CI**	**Rate**	**95% CI**
Overall in-hospital mortality	7.2	6.5 to 8.0	8.3	7.5 to 9.2
30-day in-hospital mortality	5.9	5.3 to 6.5	3.4	2.9 to 4.0
No defined complications	82.7	81.7 to 83.8	79.8	78.5 to 81.0
Return to theatre	8.5	7.7 to 9.3	10.2	9.2 to 11.3
Re-admission to higher level care	2.7	2.3 to 3.2	3.3	2.7 to 3.8

Adjusted 30-day in-hospital mortality figures following major unilateral lower limb amputation for NHS Trusts are shown in Figure 4.5. All NHS Trusts had an adjusted rate that fell within the 99.8% control limits.

For elective cases, the rates were adjusted for ASA grade (1-3 vs 4-5), level of amputation (below or above the knee) and the presence of comorbid chronic renal disease; for emergency cases, the rates were adjusted for ASA grade (1-3 vs 4-5), amputation level and the presence of chronic lung disease, ischaemic heart disease and chronic renal disease.

The overall rate of in-hospital death in AKA and BKA patients analysed together was 7.7% (95% CI: 7.1 to 8.3) and the 30-day in-hospital mortality was 4.8% (95% CI: 4.4 to 5.3; figure 4.6).

Figure 4.5: Risk-adjusted 30-day in-hospital death rate following major amputation for the audit period 2016-18, shown in comparison to the overall national average of 4.8%



Note to Figure 4.6: this figure is based on data from trusts with ≥ 10 amputations.

4.4 Discharge and follow-up

Discharge and follow-up of patients undergoing lower limb amputations, among patients discharged alive, are summarised in Table 4.5. Most patients' wounds had healed by 30 days. About two-thirds of all major amputation patients were referred to rehabilitation units or limb fitting centres. Approximately 1 in 10 patients were readmitted to hospital within 30 days of discharge.

Table 4.5: Discharge and follow-up of patients undergoing lower limb amputations, among patients discharged alive

	Below knee	%	Above knee	%
Alive at discharge	4,750	95.3	4,026	89.0
Wound healed at discharge	2,754	69.3	2,422	72.5
Wound healed at 30 days**	3,857	85.4	2,788	73.4
Referred to rehabilitation/limb fitting*	1,755	79.1	1,378	87.1
Re-admission within 30 days**	307	10.8	177	8.3

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

5. Carotid Endarterectomy

5.1 Background

In the UK, around 4,000-5,000 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.

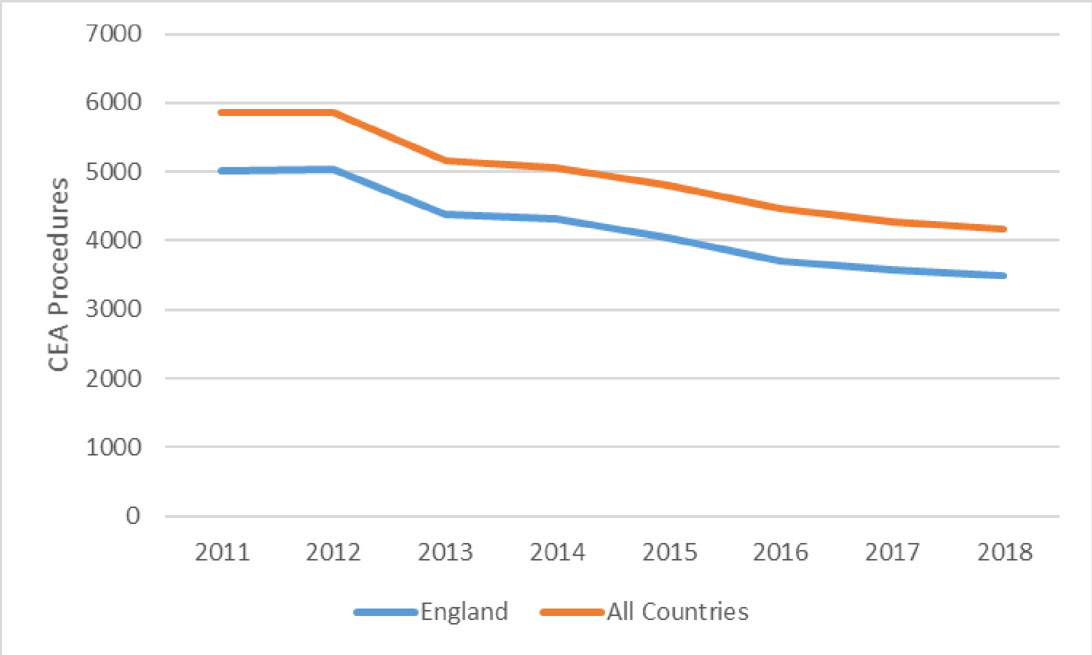
The information in this report primarily concerns the carotid procedures performed between 1 January 2018 and 31 December 2018 within NHS hospitals, and the NVR continues to achieve consistently high levels of case-ascertainment (Table 5.1). The 2018 estimated case-ascertainment figures for the four nations were: 95% for England, 93% for Northern Ireland, 93% for Scotland and 100% for Wales.

The number of procedures reported to the NVR in 2018 was similar to the previous year (Figure 5.1) but follows a period of reducing activity which is mainly attributed to a fall in the number of procedures undertaken in England. The decline has occurred in both symptomatic and asymptomatic patients. The causes contributing to these changes are currently unclear but it might reflect a change in the epidemiology of risk factors for stroke. The degree of change has not been uniform across all regions within England [Johal et al 2019].

Table 5.1: Estimated case-ascertainment of carotid endarterectomy in the UK

	2016	2017	2018	Total
Audit procedures	4,473	4,274	4,178	12,925
Expected procedures	4,830	4,661	4,358	13,849
Estimated case-ascertainment	93%	92%	96%	93%

Figure 5.1: Number of carotid endarterectomies performed within the NHS between 2011 and 2018



5.2 Treatment pathways

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

- There were 3,902 patients (93.4%) with symptomatic disease. TIA was the most common symptom (45.4%) followed by stroke (38.6%)
- Nearly three-quarters of patients had at least 70% stenosis in their ipsilateral carotid artery at the time of operation
- Only 1.0% of patients had a previous ipsilateral treatment
- Medication for cardiovascular conditions was common among patients prior to surgery. Overall, 83.0% were on antiplatelet medication, while 88.7% were taking statins.

Patients may be referred for carotid endarterectomy from various medical practitioners. In 2018, the most common source of referral was the stroke physician (84.5%), followed by vascular surgeons (3.8%), neurologists (3.2%), and general practitioners (2.8%).

VSGBI Provision of services

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

In 2018, there were 25 out of the 78 active vascular units that did not perform at least 40 CEA. This might be a consequence of the falling activity observed since 2011. Assuming the trend is not going to reverse, further reconfiguration of vascular services may be required within regions.

NICE guideline (CG68)

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 2018 was 12 days (IQR 7-23). For the three distinct phases within this pathway, the median time delays were:

- 4 days (IQR 1-9) from symptom to first medical referral
- 1 day (IQR 0-5) from first medical referral to being seen by the vascular team, and
- 5 days (IQR 2-10) from being seen by the vascular team to undergoing CEA.

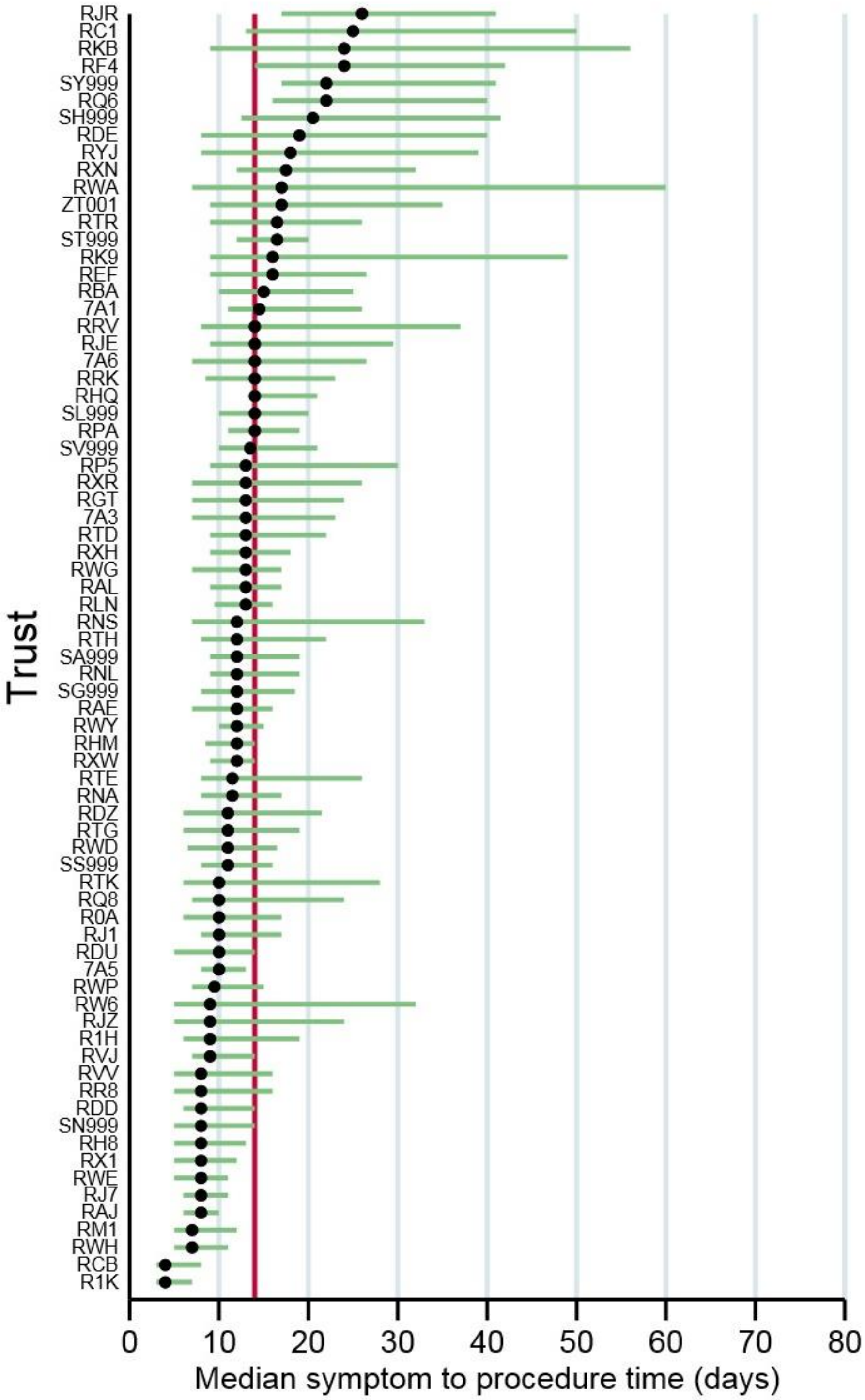
The distribution of symptom to operation times for all NHS Trusts is summarised in Figure 5.2. The graph contains figures for all organisations that performed 10 or more procedures for symptomatic cases with known symptom and procedure dates. The NICE guidance standard of 14 days is included on the graph as a vertical red line.

Figure 5.2 shows that there was considerable variation among NHS Trusts in the median time to surgery during 2018:

- 56 of the 74 NHS organisations had a median time of 14 days or less
- the median exceeded 20 days for 7 vascular units, less than half of organisations found for 2016.

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

Figure 5.2: Median time (and interquartile range) from symptom to procedure by NHS Trust for procedures done between January and December 2018



5.3 Outcomes after carotid endarterectomy

Patients may experience various complications following carotid endarterectomy. The rate of post-operative 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 13,000 procedures performed in NHS hospitals between 2016 and 2018 are summarised in Table 5.2. 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 rate of return to theatre was 2.6% (95% CI 2.4 to 2.9), and
- the rate of readmission within 30 days was 4.4% (95% CI 4.1 to 4.8).

Table 5.2: Postoperative outcomes following carotid endarterectomy

Complication	Procedures in 2016-2018	Complication rate (%)	95% confidence interval
Death and/or stroke within 30 days	12,925	2.0	1.8-2.3
Stroke within 30 days	12,925	1.7	1.5-2.0
Bleeding within admission	12,924	2.3	2.0-2.6
Myocardial Infarct within admission	12,924	1.2	1.0-1.4
Cranial nerve injury within admission	12,924	2.0	1.8-2.3

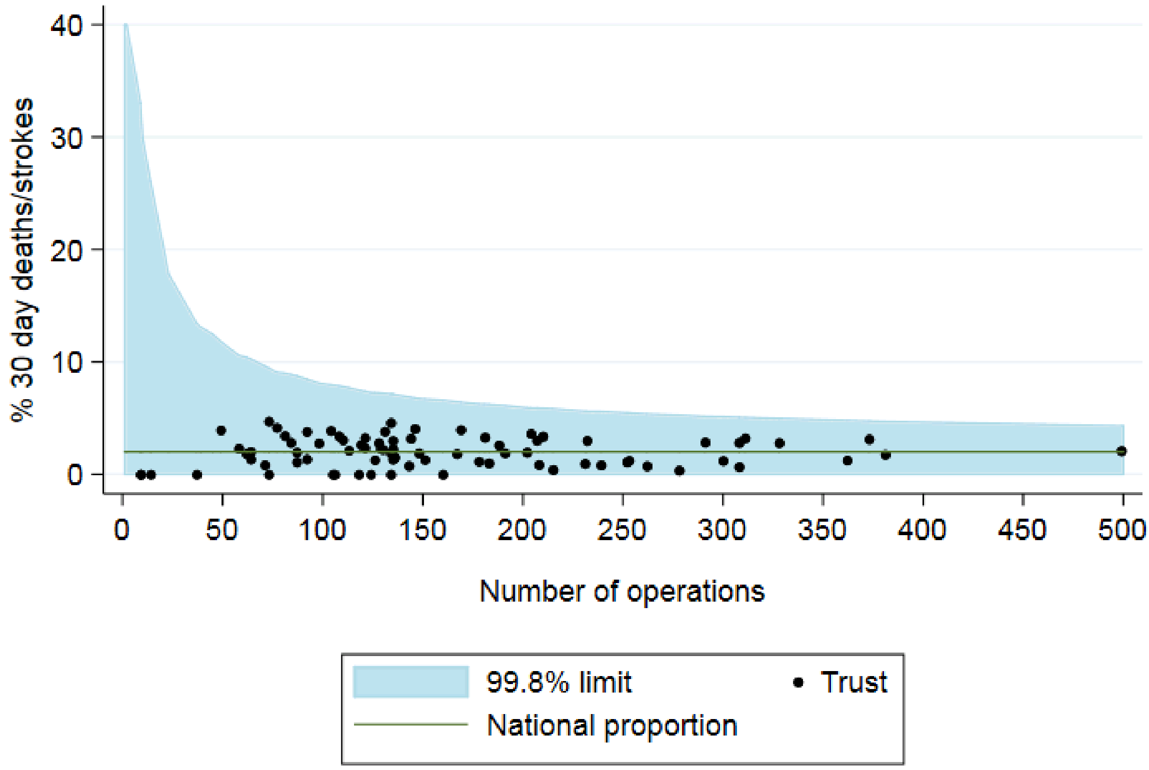
5.4 Rates of stroke/death within 30 days among NHS Trusts

The primary measure of safety after carotid endarterectomy is widely accepted to be 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 5.3. All NHS organisations were all within the expected distance of the overall national average rate of 2.0% (i.e., they were within the 99.8% control limits).

The online appendices spreadsheet gives the figures for each organisation*.

The 30-day death/stroke rates were risk adjusted to account for differences in the characteristics of patients treated at the various organisations. The risk adjustment model took into account the patient age, sex, whether they had diabetes or hypertension, and their preoperative Rankin score and ASA grade.

Figure 5.3: Funnel plot of risk-adjusted rates of stroke/death within 30 days for NHS Trusts, for carotid endarterectomies between January 2016 and December 2018



The overall national average rate of stroke/death within 30 days = 2.0%

*The online appendices spreadsheet can be found at: https://www.vsqip.org.uk/reports/2019-annual-report/

6. Repair of infra-renal abdominal aortic aneurysm

6.1 Background

The audit period from 1 January 2016 to 31 December 2018 covered in the 2019 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 82 in 2016 to 77 in 2018. There was also a fall in the number of elective infra-renal AAA repairs performed, with 3,708 procedures in 2018 compared with 4,272 in 2017 (Table 6.1).

The estimated 2018 case-ascertainment figures for the four nations were: 90% for England, 98% for Wales, 100% for Northern Ireland and 79% for Scotland. The overall case-ascertainment has remained around 90% over the last three years (Table 6.1).

The fall in the volume of AAA repairs coincided with a drop in the number of endovascular (EVAR) procedures, decreasing to 63% of the elective infra-renal AAA repairs in 2018 compared to 68% in 2017. There was no corresponding increase in the number of patients having an open repair, and this could indicate a more conservative approach to the management of sicker patients. Practice may also have been influenced by the draft NICE AAA guideline published in May 2018.

There were small differences in the characteristics of patients who had EVAR and those who had open procedures (see Appendix 3), with patients undergoing EVAR procedures 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.

Table 6.1: Estimated case-ascertainment of elective infra-renal AAA repairs**

	2016	2017	2018	Total
Audit procedures	4,276	4,272	3,708	12,256
Expected procedures	4,812	4,668	4,017	13,497
Estimated case-ascertainment	89%	92%	92%	91%

**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. Thus, the case-ascertainment rates shown above may be an underestimate for those NHS Trusts that carry out complex EVAR procedures.

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 93.7% of procedures
- the median proximal aortic neck diameter and length were 24 mm (IQR 21 to 26) and 24 mm (IQR 18 to 31), respectively
- there were 373 (16.6%) procedures that unilaterally extended into the iliac artery and 106 (4.7%) procedures required bilateral limb extensions.

Among the open repairs, the most common type of repair was with a straight 'tube' graft (63.7%), followed by a bifurcated graft (36.1%).

6.2 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 6.2 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 pathway recommendations but there is potential for greater improvement particularly in relation to the proportion of patients who:

- had pre-operative CT/MR angiography (89.3% in 2018) and
- were discussed at an MDT meeting (82.0%).

The figures 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 6.2: Overall compliance with standards related to the elective AAA care pathway

	Percentage of patients meeting standard		
	2018	2017	2016
Elective patients were discussed at MDT meetings	82.0 3,040/3,708	83.0	78.3
Patients with an AAA diameter ≥ 5.5cm deemed suitable for repair had a pre-operative CT/MR angiography assessment	89.3 2,968/3,323	89.1	84.9
Patients underwent a formal anaesthetic review	95.4 3,536/3,708	96.3	96.6
Patients whose anaesthetic review was done by a consultant vascular anaesthetist	91.3 3,229/3,536	91.6	91.9
Patients had their fitness measured	85.5 3,166/3,702	84.7	83.9
Most common assessment methods:			
CPET	51.1	49.1	47.1
Echocardiogram	42.5	43.5	45.6

National AAA Screening Programme

The National screening programme recommends a target of 8 weeks from the date of referral from the NAAASP to the date of the repair.

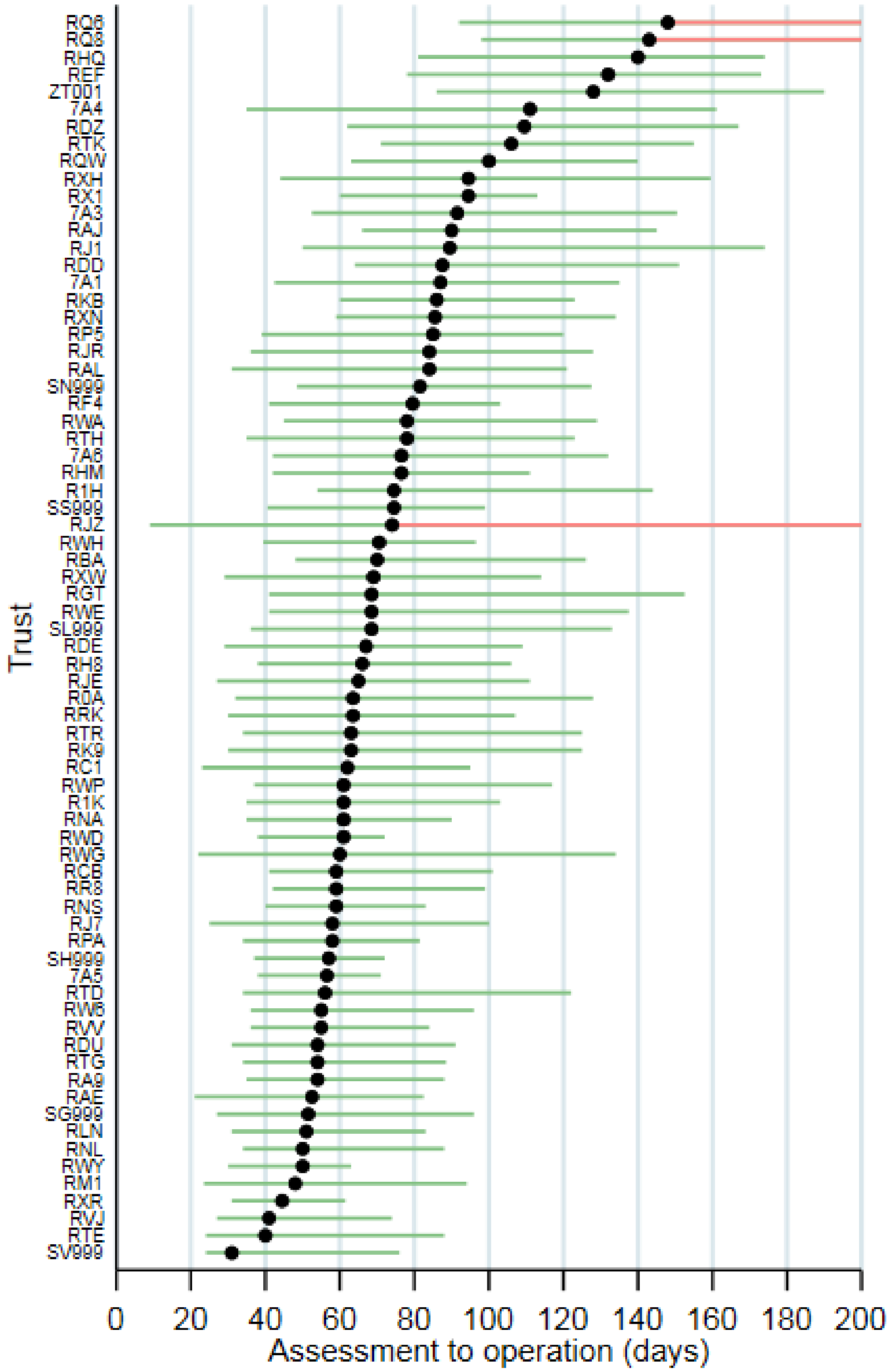
The National AAA Screening Programme has emphasised the importance of the timely scheduling of an elective repair to mitigate the risk of a patient's AAA rupturing while waiting for treatment [NAAASP 2009]. Although the standard was set for patients referred from the screening programme, the time from vascular assessment to surgery covers an important component of the care pathway and is relevant to all patients requiring AAA repair.

Figure 6.1 (overleaf) summarises the variation among NHS Trusts in the median (IQR) time from vascular assessment to surgery for procedures performed in 2018. The graph contains figures for 72 organisations that had 10 or more infra-renal AAA repairs with assessment and procedure dates.

The median delay at the majority of vascular units tended to fall within the range of 60 to 90 days. Nonetheless, at 22% of the vascular units (16 of 72), 25% of patients operated on in 2018 waited more than 140 days. There are legitimate reasons for some patients to 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 by a significant amount (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 6.1: Median (IQR) time from assessment to treatment (days) for patients who had elective infra-renal AAA repair between January and December 2018



6.3 Postoperative outcomes after elective infra-renal AAA repair

The patterns of postoperative care are described in Table 6.3, which highlights some notable differences between patients having open and EVAR procedures.

- For EVAR procedures, over 60% of patients were returned 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, 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 3.2% (95% CI 2.3 to 4.2).

Table 6.3: Postoperative details of elective infra-renal AAA repairs undertaken between January and December 2018

		Open repair (n=1,358)		EVAR (n=2,350)	
Admitted to	Ward	2.3%		61.9%	
	Level 2	61.0%		35.0%	
	Level 3	36.5%		3.1%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	2	2 to 4	1	0 to 1
	Level 3	2	1 to 3	1	1 to 2
Hospital length of stay (days)		7	6 to 9	2	1 to 3
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		3.2	2.3 to 4.2	0.4	0.2 to 0.8
Defined complications					
	Cardiac	4.3	3.3 to 5.5	1.1	0.8 to 1.7
	Respiratory	9.9	8.3 to 11.6	1.7	1.2 to 2.3
	Haemorrhage	1.5	1.0 to 2.4	0.7	0.4 to 1.2
	Limb ischaemia	3.2	2.4 to 4.3	1.2	0.8 to 1.7
	Renal failure	4.5	3.5 to 5.7	0.9	0.6 to 1.4
	Other	4.7	3.7 to 6.0	1.4	1.0 to 2.0
	None of predefined complications	78.5	76.2 to 80.6	93.8	92.7 to 94.7
Return to theatre		6.1	4.9 to 7.5	1.9	1.4 to 2.5
Readmission within 30 days		5.6	4.3 to 7.0	5.4	4.4 to 6.4

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 potentially more serious and generally require intervention. Among the EVAR procedures performed in 2018:

- 1,902 (82.2%) procedures experienced no endoleak while the patient was in hospital
- 128 (5.5%) procedures experienced a type 1 endoleak
- 154 endoleaks (of any type) required intervention at the time of the procedure.

6.4 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 2016 to 31 December 2018. A 3-year 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 6.2. 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 6.3A and 6.3B 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 2016 and 2018 were 3.1% and 0.5%, respectively.

Figure 6.2: Risk-adjusted in-hospital mortality rates after elective infra-renal AAA repair among NHS vascular units for procedures performed between January 2016 and December 2018. The overall in-hospital mortality rate was 1.4%.

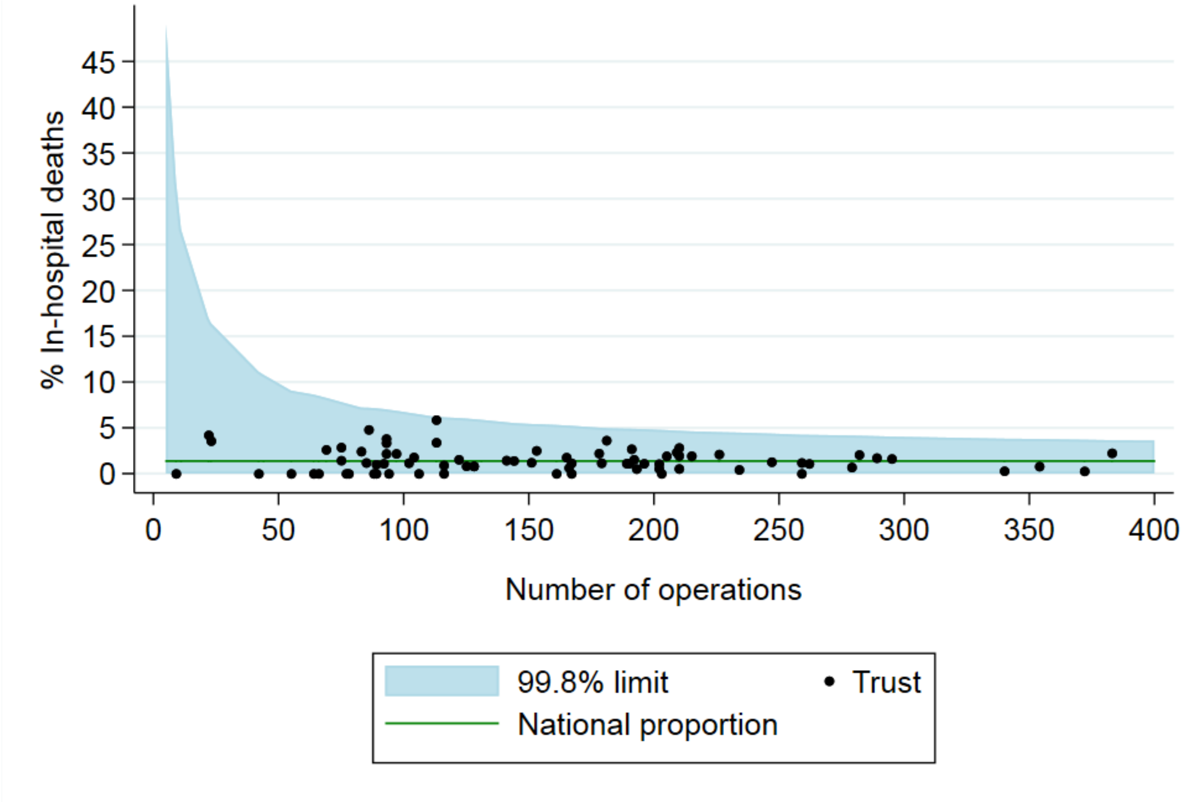
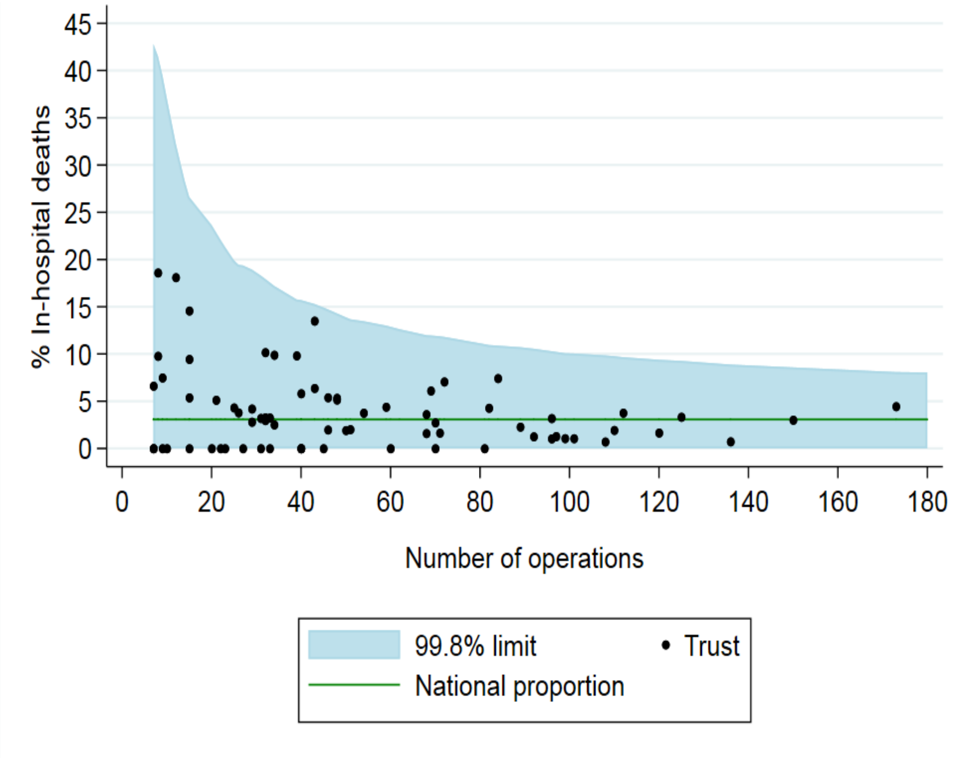
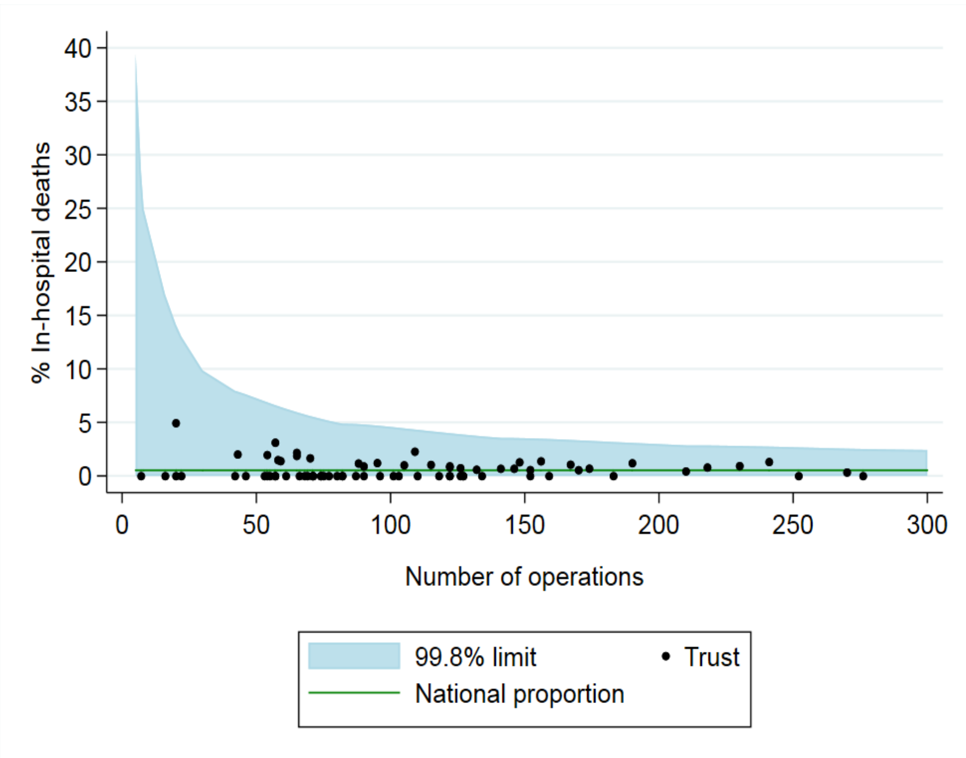


Figure 6.3: Funnel plot of risk-adjusted in-hospital mortality after elective AAA repair for open and EVAR procedures. The overall in-hospital mortality rates for open and EVAR procedures performed between 2016 and 2018 were 3.1% and 0.5%, respectively.

A: Open repairs



B: EVAR procedures



7. Elective repair of complex aortic conditions

7.1 Patterns of complex aortic surgery

While most aortic aneurysms occur below the point where arteries branch from the aorta to the kidneys (infra-renal), aneurysms may occur in other locations and are typically more complex in their physical shape. 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. Moreover, the area is evolving due to the continuing development of new complex endovascular grafts.

Complex aneurysms are categorised into:

- 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).

Various endovascular procedures are increasingly being performed to repair these complex aneurysms; the most common 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 2016 and December 2018. The NVR received 2,513 records related to complex AAA procedures, and the numbers have increased annually, with 743 procedures in 2016, 874 in 2017 and 896 in 2018. Of these procedures, 2,268 (90%) were endovascular (Table 7.1), with just over half being fenestrated repairs.

These complex AAA cases were submitted by 73 vascular units, whose level of activity differs markedly. One unit performed 326 procedures between 2016 and 2018 but the median volume was 15 procedures, and 52 of the 73 units performed fewer than 30 procedures.

Table 7.1: Characteristics of patients who had an elective repair of complex AAA between January 2016 and December 2018

		Open repair	%	Endovascular	%	Total
Total procedures		245		2,268		2,513
Age group (years)	Under 66	49	20.0	334	14.8	383
	66 to 75	123	50.2	920	40.7	1,043
	76 to 85	73	29.8	925	40.9	998
	86 and over	0	0.0	82	3.6	82
Male		211	86.1	1,856	81.8	2,067
Female		34	13.9	412	18.2	446
Type of procedure	FEVAR			1,278	56.4	
	BEVAR			211	9.3	
	TEVAR			447	19.7	
	Iliac branch graft			238	10.5	
	Composite graft			15	0.7	
	Other (e.g., chimney / snorkel / periscope)			76	3.4	

The time from vascular assessment to surgery for all complex repairs between 2016 and 2018 is shown in Figure 7.1. The graph shows the results for 36 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 140 days (IQR: 84-207). The median for the majority 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 nine vascular units, 25% of patients waited more than 220 days to have a complex AAA repair.

One reason for the long time from assessment to surgery for complex AAA repairs (compared to infra-renal AAA repairs) is the need for advice from doctors in other clinical specialties. The 2016 NVR snapshot audit found that over a quarter of patients having a complex open repair required specialist opinion from specialties such as cardiology, respiratory medicine and nephrology (renal disease). Another reason for longer waiting times can be the need for a non-conventional endovascular device. The 2016 NVR snapshot audit reported that where a non-conventional device was required (42% of endovascular patients); it took 67 days for the device to arrive on average.

Figure 7.1: Median (IQR) time from assessment to treatment (days) for patients who had an elective complex AAA repair between January 2016 and December 2018

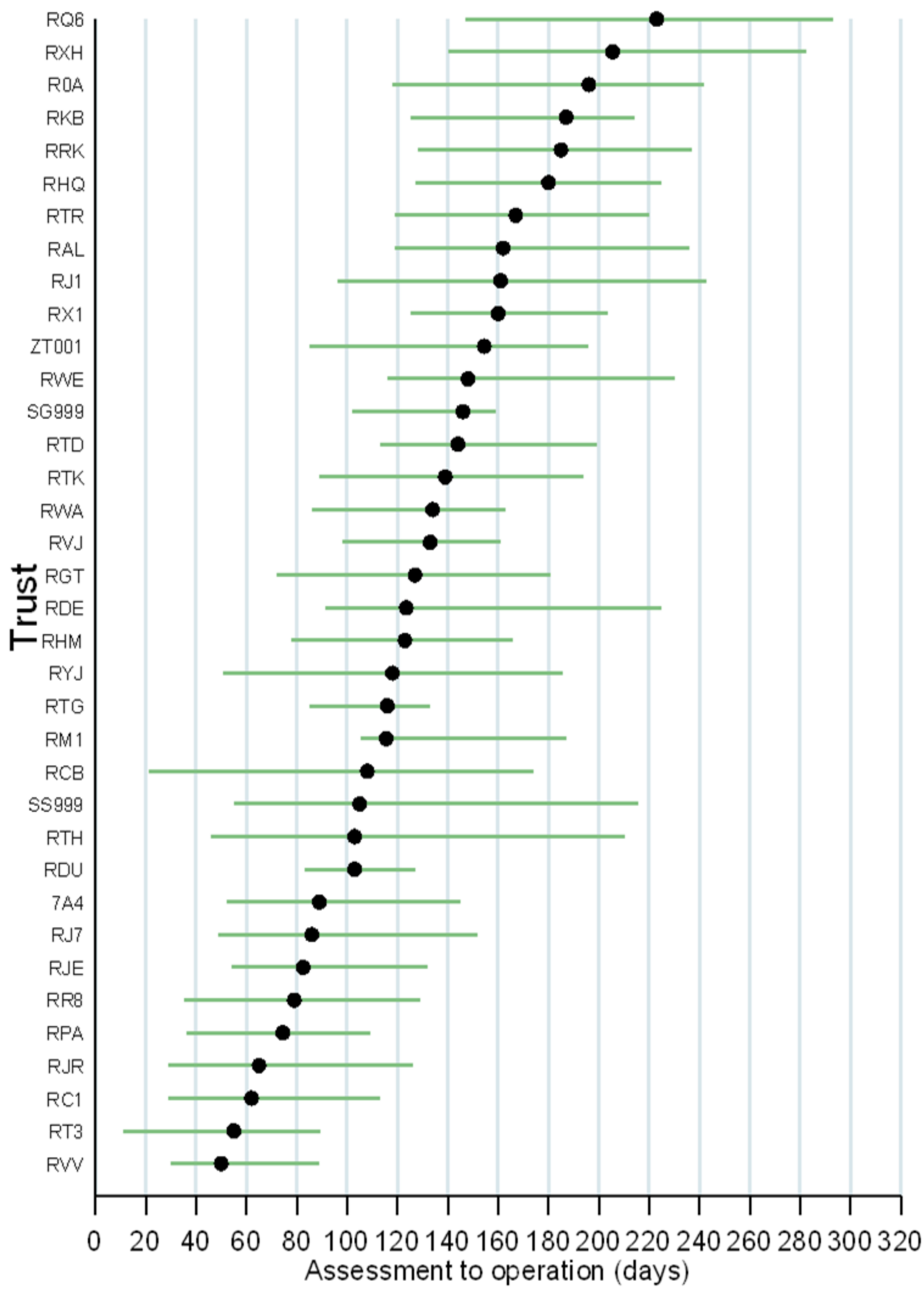


Table 7.2 describes the outcomes of elective complex AAA repairs. As with elective infra-renal AAA repairs, clear differences can be seen between open and EVAR procedures:

- For EVAR, over three-quarters of patients were admitted to either level 2 or 3 critical care. The median length of stay was 4 days.
- For open repairs, 98% were admitted to a level 2 or level 3 critical care unit, where they typically remained there for 3-4 days. The median overall postoperative stay was 9 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 (18.9%).

Between the two most common complex endovascular procedures, the outcomes for TEVAR patients were slightly higher than FEVAR patients (Table 7.3).

Table 7.2: Postoperative details of complex AAA repairs undertaken between January 2016 and December 2018

		Open repair (n=245)		Endovascular (n=2,268)	
Admitted to	Ward	1.6%		19.9%	
	Level 2	41.2%		60.9%	
	Level 3	56.3%		19.2%	
	Died in theatre	0.8%		0.1%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	3	1 to 5	2	1 to 3
	Level 3	4	2 to 7	2	1 to 3
Hospital length of stay (days)		9	6 to 16	4	3 to 7
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		14.7	10.5 to 19.8	2.4	1.8 to 3.1
Readmission to critical care		9.1	5.8 to 13.4	3.2	2.5 to 4.0
Return to theatre		18.9	14.2 to 24.4	4.7	3.8 to 5.6
30 day readmission rate		10.5	6.4 to 15.9	8.5	7.2 to 10.0

Table 7.3: Postoperative details of complex TEVAR and FEVAR undertaken between January 2016 and December 2018

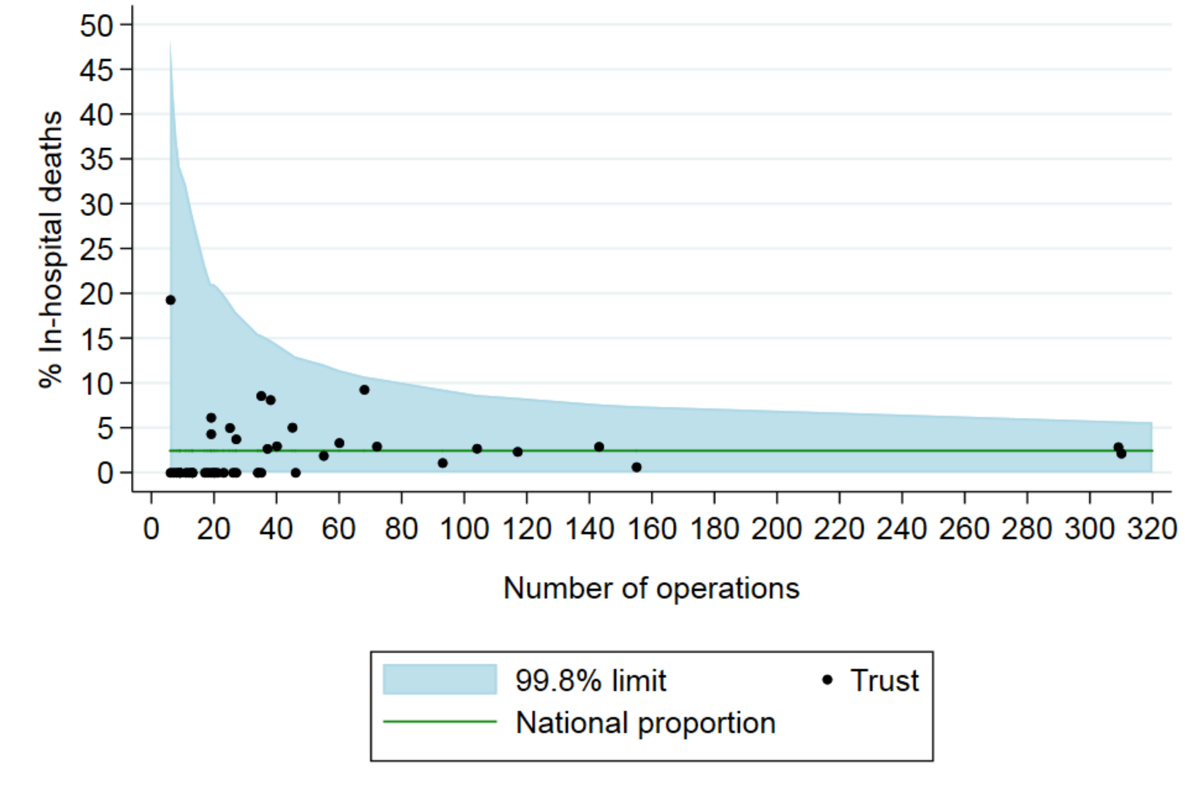
		TEVAR (n=447)		FEVAR (n=1,278)	
Admitted to	Ward	17.7%		15.3%	
	Level 2	60.0%		64.0%	
	Level 3	22.4%		20.7%	
	Died in theatre	0.0%		0.1%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	2	1 to 3	2	1 to 3
	Level 3	2	1 to 3	2	1 to 3
Hospital length of stay (days)		4	2 to 7	4	3 to 7
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		3.1	1.7 to 5.2	2.1	1.4 to 3.1
Readmission to critical care		4.7	2.9 to 7.1	2.7	1.8 to 3.7
Return to theatre		6.5	4.4 to 9.2	3.8	2.9 to 5.0
30 day readmission rate		11.9	8.5 to 16.1	7.1	5.5 to 9.0

7.2 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 2016 to 31 December 2018.

The adjusted mortality rates for individual NHS Trusts are shown using a funnel plot in Figure 7.2. All 45 NHS Trusts had an in-hospital mortality that fell within the expected range around the national average of 2.4%, given the number of procedures performed. The rates among the NHS Trusts ranged from 0 to 20% but this reflected the relatively low volumes used to calculate these rates.

Figure 7.2: In-hospital mortality after complex endovascular repairs between January 2016 and December 2018



7.3 Comment

The level of case-ascertainment for these procedures is currently unknown. The coding of complex aortic procedures in Hospital Episode Statistics (HES) prevents these procedures from being clearly identified. Consequently, we do not know whether these results are representative of the country as a whole. Nonetheless, the high postoperative mortality rate, particularly for open repairs, suggests that NHS Trusts and Commissioners should 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.

Case Study on Patients undergoing complex repair admitted as an emergency admission

There is a group of patients that undergo complex repair but who are admitted as an emergency admission. During the period between 2016 and 2018, the NVR received details of 628 emergency admissions. The majority of these underwent complex EVAR (n=477): 62.9% were TEVARs, 11.2% were FEVARs, and 13.7% were chimney/periscope/snorkel procedures.

The overall in-hospital mortality rate for this patient group was 23.4% (95% CI 20.1 to 26.9). For open repairs, the rate was 51.7% (95% CI 43.4 to 59.9), while for EVAR, it was 14.5% (95% CI 11.4 to 17.9). Among patients undergoing open repair, 84.8% were admitted to level 2 or 3 critical care where the median stay was 4-5 days (Table 7.4). 15.2% died in theatre. Nearly a half of EVARs were admitted to Level 2 care where they stayed for 2 days. The post-operative length of stay was similar for both types of procedures at around 8-9 days.

Table 7.4: Postoperative details of emergency complex AAA repairs undertaken between January 2016 and December 2018

		Open repair (n=151)	Days in critical care median (IQR)	Endovascular (n=477)	Days in critical care median (IQR)
Admitted to	Ward	0.0%		9.6%	
	Level 2	11.9%	4 (1.5 to 7)	49.7%	2 (1 to 4)
	Level 3	72.8%	5 (3 to 11)	40.3%	4 (2 to 8)
	Died in theatre	15.2%		0.4%	
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		51.7	43.4 to 59.9	14.5	11.4 to 17.9
		Median	***IQR***	***Median***	***IQR***
Length of stay (days)		8	2 to 19	9	4.5 to 17

8. Repair of ruptured abdominal aortic aneurysms

8.1 Surgical activity for ruptured AAA

This chapter describes the outcomes of emergency AAA repairs among patients with a ruptured abdominal aortic aneurysm and covers procedures performed between 1 January 2016 and 31 December 2018. For that audit period, details of 2,474 procedures were submitted to the NVR, giving an estimated case-ascertainment of approximately 90%.

Compared to patients who had an elective repair of an infra-renal AAA, 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 (see Appendix 3).

The proportion of patients having an EVAR procedure over this 3-year period was 30.0% (n=742), a gradual increase from 27.4% in the period between 2014 and 2016. The use of EVAR may reflect restrictions on the availability of endovascular facilities and skills in some vascular units, particularly outside normal working hours.

For patients undergoing EVAR, the basic characteristics of their anatomy were:

- 87.3% had a neck angle between 0-60 degrees; for 7.6%, it was 60-75 degrees
- the mean neck diameter was 23.8mm and the mean neck length was 24.8mm
- the aneurysm was extended into either the left / right iliac artery for 19.2% of procedures and was extended bilaterally for 6.1% of procedures.

For patients having open repair, 72.6% underwent tube grafts, 26.8% underwent a bifurcated graft and 6.2% had a groin incision.

The outcomes of the surgical repair for patients with a ruptured AAA are summarised in Table 8.1. There were some noticeable differences in the postoperative care required by patients undergoing open and EVAR procedures. For patients discharged alive, the median post-operative length of stay was 15 days for open repair compared with 9 days for EVAR patients. 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. There was also a greater proportion of patients who returned to theatre within their hospital admission, and who suffered from cardiac, renal and respiratory problems. This is likely to reflect differences in the severity of patients' conditions, and is also highlighted in the in-hospital postoperative mortality rates for open and EVAR procedures. The mortality rates were 40.9% (95% CI 38.6 to 43.2) and 22.6% (95% CI 19.7 to 25.8), respectively.

Table 8.1: Postoperative details of emergency repairs for ruptured AAAs undertaken between January 2016 and December 2018

		Open repair (n=1,732)		EVAR (n=742)	
Admitted to	Ward	0.2%		10.5%	
	Level 2	8.8%		40.4%	
	Level 3	84.1%		44.3%	
	Died in theatre	6.9%		4.7%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	3	2 to 6	2	1 to 3
	Level 3	4	2 to 8	2	1 to 5
Hospital length of stay (days)		10	3 to 19	8	4 to 14
Length of stay for patients discharged alive (days)		15	9 to 26	9	5 to 15
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		40.9	38.6 to 43.2	22.6	19.7 to 25.8
Defined complications					
	Cardiac	24.4	22.3 to 26.6	13.8	11.4 to 16.6
	Respiratory	30.8	28.6 to 33.1	20.2	17.3 to 23.3
	Stroke	2.2	1.5 to 3.0	0.7	0.2 to 1.6
	Haemorrhage	3.8	2.9 to 4.8	2.4	1.4 to 3.8
	Limb ischaemia	11.1	9.6 to 12.8	2.0	1.1 to 3.3
	Renal failure	26.7	24.6 to 29.0	11.1	8.9 to 13.7
	Ischaemic bowel	10.8	9.3 to 12.4	3.5	2.3 to 5.2
	None of the above	38.5	36.2 to 41.0	62.2	58.5 to 65.8
Return to theatre		20.3	18.4 to 22.4	10.1	8.0 to 12.6
Readmission within 30 days		7.0	5.4 to 8.9	9.3	6.9 to 12.3

In the last four NVR Annual Reports, the in-hospital postoperative mortality rates for open repair of a ruptured AAA were 40.4%, 41.2%, 42.3% and 40.9%; for EVAR, the rates were 20.7%, 23.2%, 22.9% and 22.6%. The in-hospital mortality rate for EVAR procedures is lower than that reported in the IMPROVE trial (30 day mortality for 275 EVAR patients with confirmed rupture was 36.4%), although the rates for open procedures is comparable (30 day mortality for 261 open repairs was 40.6%) [Powell et al 2014]. This might be due to the NVR reporting in-hospital mortality rather than 30 day mortality rates, and it may also be due to the conservative adoption of EVAR for patients with ruptured AAA.

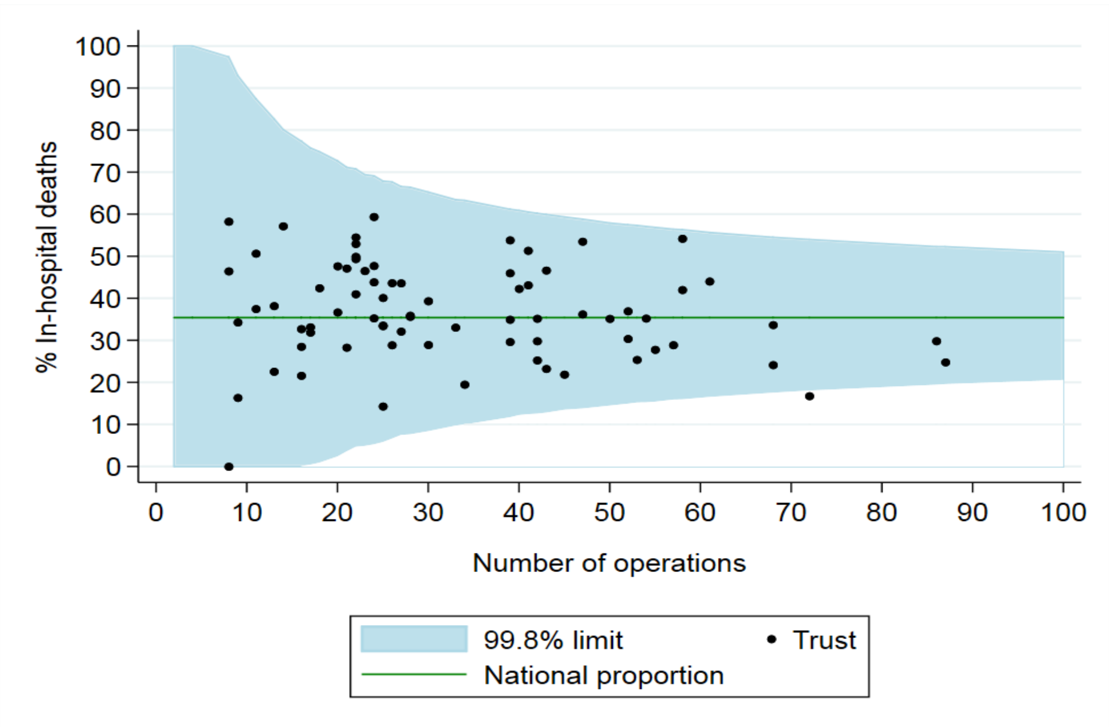
8.2 Postoperative in-hospital mortality for ruptured AAA repair

For NHS organisations undertaking repair of a ruptured AAA during the period from 1 January 2016 to 31 December 2018, the risk-adjusted postoperative mortality rates are shown using a funnel plot in Figure 8.1. All NHS Trusts had a risk-adjusted rate of in-hospital mortality that fell within the expected range around the national average of 35.4%, 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 8.1: Risk-adjusted in-hospital mortality for emergency repairs of ruptured AAAs between January 2016 and December 2018 by NHS Trust. The overall mortality rate was 35.4%.



* The online appendices spreadsheet can be found at https://www.vsqip.org.uk/reports/2019-annual-report/

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 M Brooks		VSGBI
Mr M Clarke		VSGBI
Prof R Fisher		VSGBI
Mr A Pherwani		VSGBI
Ms L Wales		VSGBI
Mrs S Ward		Society for Vascular Nursing
Mr A Nasim		National AAA Screening Programme
Dr S Habib		British Society of Interventional Radiology
Dr F Miller		British Society of Interventional Radiology
Dr R Mouton		Vascular Anaesthesia Society of GB & I

plus members of the CEU involved in the NVR: Prof David Cromwell, Dr Katriina Heikkila, Dr Amundeep Johal, and Mr Sam Waton.

Members of Project Board

Prof I Loftus, Incoming Chair	VSGBI
Prof J van der Meulen, Outgoing Chair	Royal College of Surgeons of England
Miss S Renton	VSGBI
Ms S Hewitt	HQIP
Ms S Harper	HQIP
Mr P Palmer	Northgate Public Services (UK) Limited
Mr I McLachlan	Northgate Public Services (UK) Limited

Plus members of the project / delivery team: Mr Jon Boyle (Surgical Lead), Dr Fiona Miller (IR Lead), Prof David Cromwell, Dr Katriina Heikkila, Dr Amundeep Johal, and Mr Sam Waton

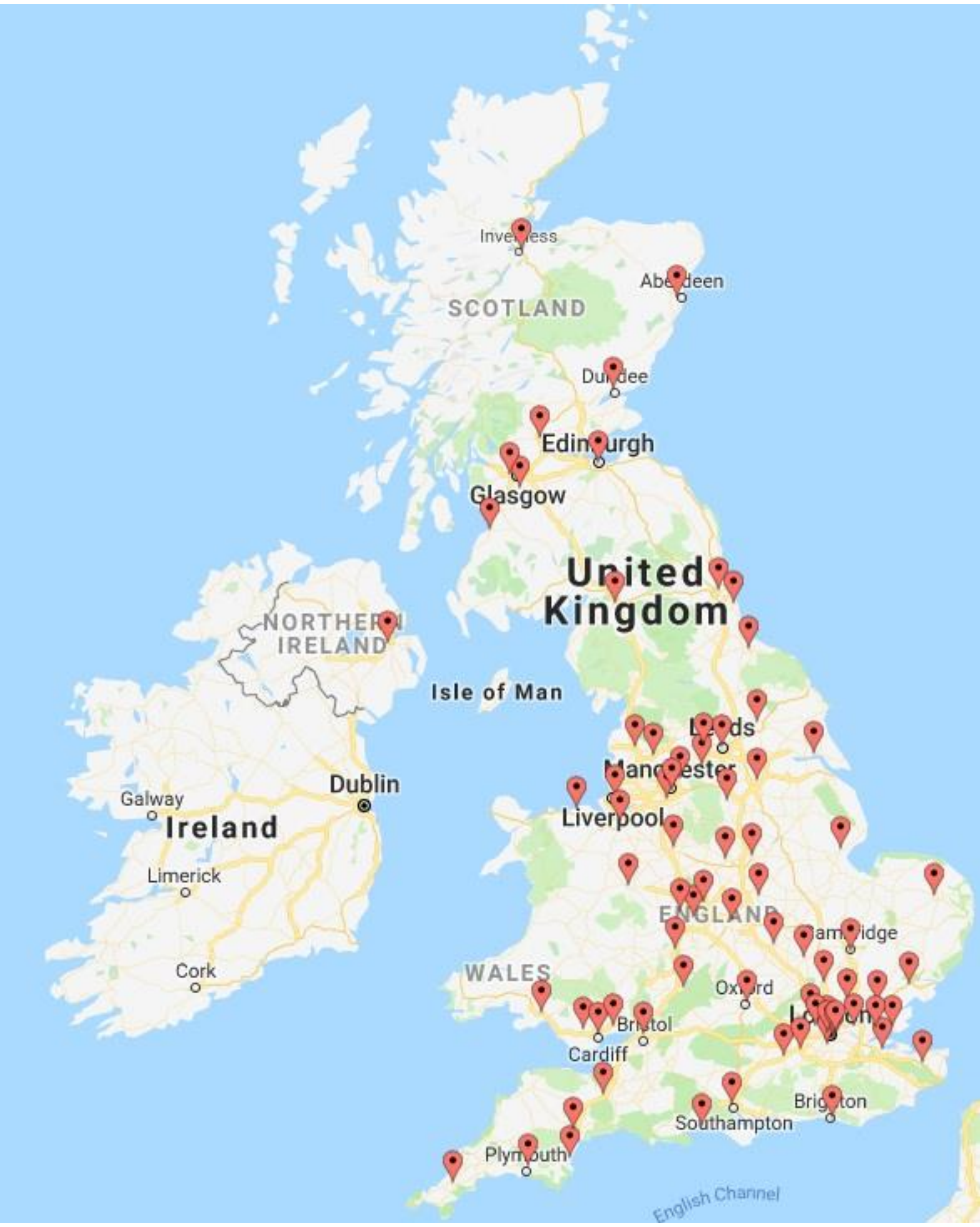
Appendix 2: NHS organisations that perform vascular surgery

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
R0A	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
RBA	Taunton and Somerset 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	Yes	Yes	Yes
RC1	Bedford Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RCB	York Teaching Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
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	Aintree University Hospital NHS Foundation Trust	No	No	No	Yes	No
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

Code	Organisation Name	CEA	AAA	Bypass	Angio	Amp
RHM	University Hospital Southampton NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RHQ	Sheffield Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RHU	Portsmouth Hospitals NHS Trust	No	No	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
RP5	Doncaster and Bassetlaw Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RPA	Medway NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RQ6	Royal Liverpool and Broadgreen University Hospitals NHS 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

Code	Organisation Name	CEA	AAA	Bypass	Angio	Amp
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
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
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	Yes	Yes	Yes	Yes	Yes
SY999	NHS Dumfries and Galloway	Yes	No	Yes	Yes	Yes
ZT001	Belfast Health and Social Care Trust	Yes	Yes	Yes	Yes	Yes

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



Appendix 3: Summary of procedures and patient characteristics

Lower limb bypass

Table A3.1 summarises the patient characteristics and risk factors of patients undergoing bypasses. This procedure was used for treating patients with a full range of disease (asymptomatic, intermittent claudication, critical limb ischemia (Fontaine scores 3 and 4)), although endovascular interventions were more common for patients with less severe symptoms. The prevalence of diabetes, hypertension and coronary heart disease was high, and only a small proportion of patients had no comorbid disease. Not surprisingly, most patients were on some form of cardiovascular/risk modification medication.

Table A3.2 summarises the length of stay of patients by the type of procedure that they underwent and admission mode.

Table A3.1: Patient characteristics of patients undergoing lower limb bypass between January 2016 and December 2018

	Bypass			
	Elective		Emergency	
	No. of procs	%	No. of procs	%
Total procedures	10,878		6,417	
Age group (years)				
Under 60	2,380	21.9	1,177	18.4
60 to 64	1,580	14.6	824	12.9
65 to 69	1,939	17.9	1,003	15.7
70 to 74	1,998	18.4	1,125	17.6
75 to 79	1,547	14.3	990	15.5
80 and over	1,411	13.0	1,278	20.0
Men	8,218	75.5	4,544	70.8
Women	2,660	24.5	1,873	29.2
Smoking				
Current smoker	3,295	30.3	2,556	39.9
Ex-smoker	6,470	59.5	3,096	48.3
Never smoked	1,112	10.2	762	11.9
Previous ipsilateral limb procedure	3,445	35.7	2,350	41.5
Fontaine score				
1 Asymptomatic	137	1.4	120	2.0
2 Intermittent claudication	4,269	43.1	301	4.9
3 Nocturnal &/or resting pain	3,392	34.2	2,530	41.5
4 Necrosis &/or gangrene	2,112	21.3	3,142	51.6
Comorbidities				
None	1,441	13.2	809	12.6
Hypertension	7,585	69.7	4,207	65.6
Ischaemic heart disease	3,723	34.2	2,490	38.8
Diabetes	3,402	31.3	2,456	38.3
Stroke	731	6.7	569	8.9
Chronic lung disease	2,490	22.9	1,586	24.7
Chronic renal disease	974	9.0	802	12.5
Chronic heart failure	508	4.7	491	7.7
Medication				
None	132	1.2	205	3.2
Anti-platelet	9,482	87.2	5,017	78.2
Statin	9,317	85.7	4,974	77.5
Beta blocker	2,520	23.2	1,548	24.1
ACE inhibitor/ARB	4,282	39.4	2,212	34.5

Table A3.2: Length of stay of patients undergoing lower limb bypass between January 2016 and December 2018 by type of procedure and anatomical location

	Bypass			
	Elective		Emergency	
Total procedures	10,878		6,417	
Length of stay (days)	***Median***	***IQR***	***Median***	***IQR***
Bypass only	6	4 to 9	15	9 to 25
Adjunct to bypass	4	3 to 7	15	8 to 25
Endartectomy alone	3	2 to 5	12	7 to 24
Femoral – femoral	4	3 to 7	12	7 to 22
Femoral – popliteal / tibial	5	3 to 8	15	9 to 25
Aorta – femoral / iliac	8	6 to 11	16	11 to 24
Iliac – femoral	4	2 to 6	13	6 to 24
Femoral endartectomy	3	2 to 4	11	7 to 23

Lower limb angioplasty/stenting

The majority of patients undergoing lower limb angioplasties have been men. About a quarter of patients were aged 80 years or older and just under a third had undergone a previous ipsilateral procedure. Lower limb angioplasty were used to treat patients with a range of symptoms, with Fontaine scores ranging from asymptomatic to tissue loss. Most procedures were elective but emergency procedures were also performed.

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

	No. of procs	%
Total procedures	22,109	
Age group (years)		
Under 60	3,579	16.2
60 to 64	2,680	12.1
65 to 69	3,293	14.9
70 to 74	3,826	17.3
75 to 79	3,454	15.6
80 and over	5,277	23.9
Sex		
Men	14,936	67.6
Women	7,173	32.4
Smoking		
Current smoker	5,481	25.4
Ex-smoker	12,038	55.7
Never smoked	4,080	18.9
Previous ipsilateral limb procedure	6,599	32.8
Mode of admission		
Elective	15,999	72.4
Emergency	6,110	27.6
Fontaine score		
No symptoms	972	4.6
Intermittent claudication	8,796	41.2
Nocturnal and/or resting pain	4,388	20.6
Necrosis and/or gangrene	7,182	33.7
Comorbidities		
None	2,794	12.6
Diabetes	9,756	44.1
Hypertension	13,635	61.7
Chronic lung disease	3,512	15.9
Ischaemic heart disease	7,358	33.3
Chronic heart failure	1,601	7.2
Chronic renal disease	3,129	14.2
Stroke	1,810	8.2
Active/managed cancer	48	0.2
Medication		
None	1,173	5.3
Anti-platelet	16,248	73.5
Statin	16,343	73.9
Beta-blocker	5,731	25.9
ACE inhibitor/ARB	7,784	35.2
Antibiotic	3,906	17.7
DVT	5,445	24.6
Oral anticoagulant	182	0.8
Single anti-platelet	795	3.6
Dual anti-platelet	246	1.1

Lower limb major amputation

Characteristics of patients undergoing major unilateral amputations are summarised in Table A3.4, 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 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 4) this cannot be explored further.

Table A3.4: Characteristics of patients undergoing major unilateral lower limb amputation

	Below knee	%	Above knee	%
Total procedures	4,983	52.4	4,525	47.6
Age group (years)				
Under 60	1,483	29.8	823	18.2
60 to 64	676	13.6	477	10.5
65 to 69	689	13.8	622	13.7
70 to 74	701	14.1	758	16.8
75 to 79	607	12.2	689	15.2
80 and over	825	16.6	1,155	25.5
Sex				
Men	3,698	74.2	3,044	67.3
Women	1,285	25.8	1,481	32.7
Smoking				
Current smoker	1,362	27.4	1,537	34.0
Ex-smoker	2,463	49.6	2,226	49.3
Never smoked	1,140	23.0	752	16.7
Presenting problem				
Acute limb ischemia	497	10.0	959	21.2
Chronic limb ischemia	974	19.6	974	21.5
Neuropathy	107	2.1	53	1.2
Tissue loss	1,927	38.7	1,628	36.0
Uncontrolled infection	1,467	29.5	857	19.0
Aneurysm	8	0.2	49	1.1
Previous ipsilateral limb procedure	2,860	66.4	2,298	58.7

Pre-operative risk factors are summarised in Table A3.5. The majority of patients had severe comorbid disease. 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 ARBs.

Table A3.5: Pre-operative risk factors among patients undergoing lower limb amputation

	Below knee	%	Above knee	%
Total procedures	4,983		4,525	
Pre-op ASA grade				
Normal	39	0.8	24	0.5
Mild disease	396	8.0	219	4.8
Severe, not life-threatening disease	3,587	72.1	2,699	59.8
Severe, life-threatening disease, or moribund patient	954	19.2	1,575	34.9
Comorbidities				
None	414	8.3	520	11.5
Diabetes	3,356	67.3	1,943	42.9
Hypertension	2,970	59.6	2,771	61.2
Chronic lung disease	914	18.3	1,226	27.1
Ischaemic heart disease	1,864	37.4	1,841	40.7
Chronic heart failure	495	9.9	557	12.3
Chronic renal disease	1,150	23.1	906	20.0
Stroke	419	8.4	581	12.8
Active/managed cancer	19	0.4	29	0.6
Medication				
None	214	4.3	228	5.0
Anti-platelet	3,282	65.9	2,862	63.2
Statin	3,601	72.3	3,033	67.0
Beta-blocker	1,376	27.6	1,265	28.0
ACE inhibitor/ARB	1,655	33.2	1,412	31.2
Antibiotic prophylaxis	3,367	67.6	3,048	67.4
DVT prophylaxis	3,299	66.2	2,892	63.9
Oral anticoagulant	48	1.0	50	1.1
Single anti-platelet	242	4.9	198	4.4
Dual anti-platelet	23	0.5	32	0.7

Carotid endarterectomy

Table A3.6: Characteristics of patients who had carotid endarterectomy between 1 Jan 2018 and 31 Dec 2018, compared with characteristics from previous two years

Patient characteristics	No. of procedures	2018 %	2017 %	2016 %
Total procedures	4,178			
Age (years), (n=4,163)				
Under 66	1,038	24.9	24.9	26.6
66 to 75	1,507	36.2	36.4	35.5
76 to 85	1,393	33.5	33.4	31.7
86 and over	225	5.4	5.3	6.3
Male	2,829	67.7	65.8	65.8
Female	1,349	32.3	34.2	34.2
Patients symptomatic for carotid disease				
Index symptom if symptomatic: (n=3,902)				
Stroke	1,505	38.6	36.4	35.8
TIA	1,770	45.4	46.5	47.3
Amaurosis fugax	565	14.5	15.1	14.7
None of the three above	62	1.6	2.0	2.2
Grade of ipsilateral carotid stenosis* (n=4,177)				
<50%	64	1.5	1.4	1.6
50-69%	1,138	27.2	26.1	25.9
70-89%	1,705	40.8	42.3	42.4
90-99%	1,260	30.2	30.0	29.9
Occluded	10	0.2	0.2	0.2
Rankin score prior to surgery				
0-2	3,780	90.5	91.1	91.8
3	343	8.2	7.7	6.8
4-5	55	1.3	1.2	1.3
Co-morbidities (n=4,170)				
Diagnosed diabetic	1,005	24.1	23.9	22.5
Current symptoms / treatment Ischaemic heart disease	1,283	30.8	31.2	31.6

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

Table A3.7: Operative details of unilateral carotid endarterectomies performed during 2018

Operation details		**Procedures (n=4,174)**	**(%)**
Anaesthetic	General only	2,499	60.1
	Local only	728	17.5
	Other	931	22.4
Type of Endarterectomy	Standard	352	8.4
	Standard + patch	3,567	85.5
	Eversion	255	6.1
Carotid shunt used		2,442	58.5
Ipsilateral patency check		2,605	62.5

Elective repair of infra-renal AAAs

The characteristics of patients who underwent an elective repair of an infra-renal AAA during 2018 are summarised in Table A3.8.

Table A3.8: Characteristics of patients who had elective infra-renal AAA repair between January and December 2018

		Open repair	%	EVAR	%	Total
Total procedures		1,358		2,350		3,708
Age group (years)	Under 66	335	24.7	169	7.2	504
	66 to 75	700	51.7	857	36.5	1,557
	76 to 85	308	22.7	1,134	48.3	1,442
	86 and over	11	0.8	187	8.0	198
Male		1,235	90.9	2,091	89.0	3,326
Female		123	9.1	259	11.0	382
Current smoker		360	26.5	459	19.6	819
Previous AAA surgery		133	9.8	291	12.4	424
Indication	Screen detected	588	43.3	751	32.0	1,339
	Non-screen	647	47.7	1,272	54.2	1,919
	Other	122	9.0	326	13.9	448
AAA diameter (cm)	Under 4.5	37	2.7	111	4.7	148
	4.5 to 5.4	68	5.0	164	7.0	232
	5.5 to 6.4	937	69.1	1,536	65.4	2,473
	6.5 to 7.4	176	13.0	346	14.7	522
	7.5 and over	138	10.2	190	8.1	328
ASA fitness grade	1,2	420	30.9	478	20.3	898
	3	899	66.2	1,752	74.6	2,651
	4,5	39	2.9	120	5.1	159
Comorbidities	Hypertension	927	68.3	1,674	71.2	2,601
	Ischemic heart disease	391	28.8	898	38.2	1,289
	Chronic heart failure	33	2.4	133	5.7	166
	Stroke	71	5.2	187	8.0	258
	Diabetes	156	11.5	406	17.3	562
	Chronic renal failure	144	10.6	367	15.6	511
	Chronic lung disease	285	21.0	755	32.1	1,040

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 A3.9). 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 A3.9: Characteristics of patients who had a repair of a ruptured AAA between January 2016 and December 2018

		Open repair	%	EVAR	%	Total
Total procedures		1,732		742		2,474
Age group (years)	Under 66	223	12.9	55	7.4	278
	66 to 75	628	36.4	200	27.0	828
	76 to 85	768	44.5	361	48.7	1,129
	86 and over	107	6.2	126	17.0	233
Male		1,441	83.2	624	84.1	2,065
Female		291	16.8	118	15.9	409
Previous AAA surgery		156	9.0	168	22.7	324
AAA diameter (cm)	<4.5	29	1.7	46	6.3	75
	4.5 to 5.4	67	3.9	48	6.5	115
	5.5 to 6.4	296	17.2	148	20.1	444
	6.5 to 7.4	341	19.8	166	22.6	507
	7.5 and over	985	57.3	327	44.5	1,312
ASA fitness grade	1 or 2	68	3.9	28	3.8	96
	3	158	9.1	94	12.7	252
	4	1,065	61.5	495	66.7	1,560
	5	441	25.5	125	16.8	566

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 June 2019. 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 captures features to captures 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 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 build-up is removed from the carotid artery.
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.
Critical Limb Ischaemia (CLI)	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. CLI is associated with severe pain at rest, which is often worse at night, and there may also be ulcers on the leg and foot.

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.

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