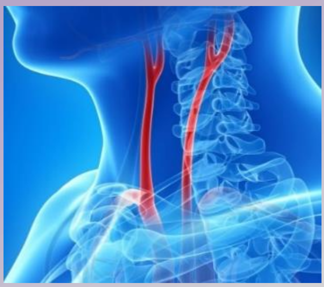

NATIONAL VASCULAR REGISTRY

2018 Annual Report

November 2018

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 2018 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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We would like to acknowledge the support of the vascular specialists and hospital staff who have participated in the National Vascular Registry and the considerable time devoted to data collection.

We would also like to thank:

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Foreword

As President of the Vascular Society of Great Britain and Ireland it gives me great pleasure to introduce the 2018 report of the National Vascular Registry. A large collaborative effort led by the Clinical Effectiveness Unit at the Royal College of Surgeons with input from the Vascular Society and the British Society of interventional Radiology has gone into this report. I would like to take this opportunity to acknowledge the work of all the above institutions whose valuable input has made this possible. We are also grateful to all those who continue to submit detailed information about patient care despite the increasing pressures on their time and resources.

In this year's report, an organisational audit provides a broader picture of current vascular services and the care they deliver to our patients. This includes the resources and facilities available, the organisation of networks, the delivery and outcomes of procedures. The GIRFT initiative has also reported this year on Vascular Surgery. Much of the data in this report will assist in developing and planning changes to meet the GIRFT recommendations.

As in previous years the headline outcomes are excellent. Mortality for elective AAA repair with EVAR is just 0.7% and 3.2% for open repair. Death or stroke after elective carotid endarterectomy is just 2.1%. Vascular teams can be proud of achieving this level of outcomes year on year.

A major conclusion of the GIRFT process was that urgent care was not being delivered quickly enough. This NVR report still demonstrates wide variations in the waiting times for AAA surgery. Although the mean time from symptom to surgery for carotid endarterectomy is better at 12 days, many units are still failing to meet the 14 day target, and few would meet the GIRFT 7 day target. Avoiding unacceptable delays in patient pathways should be a high priority for the coming year and we will look to see improvements in future NVR reports.

The data for lower limb procedures remain incomplete with low ascertainment rates for endovascular (34%) and amputation (60%) procedures. Improving case ascertainment is another GIRFT recommendation. Limb salvage is an expanding part of vascular practice, and improved data in this area will be vital in the coming years.

The organisational audit gives us great insight into the current status of network development. Forty units (55%) report functioning as a full hub and spoke network. That leaves 20 (27%) in the process of establishing a network and 13 (18%) not in a network at all. We also see from this report that 33 units are preforming less than 40 carotid procedures per year and 17 units less than 30 elective infra-renal AAA procedures per year. Complex AAA repair is also an area of concern. Of the 75 centres carrying out these procedures 55 are doing less than 10 cases per year.

So network development is underway but far from complete. Changing established practice is a major challenge. Those areas still without any network plans will be the most difficult to complete. However, the benefits of larger teams in arterial centres for sustainable emergency and urgent care delivery in good volumes demands that these networks are completed wherever possible.

In summary, this 2018 NVR report contains a wealth of valuable data on vascular services. Outcomes from procedures are very good, but waiting times need to improve. Commissioners, providers and clinical staff will find useful data in this report and should all use that to develop vascular services in the NHS further to improve the care we give to our patients.

Mr Kevin Varty
President of the Vascular Society of Great Britain and Ireland

Executive Summary

The National Vascular Registry (NVR) was established to provide information on the performance of NHS vascular units and support local quality improvement. It also aims to inform patients about major vascular interventions delivered in the NHS. The Registry is commissioned by the Healthcare Quality Improvement Partnership, and all NHS hospitals in England, Wales, Scotland and Northern Ireland are encouraged to participate in it.

This 2018 Annual report is the sixth since the NVR was launched in 2013. It contains comparative information on five major interventions for vascular disease:

- Carotid endarterectomy
- Repair of aortic aneurysms, including elective infra-renal, ruptured infra-renal, and more complex aneurysms
- Lower limb bypass
- Lower limb angioplasty/stenting
- Major lower limb amputation

The metrics used to describe hospital activity, the process of care and patient outcomes are drawn from a number of national guidelines. These include: the Vascular Society of Great Britain and Ireland (VSGBI) "Provision of Vascular Services" document published in 2015 (and due to be updated later in 2018), the VSGBI Quality Improvement Frameworks, and the National Institute for Health and Care Excellence (NICE) guidelines on stroke and peripheral artery disease.

Organisational Audit

An organisational audit of NHS vascular services was performed to describe how vascular networks were evolving within the UK, and to investigate the extent to which NHS vascular services meet the organisational standards recommended by the VSGBI. Responses were received from 83 out of 92 NHS trusts / Health Boards performing major vascular surgery, although 6 of these were not fully complete.

Respondents reported that the process of the reconfiguration was still under way, with 44 (54%) NHS vascular units reporting that they were completely reconfigured into a network. Another 21 (25%) units were in the process of reconfiguring. Most hubs reported being part of a network with three or fewer spoke units. 83% of hubs reported that vascular consultants travelled between the hub and spoke on 2 days or more during a typical week, whereas it was 59% for IR consultants.

The vascular units that stated they were not part of a network had a similar configuration of services and are grouped with hubs in the results presented below. In terms of recommended levels of staffing and facilities:

- 40 of 66 hubs (61%) reported having 6 or more full-time (FTE) vascular surgeons, but only 24 (36%) had 6 or more FTE interventional radiologists
- In-hours access to duplex ultrasound was available at 100% of hubs but only 21% of hubs had out-of-hours access
- 59% of hubs had at least one hybrid theatre; 62% had at least 10 surgical sessions and 52% had at least 10 interventional radiology sessions per week
- 48 vascular units reported performing complex aortic procedures such as thoraco-abdominal EVAR; of these, 40 units had a complex aortic MDT meeting

For patients requiring a major lower limb amputation:

- 29% of all vascular units reported that less than 50% of patients were discussed at MDT meetings
- 28% of trusts reported that less than 50% of patients were performed on an elective list
- 78% reported that all patients were assessed by an occupational therapist
- 25% reported preoperative assessments were available from a prosthetics service

At many units, a significant proportion of patients with critical limb ischaemia waited for more than 48 hours for their intervention.

Carotid artery surgery to prevent stroke

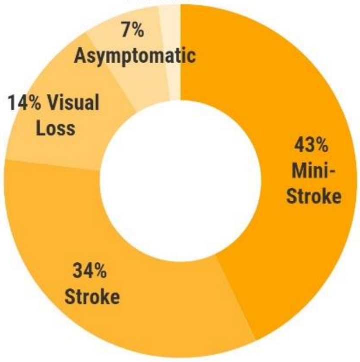
A procedure in which build-up of plaque is removed from the carotid artery in the neck is called a carotid endarterectomy (CEA).

There were 4,148 CEAs submitted to the NVR in 2017, which is approximately 90% of all procedures in the UK.

Which people had surgery?

- 66% were male
- 75% were older than 65 years
- 24% were diabetic
- 31% had heart disease

Reasons for surgery



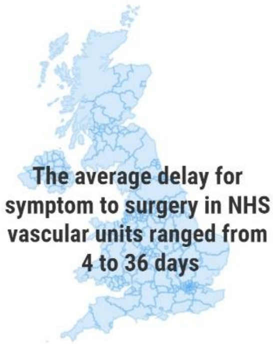
Treatment times for symptomatic patients

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 (1-10 days typical range)
- Referral to Seen by surgeon: Average 1 day (0-4 days typical range)
- Seen by surgeon to Operation: Average 5 days (2-11 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, which 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.

Outcomes of surgery

CEA

- 2.1% Died and/or had a stroke within 30 days of the procedure
- 4.3% were readmitted within 30 days
- 3 days (2-5 days) Average length of stay (typical range)

Carotid endarterectomy

Disease of the carotid arteries can predispose people to stroke. Carotid endarterectomy (CEA) can reduce that risk of a stroke if surgery is performed quickly following the onset of symptoms. The NICE guideline on secondary stroke prevention (CG68) recommends that patients have surgery within 14 days of their first symptoms.

In 2017, there were a total of 4,148 carotid interventions. The number of procedures recorded in the NVR has decreased significantly recently (15% drop from 2015 to 2017). This seems to reflect a fall in activity, as case-ascertainment has been consistently high since 2014 (>90%).

The median time from symptom to surgery decreased from 13 days in 2016 to 12 days in 2017. However, there remains significant variation between NHS trusts, with the median delay ranging from 4 days to 36 days.

Patient outcomes after carotid surgery continue to be good. Among 13,000 patients undergoing carotid endarterectomy between 2015 and 2017:

- 1.7% experienced a stroke within 30 days (95% confidence interval 1.5-1.9)
- 2.1% died and/or had a stroke within 30 days (95% CI 1.9-2.3)
- 1.9% had a cranial nerve injury during their admission (95% CI 1.7-2.2)

All NHS trusts demonstrated 30 day rate of death / stroke after surgery within the expected range, given the number of procedures performed by the vascular unit.

There is a documented volume-outcome relationship between case volume and clinical outcomes for CEA. The provision of services document from the VSGBI recommends that vascular units perform a minimum volume of 40 CEA per annum [VSGBI 2015]. In 2017, over 33 units did not meet this standard. Vascular units should only be commissioned to perform CEA if they submit complete and accurate data on case activity and outcomes to the NVR, with case numbers that allow an appropriate comparison to national standards. Further reconfiguration of services may be required, given the decreasing national caseload.

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 4,208 elective infra-renal AAA repairs submitted to the NVR in 2017, which is approximately 90% of all procedures carried out in the UK.

Of these

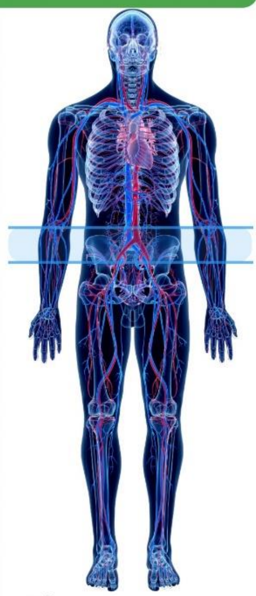
4,208

1,338 (32%) were open repair

- 89% **were male**
- 74% **were older than 65 years**
- 67% **had hypertension**
- 87% **were a current or ex-smoker**

2,870 (68%) were endovascular repair (EVAR)

- 90% **were male**
- 92% **were older than 65 years**
- 70% **had hypertension**
- 85% **were a current or ex-smoker**

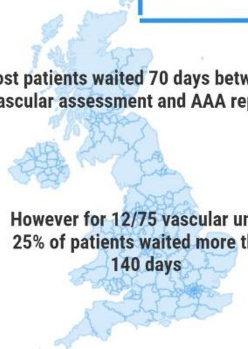


Glossary

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

How were patients assessed?

- Discussed at multi-disciplinary team meeting: 83%
- Had pre-operative angiography assessment: 89%
- Had fitness measured: 85%
- Had formal anaesthetic review: 96%
  - Of these had review by consultant vascular anaesthetist: 92%



Most patients waited 70 days between vascular assessment and AAA repair

However for 12/75 vascular units, 25% of patients waited more than 140 days

Patient outcomes after surgery

Open

- 3.2% Died in hospital
- 5.5% were readmitted within 30 days
- 8 days (6-11 days) Average length of stay (typical range)

EVAR

- 0.7% Died in hospital
- 5.8% were readmitted within 30 days
- 2 days (1-4 days) Average length of stay (typical range)

Aortic aneurysms

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) and the vascular interventions aim to prevent the AAA from rupturing. Aneurysms can develop elsewhere along the Aorta and these require more complex types of repair.

The NHS has run a national screening programme for AAA in men aged 65 years since 2009 which aims to detect aneurysms before they become symptomatic and rupture. This report provides information on procedures to repair infra-renal and complex aortic aneurysms that are carried out electively (planned), and as emergencies.

1) Elective infra-renal AAA

The NVR received detailed information on 4,208 elective AAA repairs in 2017. The proportion of cases performed by open repair and endovascular repair (EVAR) remained stable, being similar to the previous two years (32% open repair, 68% EVAR).

Patient outcomes after elective AAA repair improved dramatically following the VSGBI Quality Improvement Programme. In 2017, the in-hospital postoperative mortality was 3.2% after open repair and 0.7% after EVAR, and all NHS trusts demonstrated in-hospital mortality rates within the expected range.

The VSGBI AAA Quality Improvement Framework [VSGBI 2012] contains various recommendations about the standard of care that organisations undertaking AAA repairs. Most vascular units perform reasonably well against these standards. Specifically, among patients having elective AAA repair in 2017:

- 83.0% were discussed at MDT meetings
- 89.1% had pre-operative CT/MR angiography
- 96.3% of patients underwent a formal anaesthetic review (91.6% by a consultant vascular anaesthetist)
- 84.7% had documented formal fitness assessment tests

There remain two areas for improvement in the provision of AAA services. Firstly, the National Screening Programme has set a timeline of 8 weeks from the date of referral to repair for the majority of patients having elective AAA repair. However, there were large variations between units in the time from assessment to surgery, with the median wait at units ranging from under 30 days to over 100 days. Moreover, 25% of patients waited more than 140 days at 12 units in 2017.

Secondly, a number of vascular units continue to report a low volume of elective AAA repairs. In 2017, there were 17 NHS trusts with a case volume below 30 patients. Further reconfiguration of service is desirable to ensure patients receive treatment in vascular units with the best facilities and clinical pathways.

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 2,303 repairs of elective complex AAAs carried out in 2015-2017.

Of these

2,303

229 (10%) were open repair

2,074 (90%) were endovascular repair (EVAR)

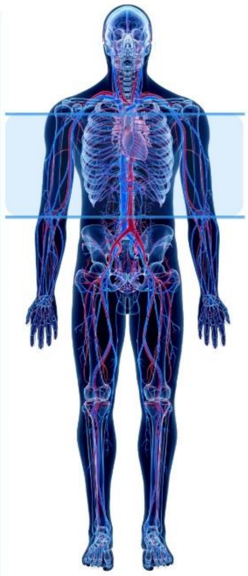
Which people had surgery?

Open repair:

- 83% **were male**
- 75% **were older than 65 years**
- 75% **had hypertension**
- 82% **were a current or ex-smoker**

EVAR:

- 83% **were male**
- 85% **were older than 65 years**
- 76% **had hypertension**
- 81% **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).

Patient outcomes after surgery

Open

- 18.3% Died in hospital
- 8.0% were readmitted within 30 days
- 9 days (7-18 days) Average length of stay (typical range)

EVAR

- 2.9% Died in hospital
- 7.1% were readmitted within 30 days
- 5 days (3-8 days) Average length of stay (typical range)

2) Complex Aneurysm Repair

Aortic aneurysms that occur above or around the arteries to the kidneys require more complex aortic procedures. While open repair was the traditional approach to repairing these complex AAA, many vascular units are increasingly using an endovascular technique.

Between January 2015 and December 2017, there were 2,303 complex AAA repairs, of which 2,074 were endovascular and 229 were open repairs. The endovascular procedures included: 1,117 fenestrated repairs (FEVAR), 184 branched repairs (BEVAR) and 395 thoracic procedures (TEVAR). These represent a relatively large case volume, although it is difficult to give an accurate estimate of case-ascertainment because the OPCS codes used to describe these procedures in routine hospital data are not sufficiently precise. Of the 75 centres performing complex AAA repairs in 2015-2017, 55 submitted fewer than 10 cases per year.

The outcomes remain favourable for EVAR compared to open repair, with in-hospital postoperative mortality rates of 2.9% and 18.3%, respectively. The figures for EVAR and open procedures should not be directly compared and taken as evidence of their relative effectiveness. In many cases, open repair may be performed because of a more complex AAA anatomically. Further research is required to clarify which patients benefit most from an endovascular approach or an open repair.

3) Ruptured AAA

Despite the national screening programme for the detection of aortic aneurysms, aneurysm ruptures still affect many people. The NVR recorded 2,682 cases from January 2015 to December 2017, which represents a case-ascertainment rate of approximately 92%.

Over this period, the adoption of EVAR has been static for ruptured AAA (approximately 30% compared to 70% for elective repair). Patients undergoing EVAR for ruptured AAA had a lower in-hospital postoperative mortality compared to open repair (22.9% and 42.3%, respectively). As with complex AAA repair, the outcome 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 postoperative in-hospital mortality rates within the expected range, given the number of procedures performed by the vascular unit. There has been some concern that outcomes are worse for patients having surgery at the weekend. The in-hospital mortality rates for ruptured AAA repairs performed on weekdays and at the weekend were 35.2% and 39.4%, but the difference was not statistically significant after adjusting for the differences amongst the patients (adjusted odds ratio 1.10; 95% CI 0.92-1.31).

Lower Limb Interventions for Peripheral Artery Disease

Peripheral artery disease (PAD) 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). Treatment options include conservative therapy, and revascularisation (ie, endovascular or open surgical interventions such as bypass of obstructed arteries). In cases where revascularisation is unsuitable, major lower limb amputation may be required.

1) Lower limb bypass

Between January 2015 and December 2017, NHS trusts submitted 17,475 bypass procedures to the NVR, with an estimated case-ascertainment rate of 90%. Among these patients, 68.9% were admitted with critical limb ischaemia, and 85.4% were recorded as being on an anti-platelet agent and 82.5% were on a statin.

Surgical outcomes for bypass procedures remained good. The in-hospital postoperative mortality rate was 1.2% (95% CI 1.0 to 1.4) for elective admissions and 5.2% (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 5.7% of elective admissions and 14.1% of emergency admissions. All but one NHS trust had an adjusted rate of postoperative in-hospital death that fell within the expected range given the volume of cases.

We also examined whether outcomes were worse for patients having bypass surgery at the weekend. The in-hospital mortality rates for emergency admissions performed on weekdays and at the weekend were 5.0% and 7.8%, but the difference was not statistically significant after adjusting for the differences amongst the patients (adjusted odds ratio 1.37; 95% CI 0.98-1.93).

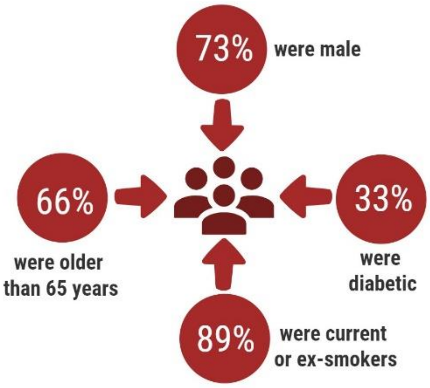
Lower limb bypass for peripheral arterial disease to prevent limb loss

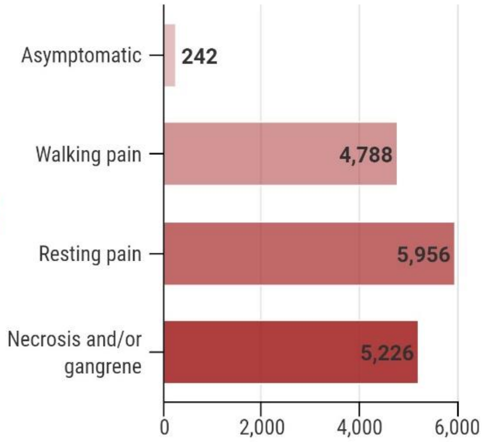
Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower limb arteries that can severely affect a patient's quality of life, and risk their limb.

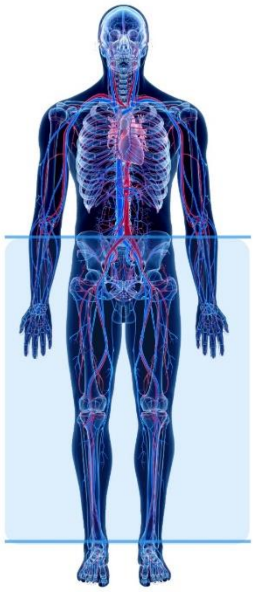
Open surgical (bypass) interventions become options when conservative therapies have proved to be ineffective.

17,475 lower limb bypass procedures carried out in 2015-2017

Patient characteristics







Glossary

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

Patient outcomes post bypass

Elective

- 1.2% Died in hospital
- 9.6% were readmitted within 30 days
- 5 days (3-8 days) Average length of stay (typical range)

Emergency

- 5.2% Died in hospital
- 14.7% were readmitted within 30 days
- 15 days (9-26 days) Average length of stay (typical range)

2) Endovascular lower limb procedures

The number of endovascular lower limb procedures submitted to the NVR has risen over the last 3 years: 4,937 in 2015, 6,670 in 2016 and 7,402 in 2017. However, the overall case-ascertainment has not increased as much as we would like and was only 33% in 2017.

Among the patients having endovascular interventions (angioplasty or stents), 53% of patients had critical limb ischaemia, and roughly 3 in 4 patients were on anti-platelet medication (78.8%) or statin therapy (74.3%).

Overall, outcomes after angioplasty / stents were good. The in-hospital postoperative mortality rate of 0.4% (95% CI 0.3 to 0.5) for elective admissions and 4.8% (95% CI 4.2 to 5.4) 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.

Nonetheless, the case-ascertainment remains too low for robust conclusions to be drawn from analysis of the data. While a few NHS trusts achieved 90% ascertainment rates, there was a disappointingly large number of vascular units with very low rates, including approximately 50% of units having a case-ascertainment estimate of less than 20%. Continued local efforts must be made to improve data collection.

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.

19,009 lower limb angioplasty/stent procedures carried out in the UK in 2015-2017

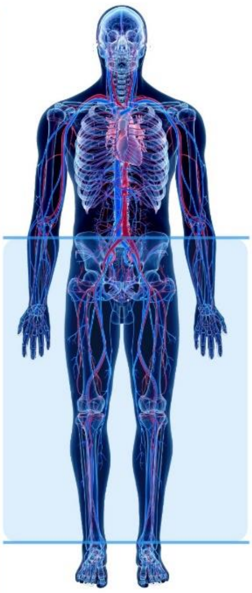
Patient characteristics

- **67%** were male
- **72%** were older than 65 years
- **42%** were diabetic
- **82%** were current or ex-smokers

Patient outcomes post procedure

Angio/Stent

- **1.6%** Died in hospital
- **8.9%** Readmitted within 30 days
- **1 day (0-7 days)** Average length of stay (typical range)

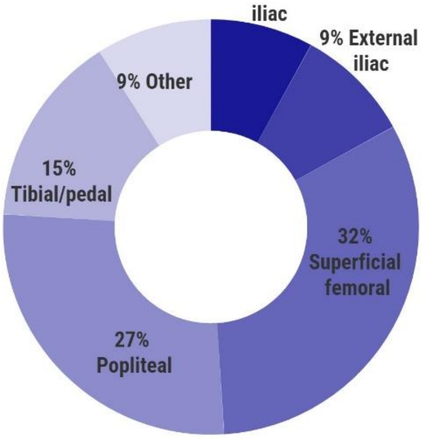


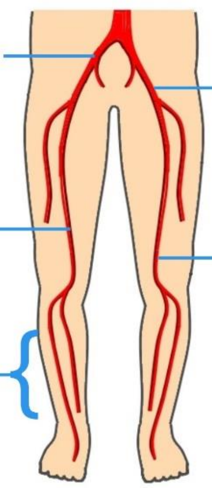
Glossary

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

Procedures by anatomical location

Lower limb angioplasty/stent procedures are carried out in various artery locations within the leg. The breakdown of these procedures is shown below





3) Major lower limb amputation

Over the three-years from 2015 to 2017, NHS trusts entered 9,293 major lower limb amputations into the NVR, giving an estimated case-ascertainment of around 60%. Significant variations in the level of data ascertainment remain between NHS trusts, with about a quarter of vascular units capturing data on less than 50% of cases.

There were a higher proportion of below-knee to above-knee amputations (52.7% BKA versus 47.3% AKA, respectively). It was common for patients to be on various medications (72% were on antiplatelet therapy and 70% took statins) and 57% were diabetic.

The 30 day in-hospital mortality after below and above knee amputations was 3.0% (95% CI 2.6 to 3.6) and 8.0% (95% CI 7.2 to 8.9), respectively. All the NHS trusts had a risk-adjusted rate of 30 day in-hospital mortality that fell within the expected range given the number of procedures performed.

Most patients were emergency admissions but over 80% of patients underwent surgery during daytime hours (8am-6pm), a key quality indicator in the VSGBI quality improvement pathway. At some vascular units, this is at odds with the figures reported in the organisational audit and suggests NHS trusts are having trouble entering operations on emergency lists into the NVR. Performance on other process measures was reasonable but requires improvement. Overall:

- a consultant surgeon was present in theatre in 81.8% of below knee and 77.1% for above knee procedures
- antibiotic/DVT prophylaxis was reported to be given to around 63% of patients

There was, however, variation in the levels achieved on the process measures across NHS vascular units. Local services should therefore examine how improvements can be made terms of both data submission and their performance against the recommendations of the NCEPOD report and the VSGBI quality improvement pathway.

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.

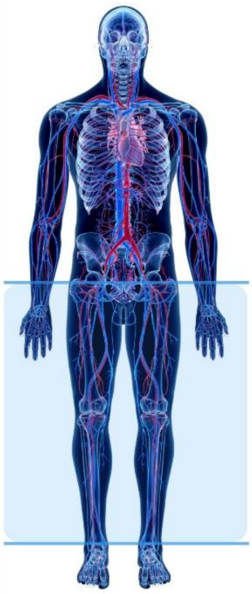
Despite open and endovascular revascularisation procedures, PAD can gradually progress in some patients to critical limb ischaemia. In these situations, patients will require amputation of the lower limb.

In 2015-2017 there were 9,293 major lower limb amputations submitted to the NVR.

9,293
amputations

4,398
Above Knee

4,895
Below Knee



Which people had surgery?

Above Knee

- 68% were male
- 73% were older than 65 years
- 42% were diabetic
- 83% were current or ex-smokers

Below Knee

- 74% were male
- 59% were older than 65 years
- 66% 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

- 11.5% Died in hospital
- 9.1% were readmitted within 30 days
- 22 days (13-39 days) Average length of stay (typical range)

Below Knee

- 5.4% Died in hospital
- 10.9% were readmitted within 30 days
- 24 days (14-41 days) Average length of stay (typical range)

Recommendations

1. Local services should review their pathways of care for patients with critical limb ischaemia, using the VSGBI Quality Improvement Framework for Amputation.
2. Networks should ensure they have enough consultant vascular surgeons and interventional radiologists to be able to provide a 24/7 on call service.
3. Local services should ensure that diagnostic imaging services are available out-of-hours.
4. NICE guideline CG68 recommends that carotid endarterectomy is undertaken within 14 days of a patient experiencing symptoms. NHS trusts that are not meeting this target should optimise referral pathways within their networks and implement improvements to drive down the waiting times. More generally, units should examine how their performance compares against the NICE guideline.
5. Vascular units should assess whether all AAA patients are discussed at the vascular MDT meeting and that this is document clearly in the medical notes. Units should ensure this information is uploaded to the NVR, including the date of discussion.
6. The National AAA Screening Programme has a target of 8 weeks for the time patients taken from referral for vascular assessment to elective AAA repair. For non-complex aneurysms, vascular units should adopt this as a target for both screen and non-screen detected AAA patients, and alter the care pathway to avoid excessive waits.
7. Complex aortic surgery remains a relatively low-volume, high-cost service. 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.
8. Vascular units should look at the numbers of complex interventions being performed and if volumes are low, consider how provision can be organised best within their regions.
9. 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.
10. 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.
11. Vascular units should review local care pathways and patient outcomes for lower limb amputation, and adopt the care pathway and standards outlined in the Vascular Society's Quality Improvement Framework.
12. Vascular units should examine how to improve their performance against the NCEPOD recommendations for amputation, specifically in relation to the use of prophylactic medication.
13. Units should ensure that all data on lower limb revascularisation and major amputation procedures are being uploaded accurately to the NVR.

1. Introduction

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

Vascular services treat patients with various conditions that affect blood circulation, and which form part of the broad spectrum of cardiovascular disease. There are two principal types of vascular disease:

- serious atherosclerotic conditions, which concern the thickening, narrowing and occlusion of arteries, or
- aneurysmal conditions (outside of the heart and brain) in which an artery has widened and is at risk of rupture.

The treatments for these conditions are typically aimed at reducing the risk of a heart attack, stroke, the rupture of an artery and other cardiovascular conditions. Treatment options will depend upon the severity of a person's vascular disease as well as the extent of other co-existing health problems. While some people may only require a combination of advice on lifestyle change and medication, others have severe arterial disease that requires surgery or an invasive procedure like angioplasty.

The NVR publishes information on adult patients undergoing emergency and elective procedures in NHS hospitals for the following patient groups:

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

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 2018 Annual Report

The aim of this report is to describe the care provided by NHS vascular units, and outcomes delivered to patients. Metrics on the process and outcomes of care are published for:

- patients having a carotid endarterectomy
- patients undergoing the elective AAA repair
- patients undergoing emergency repair of a ruptured AAA
- patients with PAD having:
  - an endovascular intervention (angioplasty or stent insertion)
  - a lower limb bypass procedure
  - a major lower limb amputation

In addition, the report presents the findings of an organisational audit. This evaluated the current arrangement of hospital vascular services, which are in the process of being re-organised into vascular networks in England and the degree to which services were meeting the organisational standards described by the 2015 "Provision of Services for Patients with Vascular Disease (POV)" document from the Vascular Society of Great Britain and Ireland [VSGBI 2015].

The information in this report is relevant to:

- vascular surgeons, interventional radiologists and vascular anaesthetists, as well as their teams working within hospital vascular units
- patients and the public who are interested in having an overall picture of the organisation of services within the NHS
- other health care professionals such a general practitioners
- policy makers and health care commissioners

Being a procedure-based clinical audit, the NVR is designed to evaluate primarily the outcomes of care, with the aim of supporting vascular specialists to reduce the risk associated with the procedure. Short-term survival after surgery is the principal outcome measure for all vascular procedures, but the report also provides information of other outcomes, such as the types of complications that occur after individual procedures.

Additional contextual information is provided by the process measures. These are linked to standards of care that are drawn from various national guidelines. The "Provision of Services for Patients with Vascular Disease" document produced by the Vascular Society [VSGBI 2015] provides an overall framework for the organisation of vascular services, while a number of other sources describe standards of care for the individual procedures, including:

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 of GB&I "Quality Improvement Framework for AAA" [VSGBI 2012]
- Standards and outcome measures for the National AAA Screening Programme (NAAASP) [NAAASP 2009]

For peripheral arterial disease

- The Vascular Society of GB&I. "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]

1.2 Publication of information on the VSQIP website

As well as producing these annual reports, the Registry publishes information on the **www.vsqip.org.uk** website for each of the five vascular procedures for all UK NHS trusts that currently perform these procedures. For each organisation, the website gives the number of operations, the typical length of stay, and the adjusted postoperative outcomes. It also contains outcome information for elective infra-renal AAA repairs and carotid endarterectomy procedures by individual consultants currently working at the organisation. Consultant-level information has also been published for NHS hospitals in Wales, Scotland and Northern Ireland for surgeons who consented.

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 2015 and 31 December 2017. To allow hospitals to enter follow-up information about the patients having these interventions, the data used in this report was extracted from the NVR IT system in July 2018. Only records that were locked (i.e., the mechanism used in the IT system for a hospital to indicate that data entry is complete) were included in the analysis.

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 are not operated upon, are not captured in the Registry.

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 12.

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. Details of data submissions are given in the Appendices.

For clarity of presentation, the terms NHS trust or Trusts has been used generically to describe NHS trusts and Health Boards.

2. Organisational Audit

2.1 Organisation of NHS hospital vascular services

The organisation of hospital vascular services within the UK continues to evolve. Current advice from the Vascular Society of Great Britain and Ireland (VSGBI) is that major vascular surgery in the UK should be provided by organising vascular services into regional networks, consisting of a hub hospital providing arterial surgery and complex endovascular interventions, and spoke hospitals providing venous surgery, diagnostic services, vascular clinics, rehabilitation, and where appropriate, day case angioplasty [VSGBI 2015].

Achieving this network organisation of services has led to a widespread reconfiguration of vascular services within regions. The changes can be illustrated by looking at the number of NHS trusts providing vascular surgery. In 2011, elective repair of infra-renal AAA was performed in 114 NHS trusts. By 2017, 35 of the NHS trusts had stopped performing elective AAA repairs, and in the remaining 79, the number of NHS trusts performing fewer than 30 operations had fallen to 18 (Figure 2.1). There has been a similar change in the number of NHS trusts performing carotid endarterectomy procedures: 120 organisations provided this service in 2011 but this had reduced to 84 in 2017.

The current location of NHS trusts performing AAA surgery is shown in Figure 2.2.

Figure 2.1: Number of NHS trusts performing elective infra-renal AAA surgery

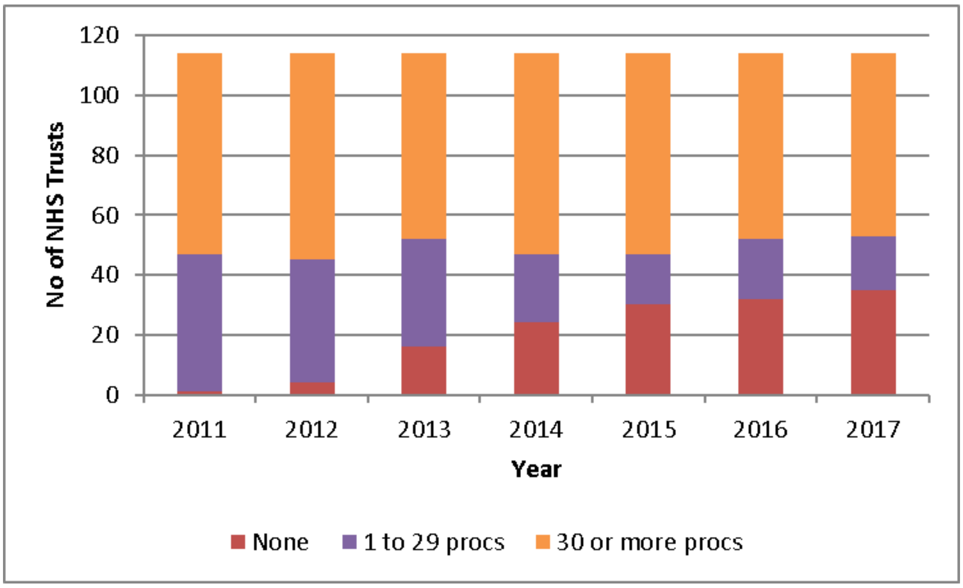


Figure 2.2: Map of vascular units in NHS trusts that currently perform elective AAA repair

There have also been major changes within NHS hospitals. One initiative has been to improve the operating environment for vascular specialists, with the increasing availability of theatres that incorporate radiological imaging equipment (so-called hybrid theatres), and dedicated daily vascular operating lists. Working within multi-disciplinary teams has also become common practice.

In 2018, the NVR undertook an organisational audit in the provision of NHS hospital vascular services in order to highlight areas of good performance and identify areas where improvement can be made. The objectives of the organisational audit were:

1. to describe the current structure and organisation of NHS vascular services in 2018
2. to examine the provision of services related to the care of lower limb ischaemia, an issue highlighted in the report on Vascular Surgery by the Get-It-Right-First-Time (GIRFT) initiative [Horrocks, 2018]
3. to investigate the extent to which NHS vascular services meet the organisational recommendations set by the Vascular Society of Great Britain and Ireland [2015]

The audit was conducted as an online survey, with responses collected between 9 July and 8 October 2018. A link to an online questionnaire was emailed to vascular leads (surgeons and one radiologist) at 92 NHS hospitals, and respondents were asked to describe their organisation's role in the regional vascular network and the services provided by their vascular unit. The survey covered topics related to surgery and interventional radiology, and trusts were asked to obtain answers to the questions from staff in both specialties. The questionnaire contained questions on the availability of and access to arterial surgical services, personnel and facilities, as well as detailed information about the organisation and systems relating to specific vascular interventions, such as bypass surgery and angioplasty for lower limb ischaemia.

Representatives from 83 trusts responded to the survey and provided information on the network role of their hospital and the range of vascular services they offered. However, 6 of these organisations provided incomplete data on the staff, services and details of specific procedures, and were only included in the description of the network arrangements and excluded from the rest of the analyses. The majority of the findings described in this chapter are based on the remaining 77 responses received.

The current organisational audit is the second one undertaken in the NVR, with the first audit having been conducted in 2015. The two audits had a different focus but where possible, key measures from the 2018 and 2015 surveys will be presented alongside one another in tables for comparison.

2.2 Organisation of vascular care in networks

Respondents to the survey confirmed that the reconfiguration of vascular services in the NHS was still ongoing. Of the 83 responding trusts, 44 (54%) reported that their organisation was part of a formal vascular network. This proportion is smaller than the corresponding proportion from the last organisational audit in 2015, when 70 (83%) of the responding NHS trusts reported that they were a part of a completely or near-completely reconfigured network. In addition, 21 trusts (25%) were now in the process of reconfiguration to become part of a vascular network and five trusts reported that reconfiguration was planned. Two trusts reported not being a part of a vascular network, with no reconfiguration planned in the next two years, and 10 organisations described other arrangements.

2.3 Availability of staff, services and facilities

The 2018 organisational survey was completed by representatives of 59 hub hospitals (arterial centres), 12 spoke hospitals (non-arterial centres) and 12 NHS trusts that were not a part of a formal vascular network. Most hubs reported having three or fewer spokes

- Arterial surgery was provided in 76 vascular units (91.6%)
- venous surgery in 79 (95.2%)
- renal access surgery in 55 (66.3%) and
- diabetic foot clinics in 76 (91.6%).

The numbers of days in a typical week when hub consultants travelled to spokes and spoke consultants travelled to the hub are shown in Table 2.1. The VSGBI recommends that consultants travel to spoke sites to provide outpatient clinics, perform day-case lists, support and manage referrals from other specialties, and deal with patient related administration [VSBGI 2015].

Table 2.1: Travel patterns among vascular specialists between hubs and spokes

No. of days per week…	Number (%) hubs (n=59)
…that hub vascular surgery consultants travel to the spokes	
0	6 (10.2)
1	4 (6.8)
2+	49 (83.1)
…that spoke vascular surgery consultants travel to the hub	
0	14 (23.7)
1	10 (17.0)
2+	35 (59.3)
…hub IR consultants travel to the spokes	
0	16 (27.1)
1	7 (11.9)
2+	36 (61.0)
…spoke IR consultants travel to the hub	
0	13 (22.0)
1	12 (20.3)
2+	34 (56.6)

In 44 hubs (74.6%), vascular consultants also provided ward cover at the spoke for inpatient referrals. 45 hubs (76.3%) reported having network policies in place for patient transfer into the hub and repatriation to spoke sites.

Vascular units acting as spokes

All 12 spoke trusts reported having a vascular multidisciplinary team (MDT) as well as a vascular MDT specifically for peripheral artery disease (PAD). In addition, in four spoke hospitals, the IR consultants regularly attended the hub vascular peripheral artery disease MDT (in person or via telephone/video conference). However, due to the low response rate from spoke hospitals, it is difficult to determine how generalizable these observations are.

Staff and facilities

The VSGBI has set recommendations on the minimum numbers of staff at various levels of vascular care that hospitals should provide in order to maintain and improve the quality of care in vascular surgery. The VSGBI advises that:

- a hub hospital should have a 24/7 emergency call rota, covered by at least six consultant vascular specialists [VSGBI 2015; p.16-17], and
- a vascular anaesthetist available round-the-clock [VSGBI 2015; p. 18 and 23].
- at least one VNS is needed within a hospital [VSGBI 2015; p. 19].

Findings from the present organisational survey suggest that these recommendations are still not met at all hospitals (Table 2.2). The 12 vascular units not within a network have been grouped with the 60 hubs given their similar service mix. Just over half of the hubs reported that they had six or more full-time consultant vascular surgeons and about a third of the hubs had six or more interventional radiologists. Most hubs and all the responding spokes had least one full-time vascular nurse specialist among their staff. These figures represent little change from the last survey in 2015, when just over half of the NHS trusts employed six or more surgeons to cover on-call rotas.

Table 2.2. Availability of vascular staff

Availability of staff	N (%) hubs in 2018 (n=66)	N (%) spokes in 2018 (n=12)	N (%) trusts in 2015 (n=84)
>=6 full-time consultant vascular surgeons in hospital[1]	40 (60.6)	1 (9.1)	45 (53.4)
>=6 full-time consultant interventional radiologists[1]	24 (36.4)	1 (9.1)	22 (26.2)
>=1 full-time vascular nurse specialists[1]	62 (93.9)	10 (90.9)	77 (91.7)
Proportion of vascular operating lists staffed by a consultant vascular anaesthetist			
100%	27 (40.9)	3 (27.3)	35 (41.7)
75-99%	33 (50.0)	0 (0.0)	39 (46.4)
<=74%	6 (9.1)	8 (72.7)	10 (11.9)
Hospital has vascular anaesthetist on-call rota	2 (3.0)	1 (9.1)	1 (1.2)
Hospital has 24/7 interventional radiology on-call provision for			
Vascular patients	47 (71.2)	8 (72.7)	
Non-vascular patients	46 (69.7)	6 (54.6)	

[1] Full-time equivalent

Table 2.3 Availability of facilities and services

Availability of facilities	**N (%) hubs in 2018 (n=66)**	**N (%) spokes in 2018 (n=11)**	**N (%) trusts in 2015 (n=84)**
Hybrid interventional theatre (with rotational fluoroscopic imaging)	39 (59.1)	3 (27.3)	36 (42.9)
Access to the hybrid theatre for combined peripheral vascular procedures	38 (57.6)	3 (27.3)	
Facility to scan the barcodes of implantable devices (e.g., stents) into a computer system available in the operating theatres used for vascular procedures			
Yes, in all theatres	41 (62.1)	8 (72.7)	
Yes, in some theatres	11 (16.7)	1 (9.1)	
No	14 (21.2)	2 (18.2)	
Number of inpatient vascular beds			
None	4 (6.1)	8 (72.7)	3 (3.6)
1-20	22 (33.3)	3 (27.3)	33 (39.3)
21-30	28 (42.4)	0 (0.0)	34 (40.5)
31+	12 (18.2)	0 (0.0)	17 (20.2)
Ward facilities for post-procedure recovery			
Standard level nursing (1 nurse to 8 patients)	62 (93.9)	11 (100)	
Extended level of care on normal ward[2]	19 (28.8)	4 (36.4)	
High Dependency Unit (Level 2) (1 nurse to 2 patients)	60 (90.9)	7 (63.6)	
Intensive Care Unit (Level 3) (1 nurse to 1 patient)	62 (93.9)	7 (63.6)	
Diagnostic services available in-hours:			
Duplex	66 (100)	10 (90.9)	82 (97.6)
CT scan	64 (97.0)	10 (90.9)	72 (85.7)
MR angiography	64 (97.0)	11 (100)	79 (94.0)
Specialist vascular physiology assessments	55 (83.3)	5 (45.5)	54 (64.3)
Diagnostic services available out-of-hours:			
Duplex	14 (21.2)	1 (9.1)	10 (11.9)
CT scan	65 (98.5)	11 (100)	81 (96.4)
MR angiography	17 (25.8)	2 (18.2)	19 (22.6)
Specialist vascular physiology assessments	1 (1.5)	0 (0.0)	2 (2.4)

[2] These may include more nursing (1 nurse to 4 patients), extended monitoring of vital signs or more frequent observation (eg, by HDU/ITU nurse).

Table 2.3 Availability of facilities and services (continued)

Availability of services	N (%) hubs in 2018 (n=66)	N (%) spokes in 2018 (n=11)	N (%) trusts in 2015 (n=84)
>=10 vascular surgery operating lists (half-day) per week	41 (62.1)	1 (9.1)	57 (67.9)
>=10 vascular IR operating lists (half-day) per week	34 (51.5)	1 9.1)	
>=5 operating lists (half-day) per week provided by local IRs	52 (78.8)	7 (63.6)	
>=5 operating lists (half-day) per week provided by visiting IRs	2 (3.0)	1 (9.1)	
Number of vascular surgical sessions per week			
1-5	0 (0.0)	2 (18.2)	At least one: 79 (94.1)
6-10	16 (24.2)	6 (54.6)	
10+	47 (71.2)	2 (18.2)	
Don't know/not answered	3 (4.6)	1 (9.1)	
Number of weekly vascular surgical sessions provided by local vascular surgeons			
1-5	3 (4.6)	4 (36.4)	
6-10	15 (22.7)	3 (27.3)	
10+	41 (61.1)	2 (18.2)	
Don't know/not answered	7 (10.6)	2 (18.2)	
Number of weekly vascular surgical sessions provided by visiting vascular surgeons			
1-5	52 (78.8)	7 (63.6)	
6-10	2 (3.0)	2 (18.2)	
10+	0 (0.0)	0 (0.0)	
Don't know/not answered	12 (18.2)	2 (18.2)	

In terms of facilities for vascular care, the VSGBI recommends that vascular units providing arterial surgery should have:

- at least one hybrid endovascular theatre,
- wards dedicated to vascular patients [VSGBI 2015; p. 23-4], and
- the facility to provide urgent access to duplex scanning of carotid arteries to support stroke care.

In 2015, fewer than half (43%) of the vascular units reported that they had at least one hybrid theatre, though at least some dedicated vascular beds were available in all NHS trusts. At the time of the present survey, 59% of hubs and non-network NHS trusts reported having a hybrid theatre and having access to this facility for vascular procedures (Table 2.3). The responding units had a range of ward facilities available for vascular patients' post-procedure recovery, and the availability of diagnostic services in-hours was generally good. However, apart from access to CT scans, diagnostic services were not widely available out-of-hours. Providing these out of hours would help to achieve the national Clinical Standard for Seven Day Services.

2.4 Complex aortic aneurysm repair

A total of 48 vascular units reported carrying out complex aortic procedures (Table 2.4). Of these, 40 (83.3%) reported that there was a complex aortic MDT. This was always attended by vascular surgeon in 95.0% of the 48 units, by interventional radiologists in 85.0% and by cardiothoracic surgeons in 27.5%. Other professionals were reported always attending at 25.0% NHS trusts.

Table 2.4. Provision of Complex Aortic Aneurysm repair (NHS trusts = 48)

Staff performing specific procedures	**NHS trusts N (%)**
TEVAR	
Vascular surgeons	34 (70.8)
Interventional radiologists	27 (56.3)
Cardiothoracic surgeons	3 (6.3)
BEVAR	
Vascular surgeons	28 (58.3)
Interventional radiologists	26 (54.2)
Cardiothoracic surgeons	0 (0.0)
FEVAR	
Vascular surgeons	38 (79.2)
Interventional radiologists	32 (66.7)
Cardiothoracic surgeons	0 (0.0)
Open thoraco-abdominal AAA repairs	
Vascular surgeons	18 (37.5)
Interventional radiologists	0 (0.0)
Cardiothoracic surgeons	13 (27.1)
Open aortic root and arch repair	
Vascular surgeons	5 (10.4)
Interventional radiologists	0 (0.0)
Cardiothoracic surgeons	25 (52.1)
Hybrid open and endovascular procedures of chest /abdomen	
Vascular surgeons	25 (52.1)
Interventional radiologists	17 (35.4)
Cardiothoracic surgeons	17 (35.4)
Facilities available for the following procedures	**NHS trusts, N (%)**
Cerebrospinal fluid drainage	39 (81.3)
Open thoracotomy	32 (66.7)
Cardiac bypass surgery	23 (47.9)
Complex combined open aortic arch surgery and TEVAR	24 (50.0)

2.5 Major lower limb amputations

In all, 73 hospitals reported performing lower limb amputations. In five hospitals (6.9%, all spokes) only minor amputations (below ankle) were performed, and the 68 hub hospitals (93.2%) performed both minor and major amputations (below and above ankle).

The 2014 NCEPOD report "Lower Limb Amputation: Working Together" set out various recommendations for lower limb amputations [NCEPOD 2014: p. 123-4], notably that:

- amputations should be performed on an elective operating list
- patients having amputations should be reviewed pre-and post-operatively by a multidisciplinary team including specialists in vascular surgery, physiotherapy, occupational therapy, diabetology, radiology, and specialist nursing
- a consultant vascular surgeon should undertake or at least be present in the operating theatre for all amputations
- There should be a complex discharge co-ordinator for lower limb amputees

The results of the 2018 NVR organisational survey suggest that many NHS trusts are not meeting these recommendations (Table 2.5). Whilst nearly all major amputation patients are being assessed by a consultant vascular surgeon, many patients are not discussed at an MDT or have their operation on an elective operating list.

Table 2.5. Availability of staff and services for major lower-limb amputations

Pre-operative assessments	**Number (%) trusts in 2018 (n=68)**	**Number (%) trusts in 2015 (n=83)**
Proportion of patients assessed by a consultant vascular surgeon		
<50%	1 (1.5)	2 (2.4)
50-80%	1 (1.5)	8 (9.6)
90-100%	66 (97.1)	73 (85.5)
Proportion of patients discussed at an MDT		
<50%	20 (29.4)	19 (22.9)
50-80%	22 (32.4)	43 (51.8)
90-100%	26 (38.2)	20 (24.1)
Proportions of operations performed on an elective list		
<50%	19 (27.9)	17 (20.5)
50-80%	30 (44.1)	51 (61.4)
90-100%	19 (27.9)	15 (18.1)
Patients usually assessed by		
Consultant in Rehabilitation Medicine	8 (11.8)	11 (13.1)
Rehabilitation physiotherapist	61 (89.7)	66 (79.5)
Care for the Elderly physician	19 (27.9)	9 (10.7)
Occupational therapist	53 (77.9)	51 (60.7)
Podiatrist (for care of contralateral limb, if applicable)	24 (35.3)	27 (33.1)
Prosthetics service representative	17 (25.0)	21 (25.0)

2.6 Interventions for peripheral artery disease (PAD)

Lower-limb angioplasty for PAD was performed at all 77 of the responding NHS trusts: 54 hubs, 11 spokes and 12 non-networked units. Lower-limb angioplasty, amputation rehabilitation and services of a podiatrist were available in-hours in the majority of the trusts. Just under half of the trusts reported that angioplasties were also performed out-of-hours and during daytime in the weekend (Table 2.6). The vascular leads reported that, in 46% of the 77 NHS trusts, vascular surgeons performed both elective and emergency angioplasty, supplementing the interventional radiology provision. In one trust, angioplasty was reported to be offered by a vascular surgeon alone.

Table 2.6. Availability of interventions for PAD (n=73)

Interventions for PAD	**N (%) NHS trusts**			
	Weekday In-hours	Weekday Out-of-hours	Daytime weekends	24/7
Lower-limb angioplasty	67 (87.0)	36 (46.8)	36 (46.8)	43 (55.8)
Amputation rehabilitation	69 (89.6)	10 (13.0)	23 (29.9)	5 (6.5)
Podiatrist	72 (93.5)	3 (3.9)	7 (9.1)	1 (1.3)

Waiting times for critical limb ischaemia (CLI) patients are described in Table 2.7. The VSGBI recommends that patients with CLI who require a revascularisation procedure, should have it within 24-48 hours of presenting [VSGBI 2015].

Of the 77 responding trusts, 42% reported that about 1 in 10 patients waited longer than 48 hours for transfer from spoke to hub in the month preceding the survey, and 25% reported that about 20-50% of patients waited this long. However, waiting for 48 hours or longer for angioplasty or bypass was common. Also, more than half (52.2%) of the respondents reported that more than 50% of patients waited 48 hours or longer for repatriation from the hub to the spoke. (For further details on pathways for patients undergoing lower limb bypass or angioplasty, see Chapters 7 and 8, respectively.)

Table 2.7 Pathways for CLI patients (n=77 NHS trusts)

Pathway details	Number (%)
Proportion of CLI transfer patients who waited for transfer from spoke to hub for more than 48 hours during the last month	
About 10% or fewer	32 (41.6)
About 20-50%	19 (24.7)
More than 50%	10 (13.0)
Don't know/not answered	16 (20.8)
Proportion of CLI patients waited for more than 48 hours for lower limb angioplasty during the last month	
About 10% or fewer	8 (10.4)
About 20-50%	38 (49.4)
More than 50%	24 (31.2)
Don't know/not answered	7 (9.1)
Proportion of CLI patients who waited for more than 48 hours for lower limb bypass during the last month	
About 10% or fewer	14 (18.2)
About 20-50%	31 (40.3)
More than 50%	26 (33.8)
Don't know/not answered	6 (7.8)
Proportion of CLI patients who waited for longer than 48 hours for repatriation from hub to spoke hospital during the last month	
About 10% or fewer	8 (10.4)
About 20-50%	13 (16.9)
More than 50%	39 (50.7)
Don't know/not answered	17 (22.1)

2.7 Conclusion

Most NHS trusts (54%) responding to the NVR organisational audit reported that they were a part of a vascular network, but overall, reconfiguration is still underway in many organisations.

The availability of staff and facilities appeared to have improved in some areas since the last organisational audit in 2015. For example, the greater numbers of patients being assessed by consultants demonstrates good progress, although the target of all patients being assessed by consultants and discussed at MDTs has not yet been achieved at all NHS trusts. And, as in the last survey, vascular units had general good access to the in-hours diagnostic services, but the out-of-hours availability could be improved in many units.

The organisational audit findings suggest that the pathways and care for lower limb amputations seem better than in those reported by the NCEPOD in 2014, but that there is still room for improvement in many areas.

3. Carotid Endarterectomy

3.1 Background

In the UK, around 4,000-5,000 patients undergo a carotid endarterectomy (CEA) each year. The information in this report primarily concerns the carotid procedures performed between 1 January 2017 and 31 December 2017. During this period, data were submitted by 476 surgeons, who were working at 84 NHS trusts and Health Boards in England, Wales, Scotland and Northern Ireland. Data were submitted to the Registry on a total of 4,148 interventions, which covered:

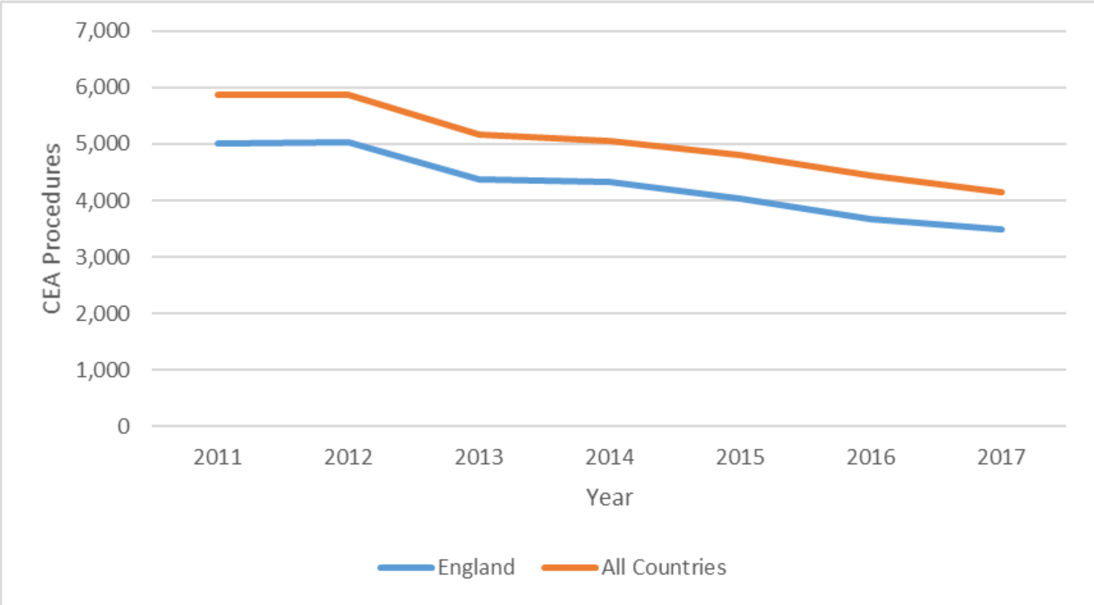
- 3,856 symptomatic patients
- 4,148 cases with complete 30 day survival information
- 2,974 cases for whom information was submitted on a follow-up appointment

The number of carotid endarterectomies reported to the NVR in 2018 was considerably lower than in the previous two years (Figure 3.1). This is mainly attributed to the procedures reported in England, which shows a parallel decline. Furthermore, it seems to reflect an overall reduction in the number of procedures being performed (a 15% drop in two years) rather than a drop in case-ascertainment, which has been consistently high for all three years (Table 3.1). There appears to be a number of reasons for this decline in procedures, and a paper is planned to investigate them. The 2017 estimated case-ascertainment figures for the four nations were: 90% for England, 93% for Northern Ireland, 75% for Scotland and 99% for Wales.

Table 3.1: Estimated case-ascertainment of carotid endarterectomy in the UK

	2015	2016	2017	Total
Audit procedures	4,797	4,445	4,148	13,390
Expected procedures	5,173	4,830	4,661	14,664
Estimated case-ascertainment	93%	92%	89%	91%

Figure 3.1: Number of CEAs performed between 2011 and 2017



3.2 Treatment pathways

Despite the reduction in the level of surgical activity over time, the characteristics of the cohort has remained stable (see appendix 3). The mean age of patients was 72 years, and there was no obvious fall in the proportion of older or more comorbid patients being treated. Similarly, the distribution of symptoms and degree of stenosis was relatively unchanged:

- Nearly three-quarters of the patients had at least 70% stenosis in their ipsilateral artery at the time of operation, and 93.0% were symptomatic.
- Among the 3,856 patients with symptomatic disease, TIA was the most common symptom (46.5%) followed by stroke (36.4%). Of the strokes, 12.1% had pre-operative thrombolysis. Only 1.0% of patients had a previous ipsilateral treatment.
- Medication for cardiovascular conditions was common among patients prior to surgery. Overall, 93.0% were on antiplatelet medication, while 87.6% were taking statins. ACE inhibitors and beta blockers were being taken by 37.9% and 24.1% of patients, respectively.

Patients may be referred for carotid endarterectomy from various medical practitioners. The most common source of referral is the stroke physician, with the proportion of patients increasing from 75.8% in 2013 to 84.4% in 2017. Other referral sources in 2017 were: neurologists (3.5%), general practitioners (3.2%) and vascular surgeons (2.7%).

The current NICE guideline (CG68) recommends two weeks as the target time from symptom to operation in order to minimise the chance of a high-risk patient developing a stroke [NICE 2008]. In the years from 2009 to 2012, there was a steady decline in the median time from the index symptom to operation for symptomatic patients, falling from 22 days (IQR 10-56) in 2009 to 13 days (IQR 7-28) days in 2012. The proportion of patients who were treated within 14 days rose from 37% to 56%. This figure has been relatively stable since then, with the median time for symptomatic patients in 2017 being 12 days (IQR 7-23) and 59% of patients being treated within 14 days.

In 2017, the median times along the care pathway were similar for patients with symptoms of stroke or TIA. Patients with amaurosis fugax, where the stroke risk is lower and greater delay is acceptable, took comparatively longer to progress from symptom onset to surgery, with the median delay being 17 days (IQR 10-34).

The patient pathway from symptom to surgery can be split into three distinct points in time. In 2017, the median time delays for these components were:

- 4 days (IQR 1-10) from symptom to first medical referral
- 1 day (IQR 0-4) from first medical referral to being seen by the vascular team, and
- 5 days (IQR 2-11) from being seen by a vascular surgeon to undergoing CEA.

The distribution of symptom to operation times for all NHS trusts is summarised in Figure 3.2. The graph contains figures for all organisations that had 10 or more symptomatic cases with exact symptom and procedure dates. The median time is represented by a black dot. The interquartile ranges (IQRs) are shown by horizontal green lines. Any upper quartile line that is red indicates that the upper quartile value was above 100 days. This typically occurs when the number of patients with exact symptom and procedure dates for that NHS organisation is relatively small. The vertical red line in the graph represents the current NICE guideline of 14 days from symptom to procedure. The dashed blue line shows the recommended time of 7 days from the GIRFT report [Horrocks, 2018].

Figure 3.2 shows that there was considerable variation among NHS trusts in the median time to surgery during 2017. The median was 14 days or less for 58 of the 78 organisations and the median exceeded 20 days for 8 vascular units, half the number found for 2016. The values for the individual organisations can be found in Appendix 5.

Figure 3.3 shows the eight NHS trusts where the symptom to procedure times were the longest in 2017. When looking at the patient pathway by the different components, it can be seen that the symptom to referral times for the eight organisations are within 11 days. However, for one NHS trust, the median time from referral to first being seen by the surgical team was nearly 30 days. The time from being seen to the procedure ranged from 4 to 14 days.

Figure 3.2: Median time (and interquartile range) from symptom to procedure by NHS trust for procedures done between January and December 2017

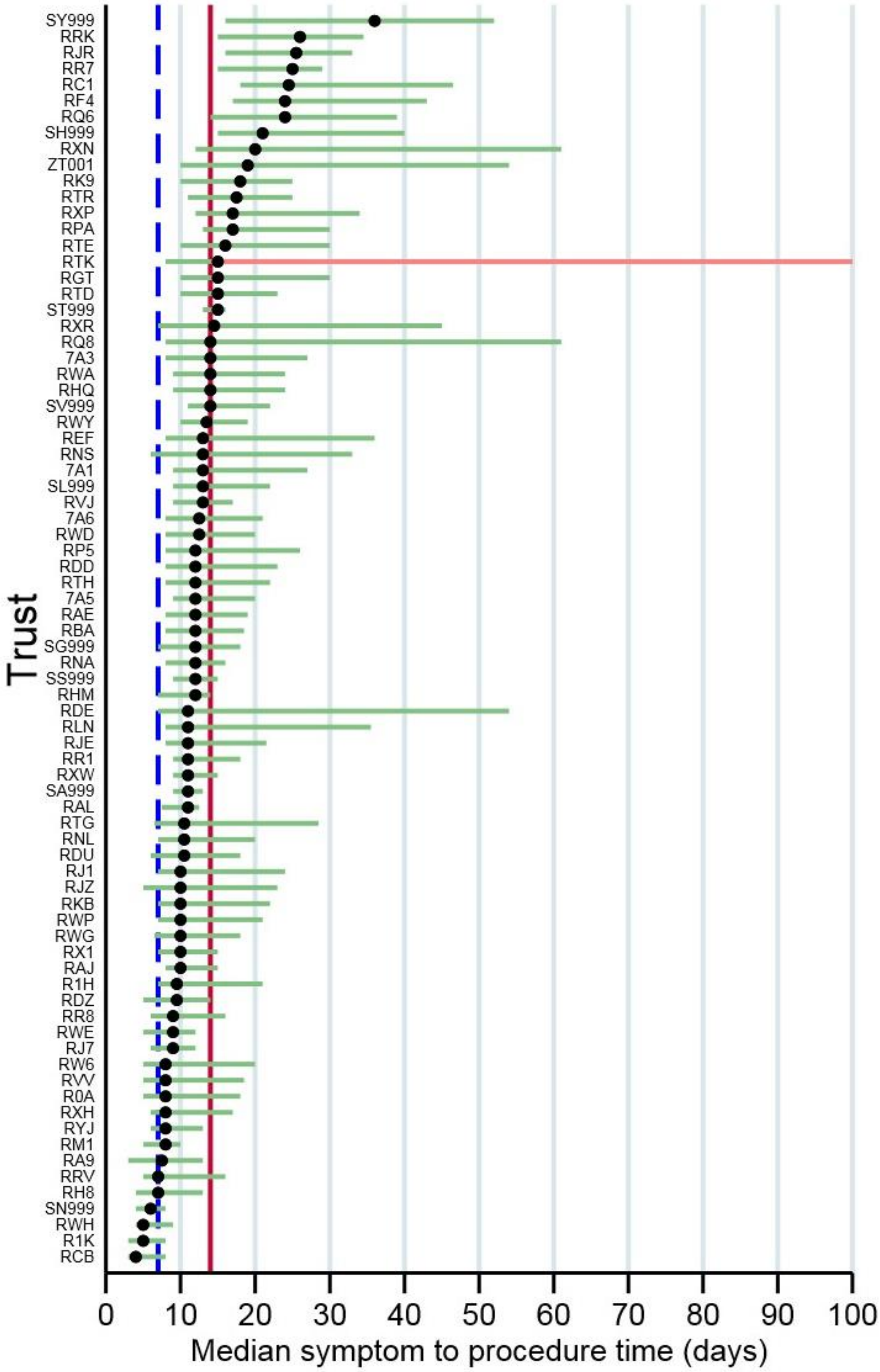
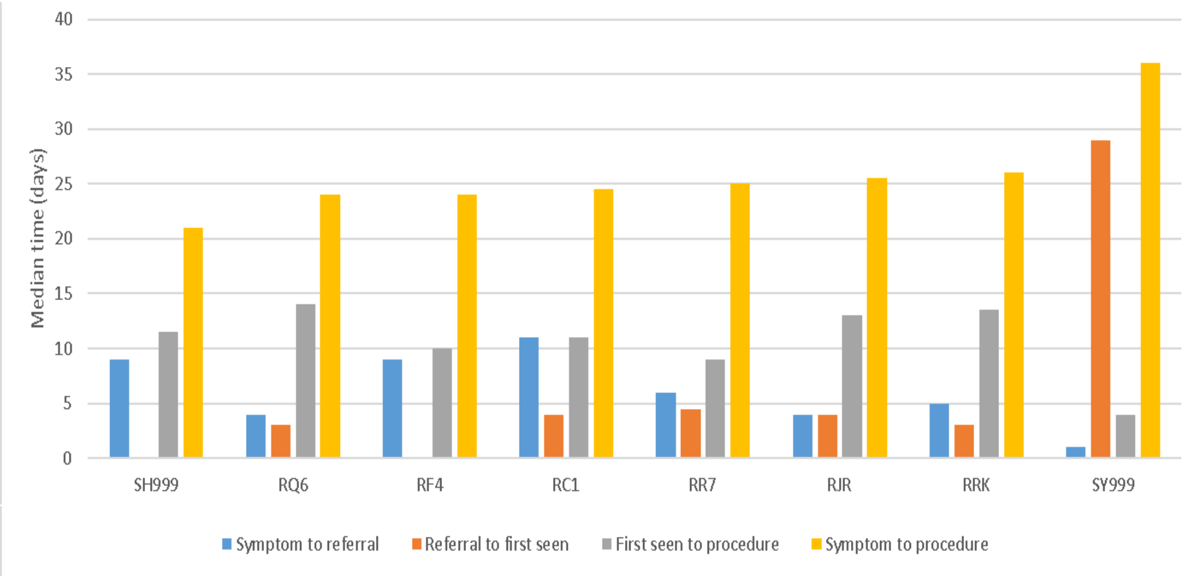


Figure 3.3: Median times for the eight NHS trusts in 2017 who had the longest symptom to procedure times.



Organisational code

3.3 Postoperative surgical outcomes

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 including a myocardial infarction
- Cranial nerve injury (CNI), which describes damage to one of the nerves to the face and neck

The risk of these various complications was low. For the nearly 13,400 procedures performed in NHS hospitals between 2015 and 2017, the rates of the different complications tended to be around 2% (see Table 3.2) and, over this 3-year period:

- the rate of return to theatre was 2.7% (95% CI 2.4 to 3.0), and
- the rate of readmission within 30 days was 4.3% (95% CI 3.9 to 4.7).

These rates have remained fairly consistent over the last few NVR annual report.

Table 3.2: Postoperative outcomes following carotid endarterectomy

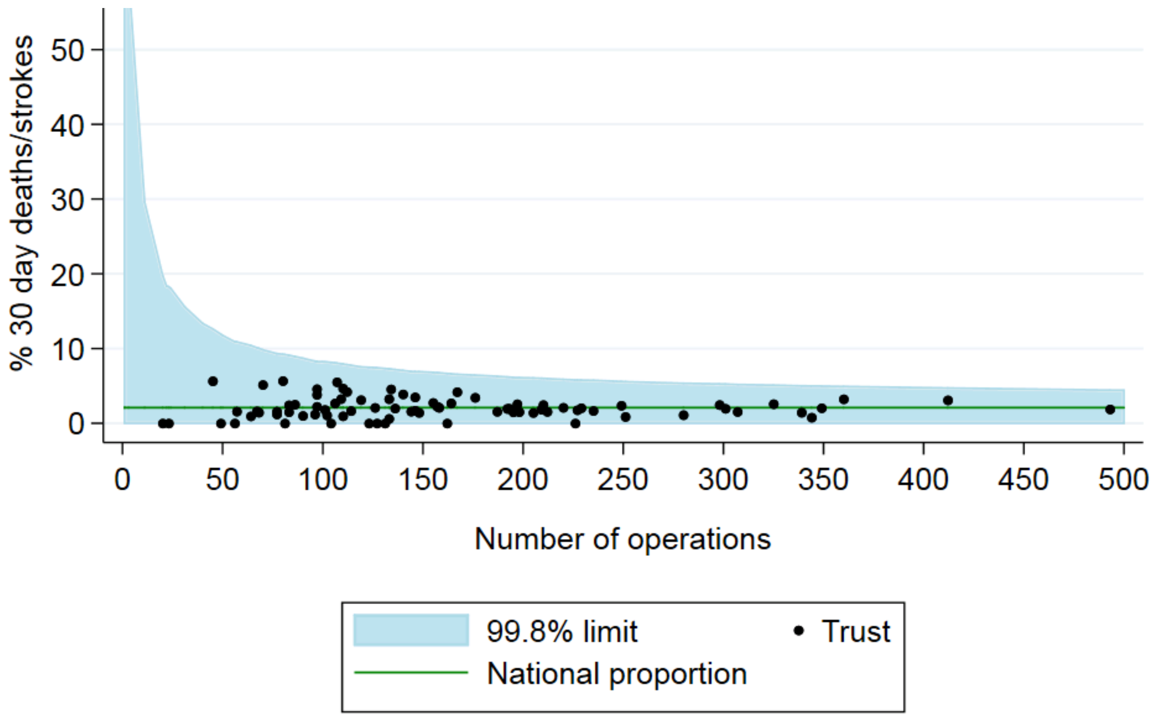
Complication	Procedures in 2015-2017	Complication rate (%)	95% confidence interval
Death and/or stroke within 30 days	13,390	2.1	1.9-2.3
Stroke within 30 days	13,390	1.7	1.5-1.9
Bleeding within admission	13,389	2.3	2.1-2.6
Myocardial Infarct within admission	13,389	1.3	1.1-1.5
Cranial nerve injury within admission	13,299	1.9	1.7-2.2

3.4 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 values for each NHS trust for this outcome are described in this section. To account for differences between the characteristics of patients treated at the various organisations, we calculated risk-adjusted rates using a logistic regression model. This model took into account the patient age, atrial fibrillation, their preoperative Rankin score and ASA grade.

The comparative, risk-adjusted 30 day death/stroke rates for individual NHS trusts are shown in the funnel plot in Figure 3.4 [Spiegelhalter 2005]. The horizontal axis shows surgical activity with dots further to the right showing the organisations that perform more operations. The 99.8% control limit defines the region within which the mortality rates would be expected to fall if the organisations' outcomes only differed from the national rate because of random variation.

Figure 3.4: Funnel plot of risk-adjusted rates of stroke/death within 30 days for NHS trusts, for carotid endarterectomies between January 2015 and December 2017



The overall national average rate of stroke/death within 30 days = 2.1%

The funnel plot shows that the risk-adjusted rate of death/stroke within 30 days for all NHS organisations were all within the expected distance of the overall national average rate of 2.1% (i.e., they were within the 99.8% control limits). Appendix 5 gives the figures for each organisation.

3.5 Conclusion

The data collected on carotid interventions in 2017 revealed that the previously observed fall in the number of carotid procedures submitted to the NVR is continuing. This seems to reflect an overall reduction in activity rather than a drop in case-ascertainment. The reasons for this change are unclear, but it might reflect a change in the epidemiology of risk factors for stroke.

Despite this reduction in activity, there was little change in the median time from symptom to surgery. This seems to have stabilised around 12 days, with 59% of patients having their surgery within the recommended time. The results continue to show improvement in the time to intervention across NHS trusts, with just 8 NHS trusts having a median above 20 days. The clinical teams and the executives of these organisations need to explore how they can meet the NICE recommendations. There are a number of vascular units that demonstrate it is possible to achieve a pathway of care that meets the NICE recommended standard for this treatment. However, during 2017, few were able to meeting the 7 day time interval proposed by GIRFT.

Despite these problems of delay at some organisations, the results show that carotid surgery continues to be performed safely in the NHS, with low rates of stroke and other post-operative complications. Most patients undergo carotid endarterectomy (in one form or another), with few centres adopting carotid stenting. This perhaps reflects the lack of evidence for stenting conferring any advantage to patients.

4. Repair of abdominal aortic aneurysm

4.1 Background

Between 1 January 2015 and 31 December 2017, the NVR received information on AAA repairs from 92 NHS organisations, decreasing to 84 by 2017. This included 77 from England, 5 in Wales, 9 in Scotland, and 1 in Northern Ireland. These organisations submitted data on 12,861 elective infra-renal AAA procedures, which gives an overall case-ascertainment of approximately 90%. There was only a slight decrease in the number of AAA repairs performed in 2017 compared to 2016 (a fall of 1%) suggesting a levelling off after a more noticeable decline in previous years.

The estimated 2017 case-ascertainment figures for the four nations were approximately 90% for England, 100% for Wales, 100% for Northern Ireland and 74% for Scotland. The overall case-ascertainment has remained fairly stable over the last three years (Table 4.1).

The estimated case-ascertainment figures for individual NHS trusts may differ slightly from those published on www.VSqip.org.uk website due to the different time periods covered.

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

	2015	2016	2017	Total
Audit procedures	4,389	4,264	4,208	12,861
Expected procedures	4,813	4,812	4,668	14,293
Estimated case-ascertainment	91%	89%	90%	90%

** 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.

From 2009 to 2013, we observed an increase in the proportion of repairs being performed as endovascular (EVAR) procedures (54% in 2009 rising to 66% in 2013). This trend has stabilised over the last few years, with EVAR procedures accounting for 68% of the elective infra-renal AAA repairs in 2017. 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. Few patients had AAAs with a diameter of less than 5.5cm, the typical threshold at which patients may be advised to have surgery. Patients were often rated as having poor levels of fitness, with severe systemic disease (ASA grade 3). This is to be expected given the high prevalence of other cardiovascular diseases; 7 in 10 had hypertension and about 4 in 10 patients suffered from some form of heart disease. A large proportion of patients were also on medication when assessed pre-operatively.

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 91.3% of procedures
- The median proximal aortic neck diameter and length were 24 mm (IQR 22 to 26) and 25 mm (IQR 18 to 32), respectively
- There were 451 (16.3%) procedures that unilaterally extended into the iliac artery and 132 (4.8%) procedures required bilateral limb extensions

Among the open repairs, the most common type of repair was with a straight ‘tube’ graft (65.3%), followed by a bifurcated graft (34.5%).

4.2 Preoperative care pathway for elective infra-renal AAA

The VSGBI AAA Quality Improvement Framework [VSGBI 2012] made various recommendations about the preoperative pathway of care for elective patients with infra-renal AAA. These include:

- 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 2017 are presented alongside the figures for the previous two years in Table 4.2, and suggest that the majority of patients are receiving care that is consistent with the recommended pathway. The overall proportion of patients having pre-operative CT/MR angiography and MDT assessment was lower than expected although it has increased over the last three years. 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 4.2. Overall compliance with standards related to the elective AAA care pathway

	Percentage of patients meeting standard		
	2017	2016	2015
Elective patients were discussed at MDT meetings	83.0 (3,493/4,208)	78.3	74.4
Patients with an AAA diameter ≥ 5.5cm deemed suitable for repair had a pre-operative CT/MR angiography assessment	89.1 (3,364/3,777)	84.9	84.1
Patients underwent a formal anaesthetic review	96.3 (4,053/4,208)	96.6	96.0
Patients whose anaesthetic review was done by a consultant vascular anaesthetist	91.6 (3,712/4,053)	91.9	92.2
Patients had their fitness measured	84.7 (3,565/4,207)	83.9	82.2
Most common assessment methods:			
CPET	49.1	47.1	47.6
Echo +/- pulmonary function tests	43.5	45.6	n/a

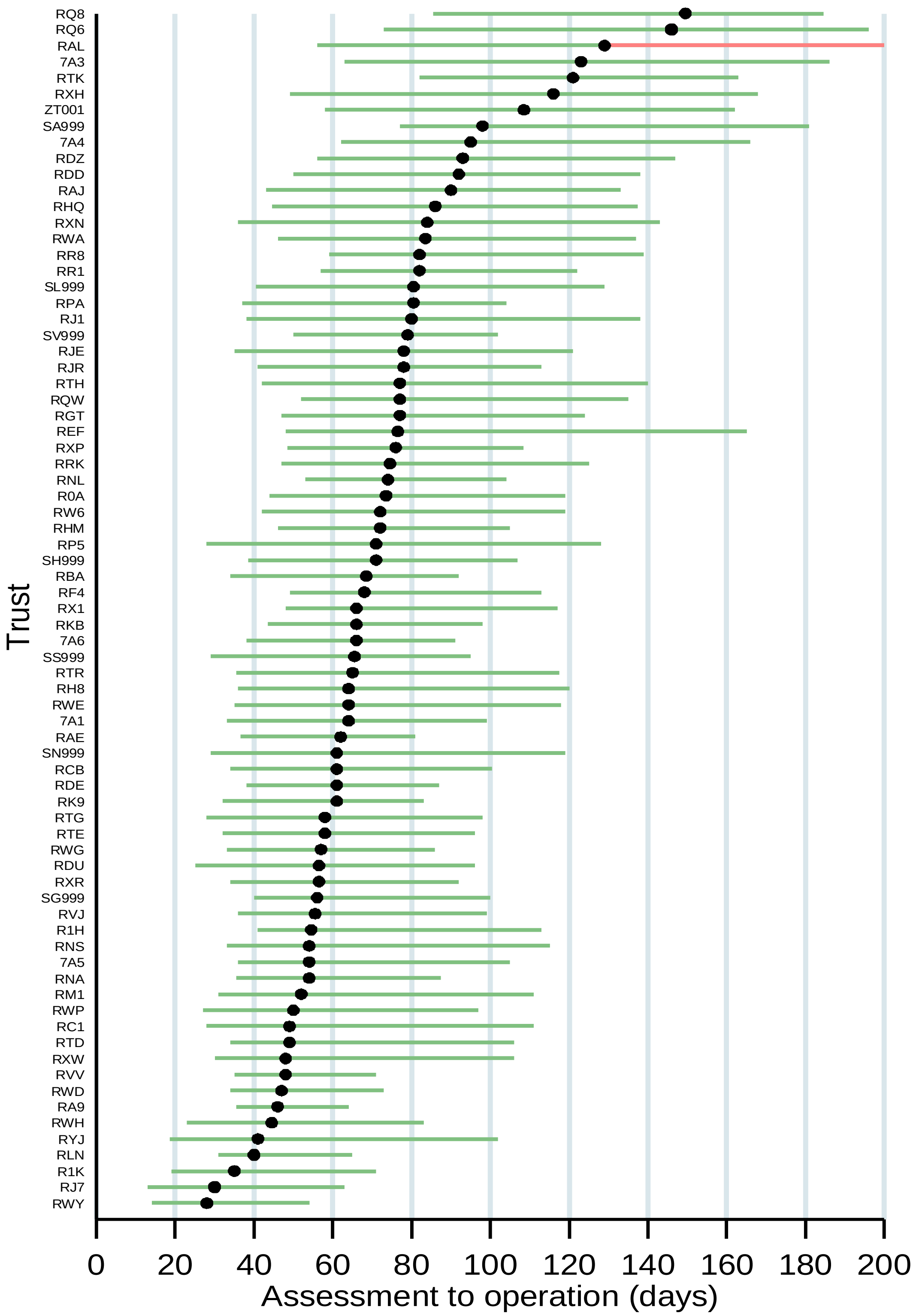
The National AAA Screening Programme has emphasised the importance of the timely scheduling of an elective repair to mitigate the risk of a patient's AAA rupturing while waiting for treatment. The absolute risk of rupture is small but the NAAASP recommends a target of 8 weeks from the date of referral from the NAAASP to the date of the repair.

For elective infra-renal AAA repairs, the time from vascular assessment to surgery covers an important component of the referral process that is under the direct control of vascular services. Figure 4.1 (overleaf) summarises the variation among NHS trusts in the median (IQR) time from vascular assessment to surgery for procedures performed in 2017. The graph contains figures for all organisations that had 10 or more infra-renal AAA repairs with assessment and procedure dates. The median time is represented by a black dot. The interquartile ranges (IQRs) are shown by horizontal green lines. Any upper quartile line that is red indicates that the upper quartile value was above 200 days. This typically occurs when the number of patients with assessment and procedure dates for that NHS organisation is relatively small.

The median delay at the majority of vascular units tended to fall within the range of 60 to 90 days. Nonetheless, the upper limit of the interquartile ranges shows that, at 16% of the vascular units (12 of 75), 25% of patients operated on in 2017 waited more than 140 days. While there are legitimate reasons for some patients to wait for surgery, such as the investigation and optimisation of comorbid medical conditions, we note that 140 days is well over the National AAA Screening Programme target of 8 weeks from date of referral to surgery. In addition, the analysis only covers the period from vascular assessment to surgery.

The values for the individual organisations can be found in Appendix 6.

Figure 4.1: Median (IQR) time from assessment to treatment (days) for patients who had elective infra-renal AAA repair between January and December 2017



4.3 Postoperative outcomes after elective infra-renal AAA repair

The overall patterns of postoperative care are summarised in Table 4.3. There were 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. Among those admitted to either level 2 or 3 critical care, the median length of stay was 1 day. The median length of the overall postoperative stay was 2 days. 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 8 days, and they had a comparatively high in-hospital mortality rate. Patients having open repair were more susceptible to cardiac, renal and respiratory complications, and the rate of return to theatre was also higher. The procedures had comparable 30 day readmission rates.

Table 4.3: Postoperative details of elective infra-renal AAA repairs undertaken between January and December 2017

		Open AAA (n=1,338)		**EVAR (n=2,870)**	
Admitted to	Ward	2.4%		64.9%	
	Level 2	58.0%		32.2%	
	Level 3	39.6%		2.9%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	2	1 to 4	1	0 to 1
	Level 3	2	1 to 4	1	1 to 2.5
Hospital length of stay (days)		8	6 to 11	2	1 to 4
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		3.2	2.3 to 4.3	0.7	0.4 to 1.1
Defined complications					
	Cardiac	6.4	5.1 to 7.8	1.5	1.1 to 2.0
	Respiratory	11.1	9.5 to 12.9	1.7	1.3 to 2.3
	Haemorrhage	2.1	1.4 to 3.0	0.5	0.3 to 0.8
	Limb ischaemia	2.2	1.5 to 3.2	0.9	0.6 to 1.3
	Renal failure	5.3	4.2 to 6.6	1.1	0.7 to 1.5
	Other	3.4	2.5 to 4.6	0.4	0.2 to 0.7
None of predefined complications		78.0	75.7 to 80.2	94.9	94.0 to 95.7
Return to theatre		6.4	5.2 to 7.9	2.0	1.5 to 2.6
Readmission within 30 days		5.5	4.2 to 7.1	5.8	4.9 to 6.8

Patients undergoing EVAR procedures may experience an endoleak, in which blood still enters the aneurysm sac after the stent is inserted. Type II endoleaks (in which blood flows into the sac from other branches of the aorta) are the most common and least serious type. These may not require immediate treatment as some will resolve spontaneously. 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 2017:

- 2,273 (80.5%) procedures experienced no endoleak while the patient was in hospital
- Type 1 endoleaks occurred in 160 (5.7%) procedures
- 193 endoleaks (of any type) required intervention at the time of the procedure

4.4 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 2015 to 31 December 2017. 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 4.2. The horizontal axis shows surgical activity with dots further to the right showing the hospitals that perform more operations. The 99.8% control limit defines the region within which mortality rates would be expected to fall if NHS trust outcomes only differed from the national rate because of random variation. The overall in-hospital mortality rate was 1.3%, 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 4.3A and 4.3B 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 period between 2015 and 2017 were 3.0% and 0.6%, respectively.

Figure 4.2: Risk-adjusted in-hospital mortality rates after elective infra-renal AAA repair among NHS vascular units for procedures performed between January 2015 and December 2017. The overall in-hospital mortality rate was 1.3%.

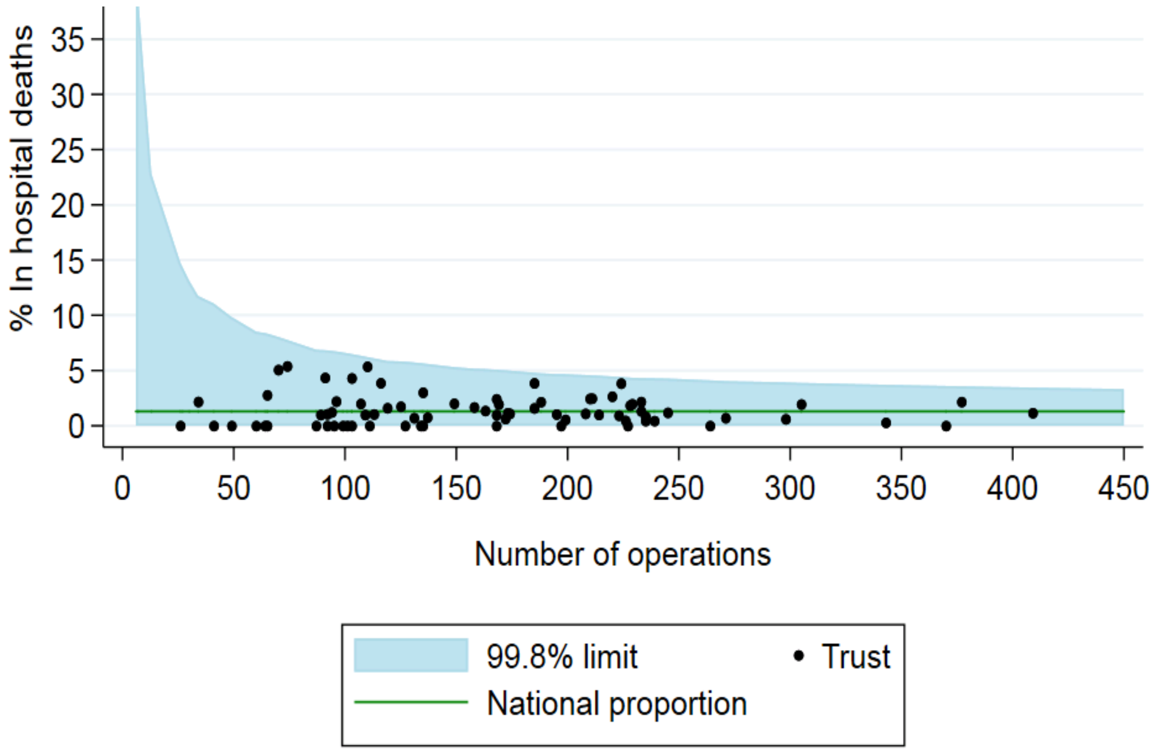
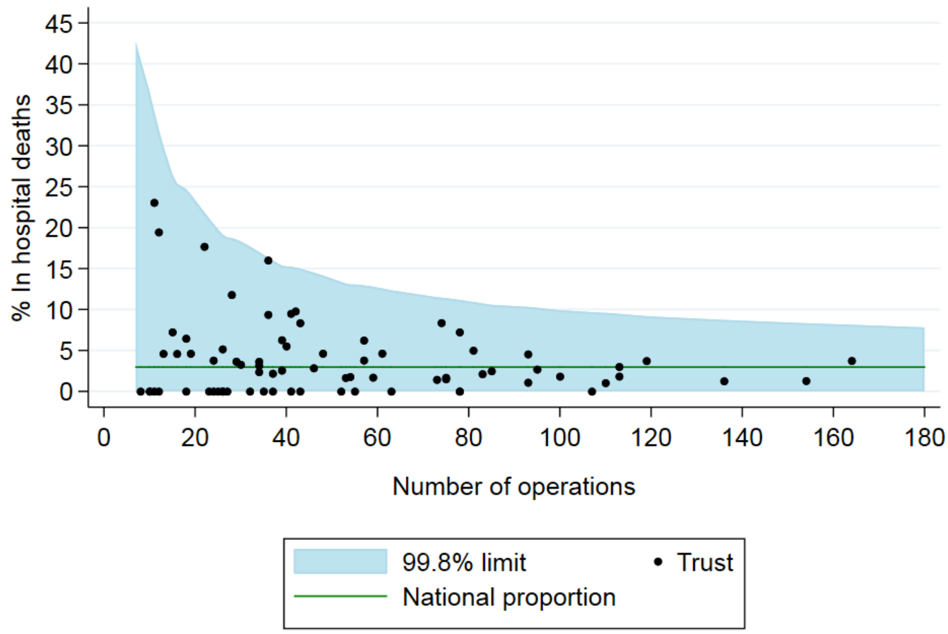
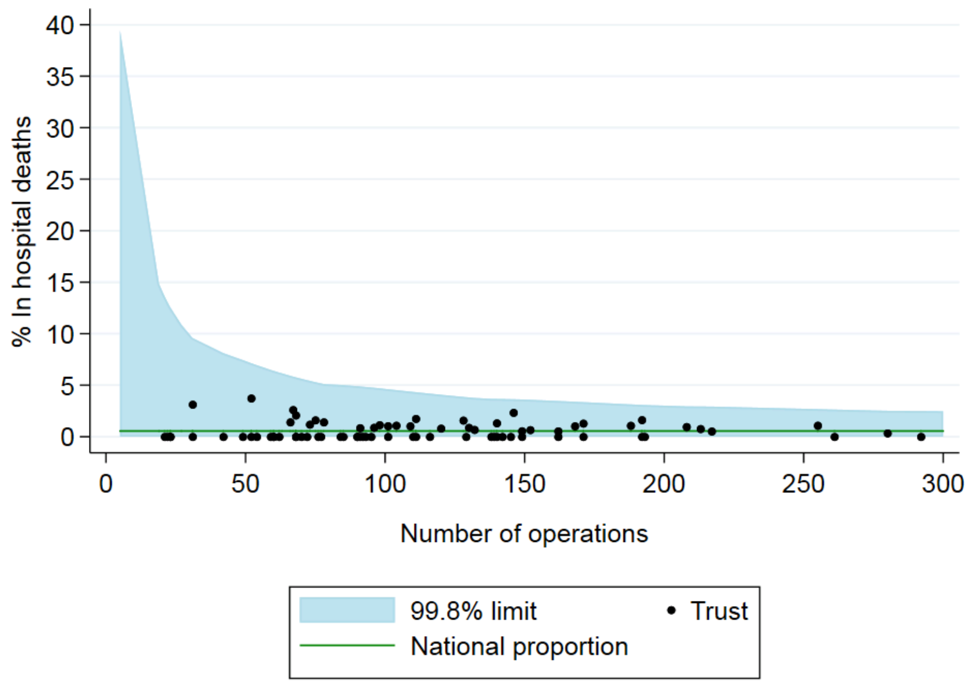


Figure 4.3: Funnel plot of risk-adjusted in-hospital mortality after elective AAA repair for open and EVAR procedures. The overall in-hospital mortality rates for open and EVAR procedures performed between 2015 and 2017 were 3.0% and 0.6%, respectively.

A: Open repairs



B: EVAR procedures



4.5 Conclusion

For many years, the focus of quality improvement around elective infra-renal AAA surgery has been to reduce postoperative mortality. In 2008, the mortality rate following elective infra-renal AAA repair in the UK was 7%; by 2013, it had fallen to 2.4%. The results in this report show that vascular units continue to improve the safety of the procedure, and all are performing at a similar standard of care.

Nonetheless, postoperative mortality only reflects one part of the spectrum of outcomes that are important to patients, and this report highlights various issues for NHS trusts to examine along the care pathway. While many patients received care that met the VSGBI standards for pre-operative assessment, individual NHS trusts with comparatively low rates of compliance should examine how performance can be improved. Firstly, over 15% of patients were not discussed at an MDT meeting. Secondly, while the time from vascular assessment to surgery may legitimately be many weeks for individual patients, the overall pattern of delay for individual vascular units should ideally be consistent with the 8 weeks referral to repair target. A significant proportion of vascular units did not meet this standard and should investigate how the time to surgery can be shortened.

5. Elective repair of complex aortic conditions

5.1 Patterns of complex aortic surgery

Most abdominal aortic aneurysms occur below the point where arteries branch from the aorta to the kidneys (infra-renal). Aortic aneurysms may occur in other locations, however, and those that occur above this point are typically more complex in their physical shape. Aneurysms that occur above this point are categorised into three types:

- 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)

Endovascular procedures are increasingly being performed instead of open surgery for complex aneurysm repair as new endovascular grafts have been developed. Collectively these procedures are known as complex endovascular repairs, but the term covers a number of techniques. 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 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 2015 and December 2017. NHS trusts have submitted 2,303 records related to complex AAA procedures, with the numbers increasing annually (703 procedures in 2015, 742 in 2016 and 858 in 2017). These cases were submitted by 75 vascular units, and the volume of activity within these units ranged from 1 to 306 procedures (median=14). 55 of these units performed fewer than 30 procedures over the three years. Of these procedures, 2,074 (90%) were endovascular (Table 5.1), with just over half being fenestrated repairs.

Table 5.1: Characteristics of patients who had an elective repair of complex AAA between January 2015 and December 2017

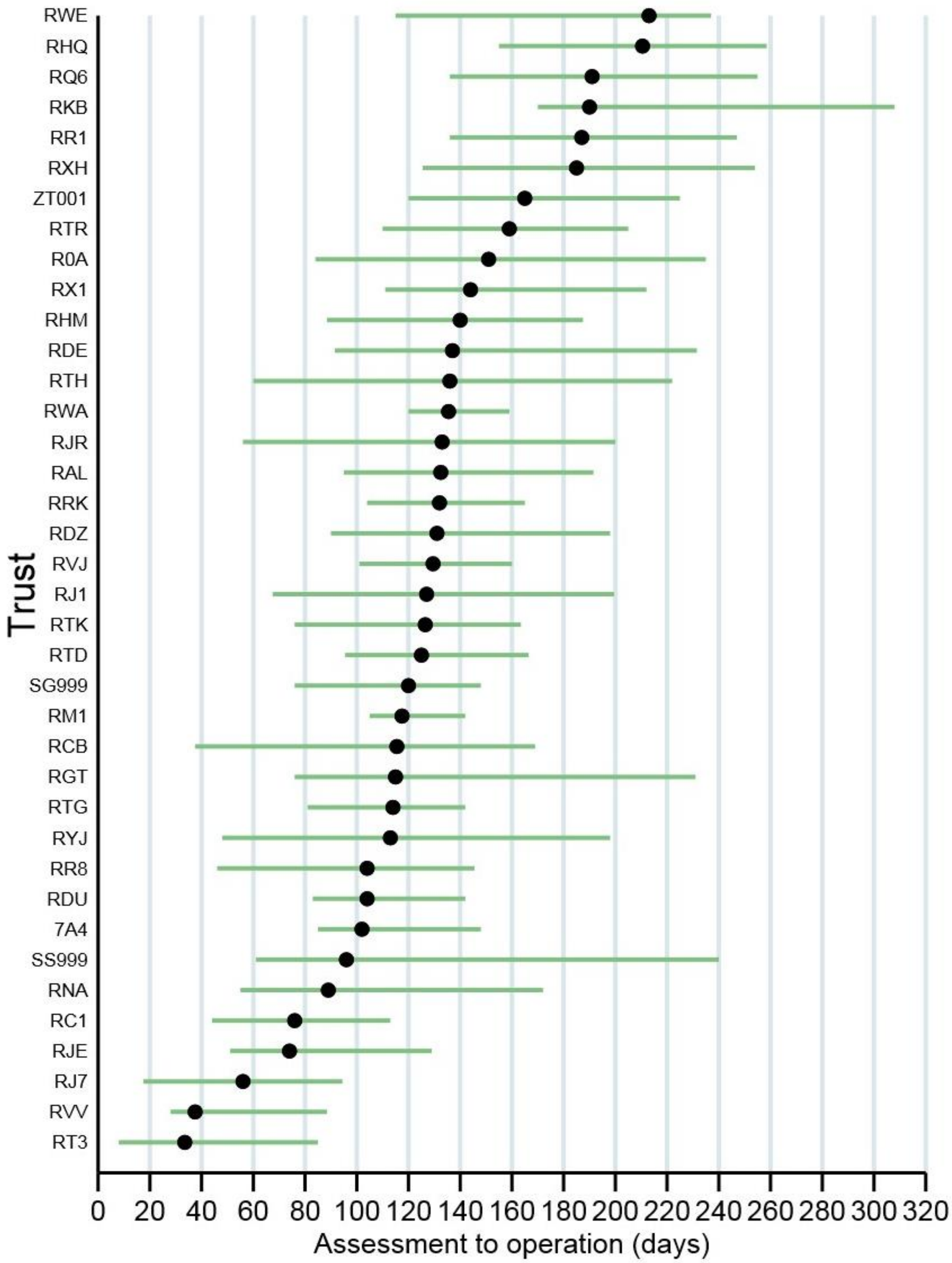
		Open AAA	%	EVAR	%	Total
Total procedures		229		2,074		2,303
Age group (years)	Under 66	56	24.6	311	15.0	367
	66 to 75	109	47.8	845	40.9	954
	76 to 85	62	27.2	850	41.1	912
	86 and over	1	0.4	61	3.0	62
Male		190	83.0	1,721	83.0	1,911
Female		39	17.0	353	17.0	392
Type of procedure	FEVAR			1,117	53.9	
	BEVAR			184	8.9	
	TEVAR			395	19.1	
	Iliac branch graft			252	12.2	
	Composite graft			25	1.2	
	Other (e.g., chimney / snorkel / periscope)			100	4.8	

The time from vascular assessment to surgery for all complex repairs between 2015 and 2017 is shown in Figure 5.1. We chose three years in order to obtain a reasonable volume of data. Nonetheless, the graph only shows the results for 38 of the 75 organisations that undertook 10 or more complex repairs during this time.

The median time from assessment to surgery for all patients was 132 days (79-197). 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 twelve vascular units, 25% of patients having a complex AAA repair between 2015 and 2017 waited more than 220 days.

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 were a non-conventional device was required (42% of endovascular patients), it took 67 days to be obtained on average.

Figure 5.1: Median (IQR) time from assessment to treatment (days) for patients who had an elective complex AAA repair between January 2015 and December 2017



The outcomes of elective repairs for patients with complex AAA are summarised in Table 5.2. For endovascular procedures, over three-quarters of patients were admitted to either level 2 or 3 critical care. For patients undergoing open repair, 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. In addition, open repair patients were four times more likely to return to theatre.

The median length of stay for endovascular repair was slightly shorter than for open repairs (5 v 9 days). Furthermore, patients having endovascular repair were less likely to be readmitted into critical care. There was very little difference in the outcomes between the two most common complex endovascular procedures apart from TEVAR patients experiencing a higher 30 day readmission rate (Table 5.3).

The in-hospital postoperative mortality rates for open and endovascular procedures were around six times greater than the equivalent rates for infra-renal AAA repair, reflecting the complex nature of the disease and surgery.

Table 5.2: Postoperative details of complex AAA repairs undertaken between January 2015 and December 2017

		Open AAA (n=229)		**Endovascular (n=2,074)**	
Admitted to	Ward	1.3%		20.2%	
	Level 2	45.0%		58.7%	
	Level 3	52.8%		21.0%	
	Died in theatre	0.9%		0.1%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	3	1 to 4	2	1 to 3
	Level 3	4	3 to 9	2	1 to 3
Hospital length of stay (days)		9	7 to 18	5	3 to 8
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		18.3	13.5 to 24.0	2.9	2.3 to 3.8
Readmission to critical care		9.7	6.2 to 14.3	2.8	2.1 to 3.6
Return to theatre		20.3	15.2 to 26.1	5.4	4.5 to 6.5
30 day readmission rate		8.0	4.3 to 13.3	7.1	5.9 to 8.5

Table 5.3: Postoperative details of complex TEVARS and FEVARs undertaken between January 2015 and December 2017

		TEVAR (n=395)		FEVAR (n=1,117)	
Admitted to	Ward	14.4%		15.7%	
	Level 2	62.8%		60.6%	
	Level 3	22.8%		23.6%	
	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)		5	3 to 9	5	4 to 8
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		3.5	2.0 to 5.9	2.8	1.9 to 3.9
Readmission to critical care		4.1	2.3 to 6.5	2.3	1.5 to 3.4
Return to theatre		7.1	4.8 to 10.1	5.0	3.8 to 6.5
30 day readmission rate		11.0	7.5 to 15.3	6.4	4.8 to 8.3

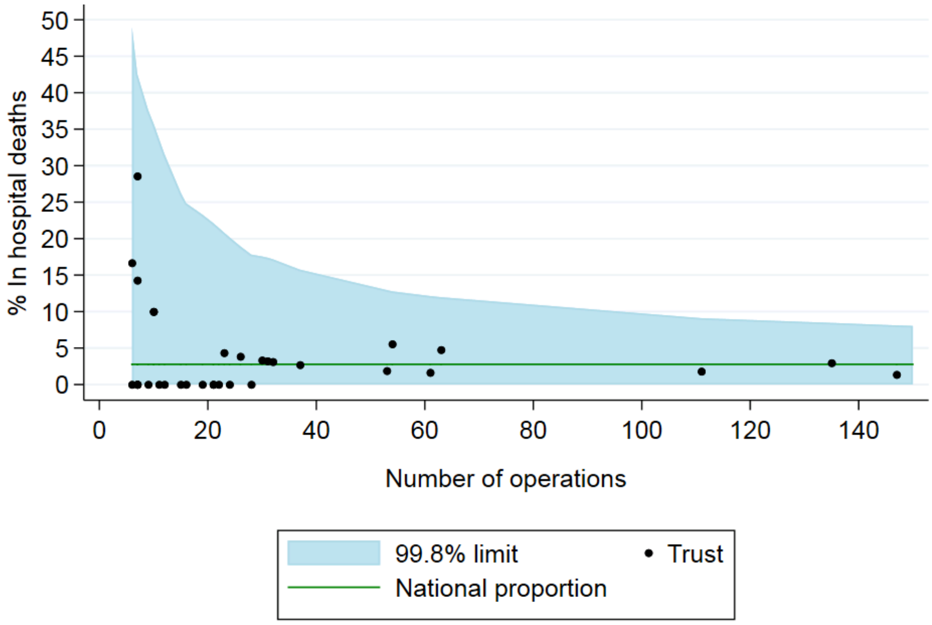
5.2 Postoperative in-hospital mortality for Fenestrated EVAR

This section describes the in-hospital mortality rates for NHS organisations undertaking FEVAR procedures during the period from 1 January 2015 to 31 December 2017.

The unadjusted mortality rates for individual NHS trusts are shown using a funnel plot in Figure 5.2. The horizontal axis shows surgical activity with dots further to the right showing the hospitals that performed more operations. The 99.8% control limit defines the region within which the mortality rates would be expected to fall if the NHS trust outcomes only differed from the national rate because of random variation.

All 33 NHS trusts had an in-hospital mortality that fell within the expected range around the national average of 2.8%, given the number of procedures performed. The rates among the NHS trusts ranged from 0 to 30% but this reflected the relatively low volumes used to calculate these rates.

Figure 5.2: FEVAR in-hospital mortality after Fenestrated EVAR between January 2015 and December 2017



5.3 Conclusion

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. Consequently, as well as supporting NHS trusts to benchmark their delivery of complex AAA repairs, the results are also pertinent to the commissioning of these vascular services.

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.

6. Repair of ruptured abdominal aortic aneurysms

6.1 Surgical activity for ruptured AAA

This chapter describes the outcomes of emergency AAA repairs among patients with a ruptured abdominal aortic aneurysm. We also explore the variation in patient outcomes depending on whether they were operated on during a weekday or weekend. The analysis included procedures performed between 1 January 2015 and 31 December 2017. Details of 2,682 procedures were submitted to the NVR, giving an estimated case-ascertainment of approximately 92%. The proportion of patients having an EVAR procedure over this 3-year period was 29.5% (n=790), slightly up from 27.4% in the period between 2014 and 2016.

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).

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. There was also a higher proportion of over 85 year olds operated on compared to open repair (17.2% versus 7.6%).

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

- 86.8% had a neck angle between 0-60 degrees; for 7.4%, it was 60-75 degrees
- The mean neck diameter was 23.9mm and the mean neck length was 24.6mm
- The aneurysm was extended into either the left / right iliac artery for 18.9% of procedures and was extended bilaterally for 5.4% of procedures.

For patients having open repair, 74.8% underwent tube grafts, 19.4% underwent bifurcated iliac and 5.4% underwent bifurcated groin.

The outcomes of the surgical repair for patients with a ruptured AAA are summarised in Table 6.1. There were some noticeable differences in the postoperative care required by patients undergoing open and EVAR procedures. For patients discharged alive, the median length of stay was 16 days for open repair compared with 10 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 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 42.3% (95% CI 40.1 to 44.6) and 22.9% (95% CI 20.0 to 26.0), respectively.

Table 6.1: Postoperative details of emergency repairs for ruptured AAAs undertaken between January 2015 and December 2017

		Open AAA (n=1,892)		EVAR (n=790)	
Admitted to	Ward	0.3%		9.2%	
	Level 2	7.6%		40.8%	
	Level 3	84.4%		44.8%	
	Died in theatre	7.8%		5.2%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	3	2 to 6	1	1 to 3
	Level 3	4	2 to 9	2	1 to 5
Hospital length of stay (days)		11	3 to 21	8	4 to 15
Discharged alive length of stay		16	10 to 27	10	6 to 16
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		42.3	40.1 to 44.6	22.9	20.0 to 26.0
Defined complications					
	Cardiac	26.2	24.1 to 28.3	14.2	11.8 to 17.0
	Respiratory	33.2	31.0 to 35.5	21.4	18.6 to 24.5
	Haemorrhage	4.6	3.7 to 5.7	2.4	1.4 to 3.8
	Limb ischaemia	11.0	9.5 to 12.5	2.8	1.7 to 4.2
	Renal failure	28.1	26.0 to 30.2	10.7	8.5 to 13.1
	Other	12.5	11.0 to 14.2	4.8	3.4 to 6.6
None of predefined complications		35.3	33.1 to 37.6	62.5	58.9 to 65.9
Return to theatre		21.4	19.5 to 23.4	9.7	7.7 to 12.1
Readmission within 30 days		6.4	4.9 to 8.2	10.4	7.9 to 13.4

In the last three NVR Annual Reports, the in-hospital postoperative mortality rates for open repair were 40.4%, 41.2% and 42.3%, while for EVAR they were 20.7%, 23.2% and 22.9%. This continuation of higher mortality rates may reflect the increased case-ascertainment, with the NVR capturing more of the sickest patients. 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.

Another area of interest is the number of procedures that are performed at the weekend and whether the quality of care and outcomes differ from a weekday operation. The weekend figures includes all operations that take place between Friday 18:00 and Monday 08:00. Table 6.2 shows that, of the 899 procedures undertaken on the weekend, 22.8% were EVARs. During the weekday, 32.8% were EVARs.

At the weekend, almost 40% of patients died in-hospital. This was higher than the rate for weekday operations of 35.2%, but after adjusting for differences in patient characteristics, the difference was found not to be statistically significant (adjusted odds ratio 1.10; 95% CI 0.92-1.31). These results are comparable with an earlier study where the NVR was analysed for cases between 2013 and 2015 [Ambler et al 2017].

Table 6.2: Postoperative outcomes after emergency repair for ruptured AAAs undertaken between January 2015 and December 2017, stratified by the time of procedure

	Discharged Alive	In-hospital deaths	Total	Unadjusted mortality rate
Weekday	1,155	628	1,783	35.2%
Weekend	545	354	899	39.4%
Total	1,700	982	2,682	36.6%
				Adjusted odds ratio=1.10; 95% CI 0.92 to 1.31

6.2 Postoperative in-hospital mortality for ruptured AAA repair

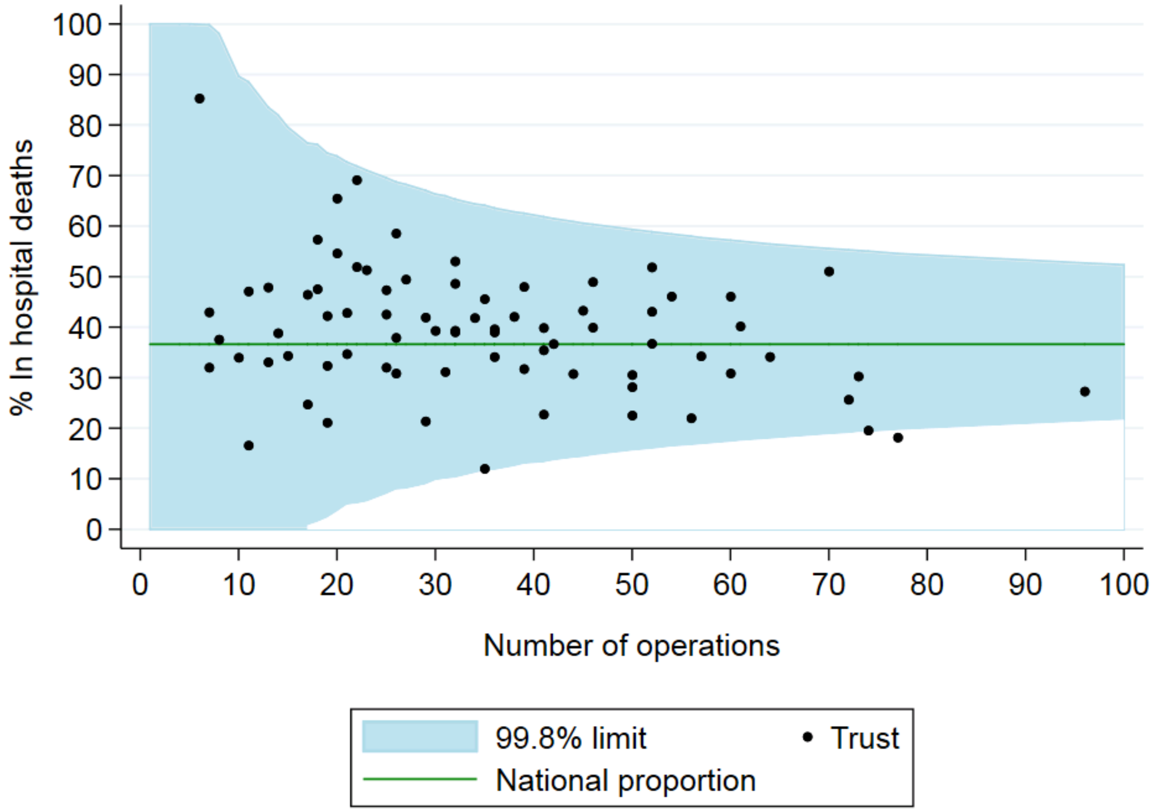
In this section, we report in-hospital mortality for NHS organisations undertaking ruptured AAA repairs during the period from 1 January 2015 to 31 December 2017. This is in order to have better statistical power and improve the risk-adjustment process.

The risk-adjusted mortality rates for individual NHS trusts are shown using a funnel plot in Figure 6.1. The horizontal axis shows surgical activity with dots further to the right showing the hospitals that performed more operations. The 99.8% control limit defines the region within which the organisational mortality rates would be expected to fall if their outcomes only differed from the national rate because of random variation.

All but two of the NHS trusts had a risk-adjusted rate of in-hospital mortality that fell within the expected range around the national average of 36.6%, given the number of procedures performed. There were two NHS trusts that had mortality rates that were lower than expected.

The rates among the NHS trusts typically ranged from 20-60% which reflects the relatively low volumes of cases used to calculate these rates. Appendix 8 gives the figures for each NHS trust.

Figure 6.1: Risk-adjusted in-hospital mortality for emergency repairs of ruptured AAAs between January 2015 and December 2017 by NHS trust. Mean mortality was 36.6%.



6.3 Conclusion

Ruptured AAA remains a very serious condition, with high postoperative mortality and morbidity.

An interesting feature of these results is the limited used of EVAR. Only 29% of patients undergo an EVAR procedure for a ruptured AAA, and the proportion has not increased greatly over time. The comparatively favourable results for EVAR procedures suggest that it is being introduced cautiously in patients for whom it is most clearly appropriate.

Nonetheless, the use of EVAR may reflect current restrictions on the availability of endovascular facilities and skills in some vascular units, particularly outside normal working hours. NHS trusts should investigate whether pathway factors are influencing the use of EVAR for ruptured AAA patients and look for ways to overcome restrictions in capacity.

Patients with unruptured AAA admitted as an emergency admission

There are a group of patients with a symptomatic AAA who are admitted as an emergency admission but whose AAA has not ruptured. During the period between 2015 and 2017, the NVR received details of 1,434 emergency admissions of patients with an unruptured AAA. The majority of these underwent EVAR (n=957).

The overall in-hospital mortality rate for this patient group was 4.9% (95% CI 3.8 to 6.1). For open repairs, the rate was 10.9% (95% CI 8.2 to 14.0), while for EVAR, it was 1.9% (95% CI 1.1 to 3.0). Among patients undergoing open repair, 97% were admitted to level 2 or 3 critical care where the median stay was 3 days (Table 6.3). Conversely, over half of EVARs were admitted to the ward.

Table 6.3: Postoperative details of non-ruptured emergency AAA repairs undertaken between January 2015 and December 2017

		Open AAA (n=477)	Days in critical care median (IQR)	EVAR (n=957)	Days in critical care median (IQR)
Admitted to	Ward	1.9%		53.3%	
	Level 2	35.6%	3 (2 to 5)	36.6%	1 (1 to 2)
	Level 3	61.4%	3 (2 to 5)	10.1%	2 (1 to 3)
	Died in theatre	1.0%		0.0%	

7. Lower limb bypass for PAD

7.1 Introduction

This chapter presents results on the processes and outcomes of lower limb bypass procedures, focusing on data from 17,475 procedures entered into the NVR during the three years between January 2015 and December 2017. It is estimated that the NVR has captured approximately 90% of the procedures performed between 2015 and 2017 in the NHS.

Some patients with diabetic foot disorders are common to both the NVR and the National Diabetic Foot audit. Currently we present data for revascularization and amputation for both diabetic and non-diabetic patients together. The pathways described in the Provision of Vascular Services documents both in 2015 and in the forthcoming 2018 version are distinctly different for patients with diabetic foot problems than those non-diabetics with chronic and critical limb ischaemia. We recognise that presenting outcomes for diabetics and non-diabetics separately may be useful going forward and potentially could report outcomes separately for lower limb bypass where case ascertainment is currently good in 2019, and potentially also for amputation and angioplasty in the future when case ascertainment rates improve.

The GIRFT driven Lower Limb Ischaemia Quality Improvement Framework LLIQIF) is currently under development and led by the Audit and Quality Improvement Committee. This will include targets to improve outcomes for both diabetics and non-diabetics with limb ischaemia and this work will be complete in 2019.

Table 7.1 summarises the characteristics of lower limb bypass procedures, the majority of which were performed under general anaesthetic. The most common anatomical location for the elective bypass procedure was a femoral to above knee (popliteal) procedure (24.3%). For emergencies, femoral to below knee and femoral to tibial procedures were the most prevalent at 21%. Most graft types were autologous, accounting for nearly 50% of the procedures.

Table 7.1: Characteristics of lower limb bypass procedures undertaken between January 2015 and December 2017

	Elective procedures (n=11,103)	%	Emergency procedures (n=6,372)	%
Anaesthetic type				
General	8,224	74.1	5,034	79.0
Regional	1,486	13.4	662	10.4
GA + regional	1,050	9.5	447	7.0
Other	339	3.1	226	3.5
Bypass location				
Femoral – femoral	814	7.3	424	6.7
Femoral – above knee	2,700	24.3	1,060	16.6
Femoral – below knee	1,920	17.3	1,336	21.0
Femoral – tibial	1,262	11.4	1,356	21.3
Other	4,551	41.0	2,243	35.2
Endarterectomy				
Alone	1,035	9.3	363	5.7
Adjunct to bypass	4,477	40.3	2,328	36.5
Graft type				
Autologous	4,589	41.3	3,338	52.4
Vein and prosthetic	335	3.0	283	4.4

Lower limb bypass was recorded as being performed for a full spectrum of peripheral artery disease as measured with the Fontaine scores: asymptomatic, intermittent claudication, critical limb ischemia. However, 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 (see Appendix 3).

The outcomes of the revascularisation procedures are summarised in Table 7.2. As might be expected, the outcomes show a distinct pattern with regard to mode of admission. The in-hospital postoperative mortality rate for elective patients was 1.2% (95% CI 1.0 to 1.4) while for emergency patients, it was 5.2% (95% CI 4.7 to 5.8). The median length of stay was much greater for emergency patients at 15 days compared with 5 days for elective cases. Of the elective cases, patients who had a bypass only had a longer hospital stay of 6 days compared to adjunctive and endarterectomy procedures, where it was 4 days (see Appendix 3).

Table 7.2: Postoperative outcomes for patients undergoing elective and emergency lower limb bypasses between January 2015 and December 2017

		Elective		Emergency	
		No. of procs	**%**	**No. of procs**	**%**
Total procedures		11,103		6,372	
Admitted to	Ward	8,084	72.8	4,387	68.9
	Level 2	2,453	22.1	1,523	23.9
	Level 3	558	5.0	454	7.1
	Day case unit	0	0.0	<5	0.0
	Died in theatre	<5	0.0	<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 4	2	1 to 4
Hospital length of stay (days)		5	3 to 8	15	9 to 26
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital mortality rate		1.2	1.0 to 1.4	5.2	4.7 to 5.8
Defined complications					
Cardiac		2.5	2.2 to 2.8	5.4	4.8 to 5.9
Respiratory		3.0	2.7 to 3.4	5.4	4.8 to 6.0
Haemorrhage		1.7	1.5 to 2.0	2.7	2.3 to 3.1
Limb ischaemia		3.2	2.8 to 3.5	6.8	6.2 to 7.4
Renal failure		1.1	0.9 to 1.3	2.4	2.1 to 2.9
Other		0.3	0.2 to 0.4	0.5	0.4 to 0.8
None of predefined complications		90.0	89.5 to 90.6	81.2	80.2 to 82.1
Further unplanned lower limb procedure					
None		94.3	93.8 to 94.7	85.9	85.0 to 86.7
Angioplasty without stent		0.5	0.4 to 0.7	0.9	0.7 to 1.1
Angioplasty with stent		0.3	0.2 to 0.4	0.5	0.3 to 0.7
Lower limb bypass		1.9	1.6 to 2.2	2.9	2.5 to 3.3
Amputation at any level		0.4	0.3 to 0.5	2.0	1.7 to 2.4
Readmission to higher level care		1.9	1.6 to 2.2	3.7	3.2 to 4.1
Readmission within 30 days		9.6	9.0 to 10.2	14.7	13.8 to 15.7

Complications were relatively uncommon and 90% of elective patients and 81% of emergency patients did not require further unplanned intervention. The key outcome measure for both endovascular and bypass procedures is amputation-free survival. The national rates of unplanned amputation during the same admission was around 1 in 200 elective patients and around 1 in 50 emergency cases.

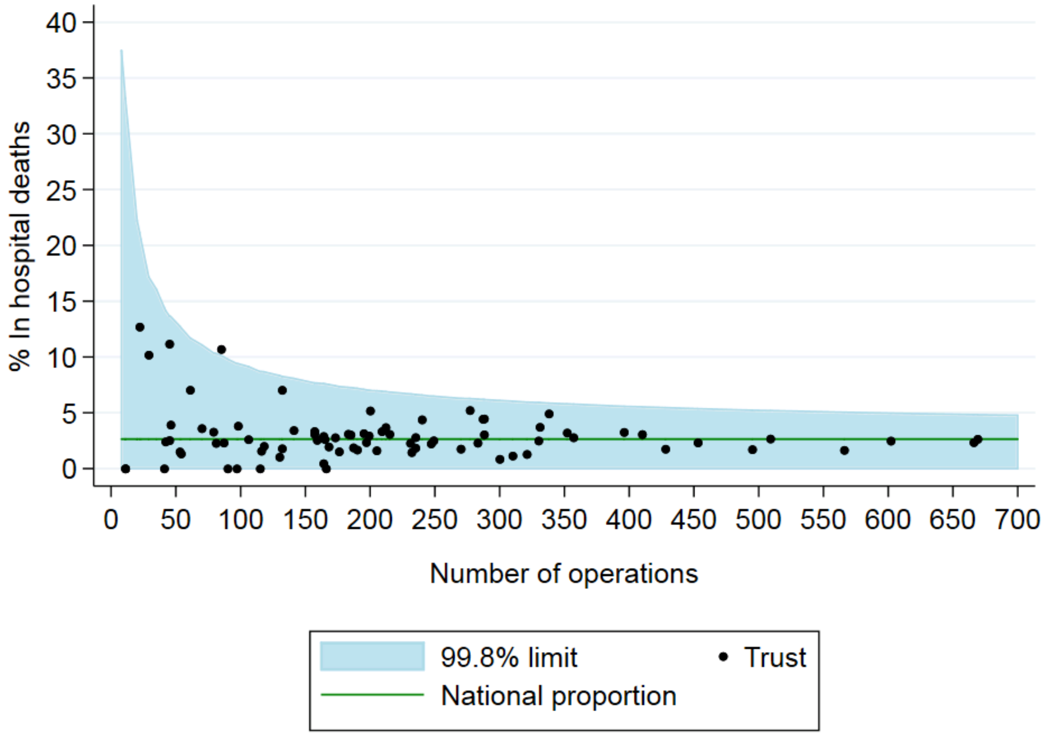
The outcomes for lower limb bypass are in line with recent literature. However, the observed 11% unplanned readmission rate suggests this is an area for improvement. The NVR does not have information on the reasons for readmission but local services should review their local readmission rates to determine their cause.

7.2 Rates of in-hospital death after lower limb bypass

Risk-adjusted rates of in-hospital death for lower limb bypasses were calculated for each NHS trust. The rates 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, type of procedure, ASA grade, mode of admission, cardiac disease, renal disease and chronic lung disease.

Figure 7.1 shows the funnel plot of risk-adjusted mortality rates for the bypass procedures performed between January 2015 and December 2017. The national average has slightly improved decreasing from 2.8% (for 2014 to 2016) to 2.6% (for 2015 to 2017). All but one NHS trust had a risk-adjusted rate of in-hospital death that fell within the expected range (99.8 limit) given the number of procedures performed. This trust is Barking, Havering and Redbridge University Hospitals NHS Trust (RF4) and they have confirmed that the data entered into the NVR was correct, and has been handled according to the NVR's outlier policy.

Figure 7.1: Funnel plot of risk-adjusted in-hospital deaths of a lower limb bypass for NHS trusts, shown in comparison to the overall average of 2.6% for procedures performed between January 2015 and December 2017



7.3 Weekend effect on outcomes after lower limb bypass

We assessed whether the rate of in-hospital mortality after lower limb bypass procedures differed for operations that occurred during the weekend compared with those performed between Monday and Friday.

For the period from January 2015 to December 2017, 735 bypass procedures were performed at the weekend (ie, any operation between Friday 18:00 and Monday 08:00), which was a comparatively small proportion of all bypass procedures. Not surprisingly, the majority (84%) of weekend procedures were emergency admissions (Table 7.3).

For the emergency cases, the unadjusted in-hospital mortality rate at the weekend was 7.8%, which was higher than the 5.0% observed for weekday operations. This difference was found not to be statistically significant after adjustment for differences in the patients operated on at weekends compared to weekdays (adjusted odds ratio=1.37; 95% CI 0.98 - 1.93).

Table 7.3: Postoperative outcomes for patients undergoing elective and emergency lower limb bypasses between January 2015 and December 2017 by day of week

	Total Elective	% Elective in-hospital deaths	Total emergency	% Emergency in-hospital deaths
Weekday	10,983	1.2%	5,757	5.0%
Weekend	120	1.7%	615	7.8%
Total	11,103	1.2%	6,372	5.2%
				Adjusted odds ratio=1.37 (95% CI 0.98 - 1.93)

8. Lower limb angioplasty/stent for peripheral artery disease

8.1 Introduction

This chapter describes the process and outcomes of care for patients undergoing lower limb endovascular procedures, which involve either angioplasty and/or the insertion of a stent. The NVR has collected data on endovascular revascularisation since 2014. In this report, we provide results based on three years of data, covering the period from January 2015 to December 2017. In all, data were available on 19,009 lower limb endovascular procedures: 4,937 performed in 2015, 6,670 in 2016 and 7,402 in 2017.

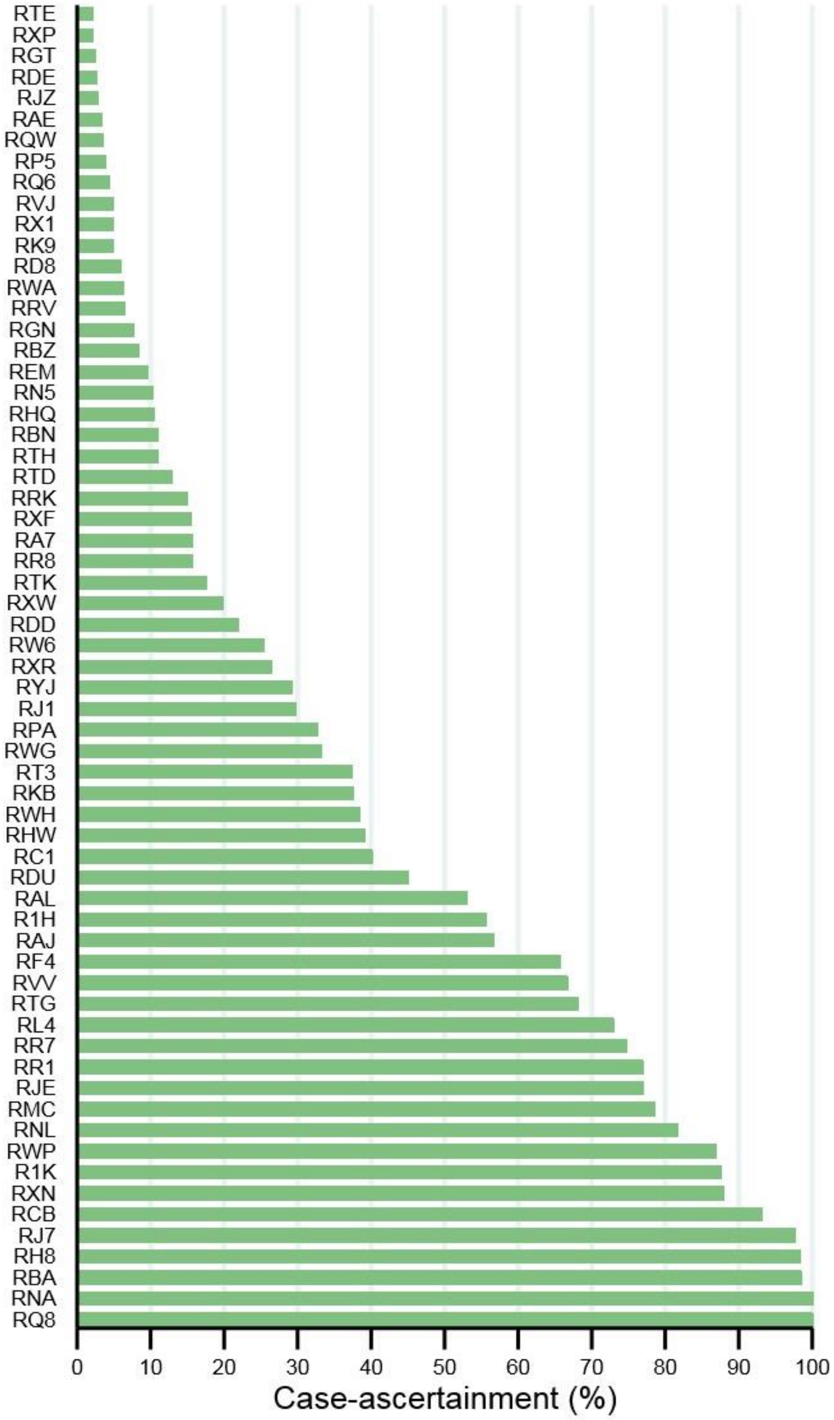
Case-ascertainment for these procedures was estimated by comparing the numbers in the NVR to those in routinely collected national hospital datasets (Table 8.1). The estimated overall case-ascertainment has increased over the data collection period, from approximately 21% in 2015 to 33% in 2017, but there is considerable variation between NHS trusts (Figure 8.1) and the case-ascertainment remains far from ideal. Some NHS trusts achieved a case-ascertainment of 90% but there was a large number of organisations that submitted less than 10% of the procedures in the national routine datasets.

Table 8.1. Estimated case-ascertainment by year

	2015	**2016**	**2017**
NVR procedures	4,937	6,670	7,402
Expected procedures[1]	23,611	22,218	22,654
Estimated case-ascertainment	21%	30%	33%

[1] Data not fully available for 2017; the figure was estimated.

Figure 8.1 Case-ascertainment by NHS Trust



Throughout the data collection period, 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 / stent procedures 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. Pre-operative risk factors among angioplasty patients are summarised in Appendix 3. The prevalence of ischaemic heart disease, hypertension and diabetes was high and most patients were on antihypertensive or antiplatelet medication.

8.2 Procedure characteristics

Characteristics of lower-limb procedures, by the anatomical location of the procedure, are summarised in Table 8.2. Superficial femoral angioplasty was the most common procedure site, accounting for 40% of cases, followed by popliteal and tibial/pedal angioplasties.

Overall, most endovascular procedures were performed under local anaesthetic (16,317 procedures, 87.9%) but general anaesthetic (1,788 procedures, 9.6%) and regional anaesthetic (450 procedures, 2.4%) were also used. Stents were used in 2,435 (12.8%) procedures.

Many angioplasties were performed as day cases, although the proportions varied between NHS trusts. Among the patients who did stay in hospital overnight, the length of stay was generally short.

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 8.2. Encouragingly, over 80% of the procedures were reported as successful in most NHS trusts.

The proportions of angioplasties performed as day cases, by NHS trust, are shown in Figure 8.3. There is wide variation in the proportion of patients admitted as day cases, but it is unclear whether this represents an accurate picture of practice. It is possible that the data collection process within some NHS trusts means day cases are less likely to be entered into the NVR. Further details of the patient pathways and the availability of staff and facilities (e.g. hybrid theatres) for the care of patients having lower limb angioplasty are provided in Chapter 2.

Table 8.2: Characteristics of lower limb endovascular procedures by anatomical location

	Procedure N (%) [1]	**ASA grade 4-5** (%)	**Type of lesion** Occlusion (%) Stenosis (%)	**Procedure success (%)**	**Admitted as day cases** (%)	**Admitted to critical care** (%)	**Length of stay among overnight admissions** Median (IQR), days
Common iliac	1,994 (10.5)	55 (3.5)	432 (21.8) 1,548 (78.2)	1,792 (90.6)	629 (31.5)	85 (4.3)	1 (0 to 6)
External iliac	2,188 (11.5)	57 (3.5)	407 (19.4) 1,687 (80.6)	1,931 (92.2)	615 (29.2)	73 (3.5)	1 (0 to 7)
Common iliac & external iliac	676 (3.6)	26 (5.1)	148 (22.1) 522 (77.9)	611 (91.2)	190 (28.1)	27 (4.0)	2 (0 to 7)
Superficial femoral	7,488 (39.4)	235 (4.1)	2,952 (40.8) 4,2991 (59.2)	6,364 (87.9)	2,073 (28.5)	180 (2.5)	2 (1 to 13)
Superficial femoral & popliteal	2,603 (13.7)	117 (5.8)	919 (35.6) 1,661 (64.4)	2,273 (88.1)	615 (23.7)	55 (2.1)	4 (1 to 15)
Popliteal	4,567 (24.0)	199 (5.7)	1,766 (39.7) 2,685 (60.3)	3,856 (86.7)	1,000 (22.4)	113 (2.5)	4 (1 to 15)
Popliteal and tibial/pedal	1,385 (7.3)	104 (9.7)	597 (43.3) 783 (56.7)	1,166 (84.5)	231 (16.7)	38 (2.7)	7 (1 to 18)
Tibial/pedal	3,412 (18.0)	230 (8.6)	1,572 (46.3) 1,823 (53.7)	2,776 (81.8)	562 (16.5)	70 (2.1)	8 (1 to 21)
Other	4,173 (22.0)	143 (4.4)	1,717 (42.5) 2,327 (57.5)	3,855 (95.4)	1,064 (26.0)	242 (5.9)	2 (1 to 9)

[1] These numbers do not add up to the total number of angioplasties in the NVR because they relate to procedures on one leg, and many patients had procedure(s) on both legs.

Figure 8.2. Success rate (procedure defined as successful by the operator), by NHS trust

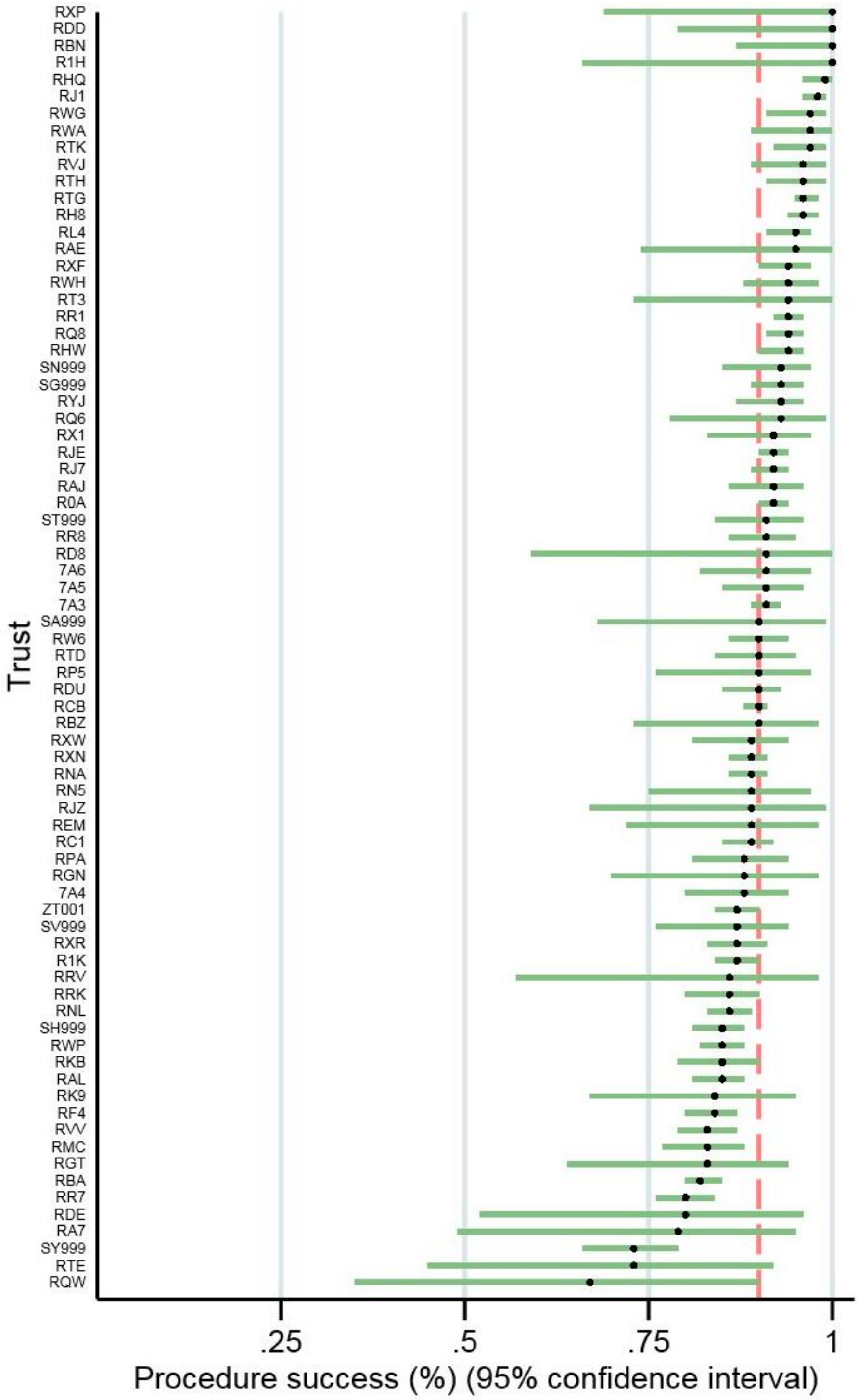
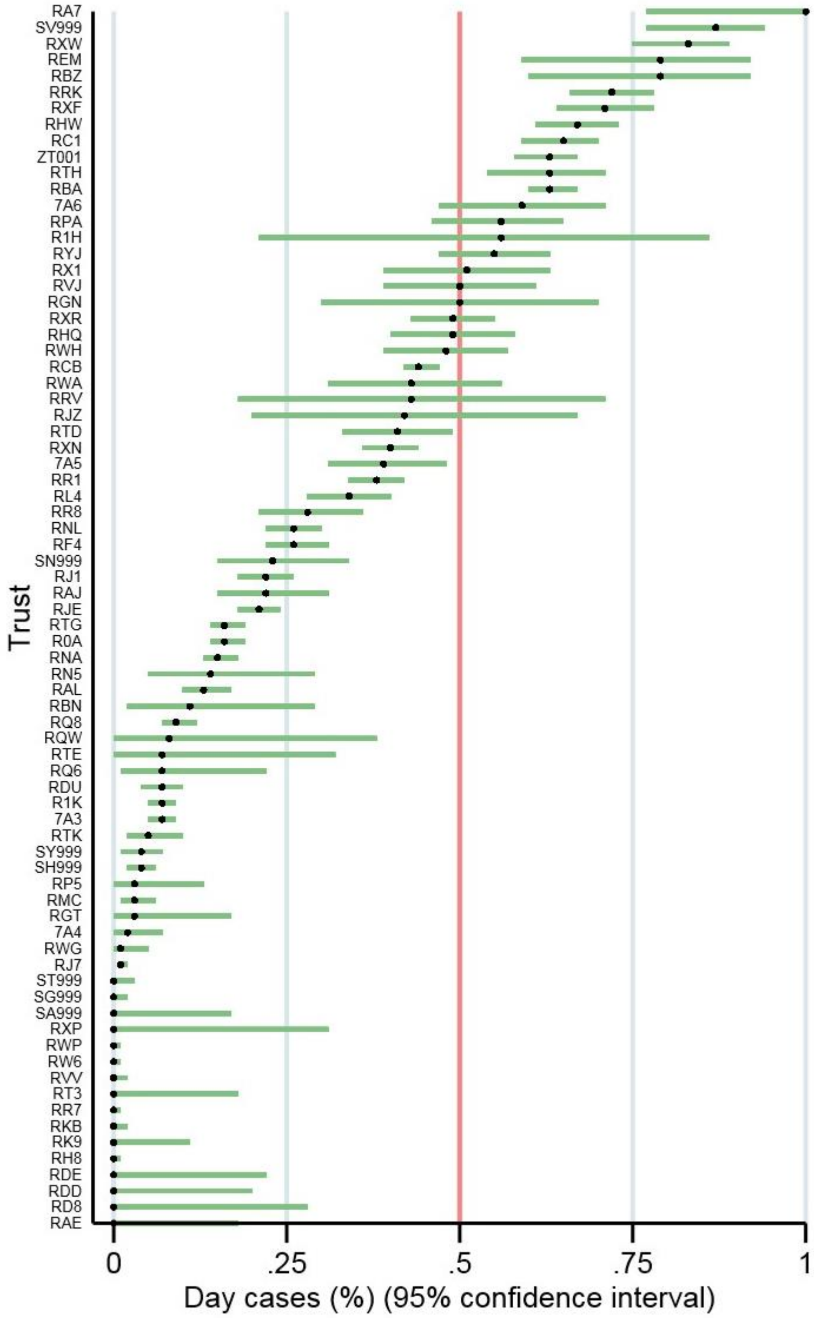


Figure 8.3. Proportion of procedures as day cases, by NHS trust



8.3 Outcomes of lower limb angioplasty/stents

Overall, only a small number of patients were admitted to critical care and a large majority of patients had no post-procedural complications. However, all outcomes differed by admission status, and patients having endovascular revascularisation after an emergency admission generally had worse outcomes than those undergoing elective procedures. These are summarised in Table 8.3.

Table 8.3: Postoperative outcomes following endovascular lower limb revascularisation, by mode of admission

		Emergency	%	Elective	%
Total procedures		5,179	27.2	13,830	72.8
Admitted to	Ward	4,586	92.8	8,459	62.1
	Level 2	225	4.6	321	2.4
	Level 3	76	1.5	51	0.4
	Day case unit[1]	54	1.1	4,780	35.1
	Died in theatre	<5	<0.05	<5	<0.05
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	1	0 to 2	1	0 to 1
	Level 3	2	1 to 4	1	1 to 3
Hospital length of stay (days)		13	6 to 28	0	0 to 1
Overnight length of stay (days)		6	2 to 17	0	0 to 1
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital mortality rate		4.8	4.2 to 5.4	0.4	0.3 to 0.5
Defined complications					
Cardiac		3.9	3.3 to 4.4	1.7	1.6 to 2.0
Respiratory		3.7	3.2 to 4.2	1.0	0.8 to 1.2
Haemorrhage		0.5	0.3 to 0.7	0.3	0.2 to 0.4
Limb ischaemia		3.2	2.7 to 3.7	0.5	0.4 to 0.6
Renal failure		1.4	1.1 to 1.8	0.1	0.07 to 0.2
Cerebral		0.3	0.2 to 0.5	<0.05	n/a
Haematoma[1]		1.1	0.7 to 1.6	1.7	1.3 to 2.0
False aneurysm[1]		0.5	0.2 to 0.9	0.5	0.3 to 0.7
Vessel perforation[1]		0.6	0.3 to 1.0	0.4	0.2 to 0.6
Distal embolus[1]		0.8	0.5 to 1.3	0.7	0.5 to 0.9
None of predefined complications		89.3	88.6 to 90.1	96.2	95.9 to 96.5
Further unplanned lower limb procedure					
None		81.1	80.0 to 82.1	95.3	95.0 to 95.7
Angioplasty without stent		3.1	2.6 to 3.6	1.0	0.9 to 1.2
Angioplasty with stent		2.0	1.6 to 2.4	0.9	0.8 to 1.1
Lower limb bypass		2.8	2.3 to 3.3	0.8	0.6 to 0.9
Amputation at any level		9.5	8.8 to 10.4	1.0	0.9 to 1.2
Readmission to higher level care		2.9	2.4 to 3.4	0.9	0.7 to 1.0
Readmission within 30 days		17.5	16.4 to 18.6	6.8	3.4 to 7.3

[1] Figures based on procedures performed in 2017.

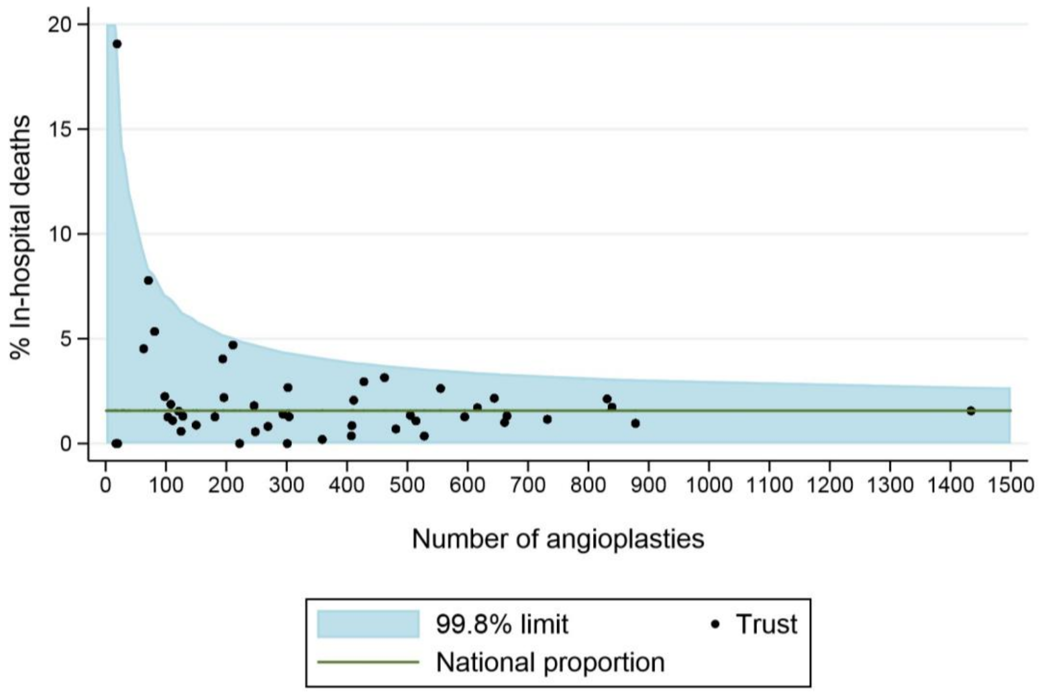
8.4 Risk-adjusted in-hospital deaths

Risk-adjusted rates of in-hospital death were calculated for each NHS trust. The rates 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 due to the different number of observed events. The postoperative mortality rates for emergency cases were adjusted for patient age and chronic lung disease, chronic heart failure and chronic renal disease as comorbidities. The model for elective cases included patient age, Fontaine score at admission (4 vs. <4) and comorbid chronic heart failure.

Risk-adjusted rates of in-hospital mortality following endovascular lower limb revascularisation are shown, by NHS trust, in Figure 8.4. As the numbers of endovascular procedures submitted by some organisations were small (and many 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' risk adjusted mortality rates were within 99.8% control limits (Figure 8.4).

Figure 8.4: Risk-adjusted in-hospital deaths following lower limb angioplasty, shown in comparison to the national average of 1.57%



Note: This figure is based on data from Trusts actively performing angioplasties, with at least 10 angioplasties in the NVR and a case-ascertaintment of at least 20%.

8.5 Conclusion

It is encouraging that, within the limitations of the poor case-ascertainment, NHS trusts had risk-adjusted in-hospital mortality rates that fell within the expected range. Nonetheless, case-ascertainment for lower limb angioplasty remains low. It is important that the NHS trusts preforming lower limb endovascular procedures review how they identify and submit cases, with the aim of overcoming barriers to recording patients in the NVR. Increased administrative support and the funding for the NVR to utilise modern IT capabilities may provide ways to tackle this issue locally. To assist this process, the NVR is undertaking a number of initiatives to engage with interventional radiologists. In particular, we will be introducing modifications to the NVR dataset for these procedures in January 2019 to improve its ease of completion by interventional radiologists.

9. Major lower limb amputation

9.1 Introduction

This chapter describes the patterns of care and outcomes for patients undergoing unilateral major lower limb amputations due to vascular disease during the three-year period from January 2015 to December 2017. Amputations due to trauma (n=139, 1.1% of all amputations recorded in the NVR in 2015-2017) were excluded from the figures reported in this chapter.

The principal analyses focus on unilateral major amputations. For this reason, bilateral amputations (n=263, 2.0% of all recorded amputations), minor amputations (n=3,072, 23.6%, with an estimated case-ascertainment of 13%) and amputations associated with a bypass (376 procedures, 2.9%) have been excluded from the main analyses. Linked amputations have been included in the case-ascertainment estimates.

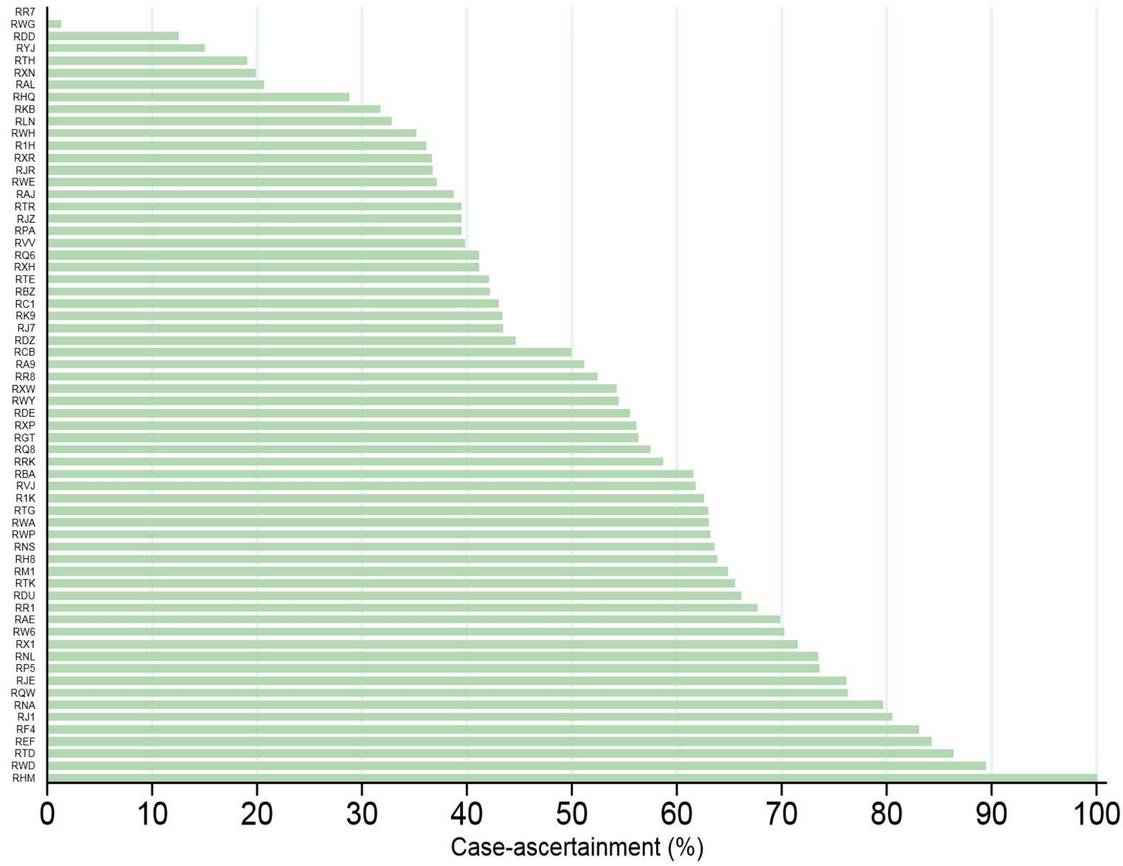
Yearly case-ascertainment estimates, based on comparisons with routinely collected hospital datasets, are show in Table 9.1. The yearly estimates suggest that the overall case-ascertainment improved slightly over the data collection period. However, the variation shown in Figure 9.1 indicates that many NHS trusts are still failing to record large proportions of their amputations in the NVR.

Table 9.1 Estimated case-ascertainment for all vascular amputations by year

Case-ascertainment	**2015**	**2016**	**2017**
Audit procedures	3,253	3,192	3,033
Expected procedures[1]	5,569	4,987	5,193
Estimated case-ascertainment	58%	64%	58%

[1] Data not fully available for 2017; the figure was estimated.

Figure 9.1 Estimated case-ascertainment for all vascular amputations by NHS trust



Over the three-year data collection period, 9,293 major unilateral amputations were recorded in the NVR: 3,177 were performed in 2015, 3,134 in 2016 and 2,982 in 2017. The recorded procedures comprised 4,895 (52.7%) below the knee amputations (BKA) and 4,398 (47.3%) above the knee amputations (AKA). Many results in this chapter are presented separately for these two types of procedure.

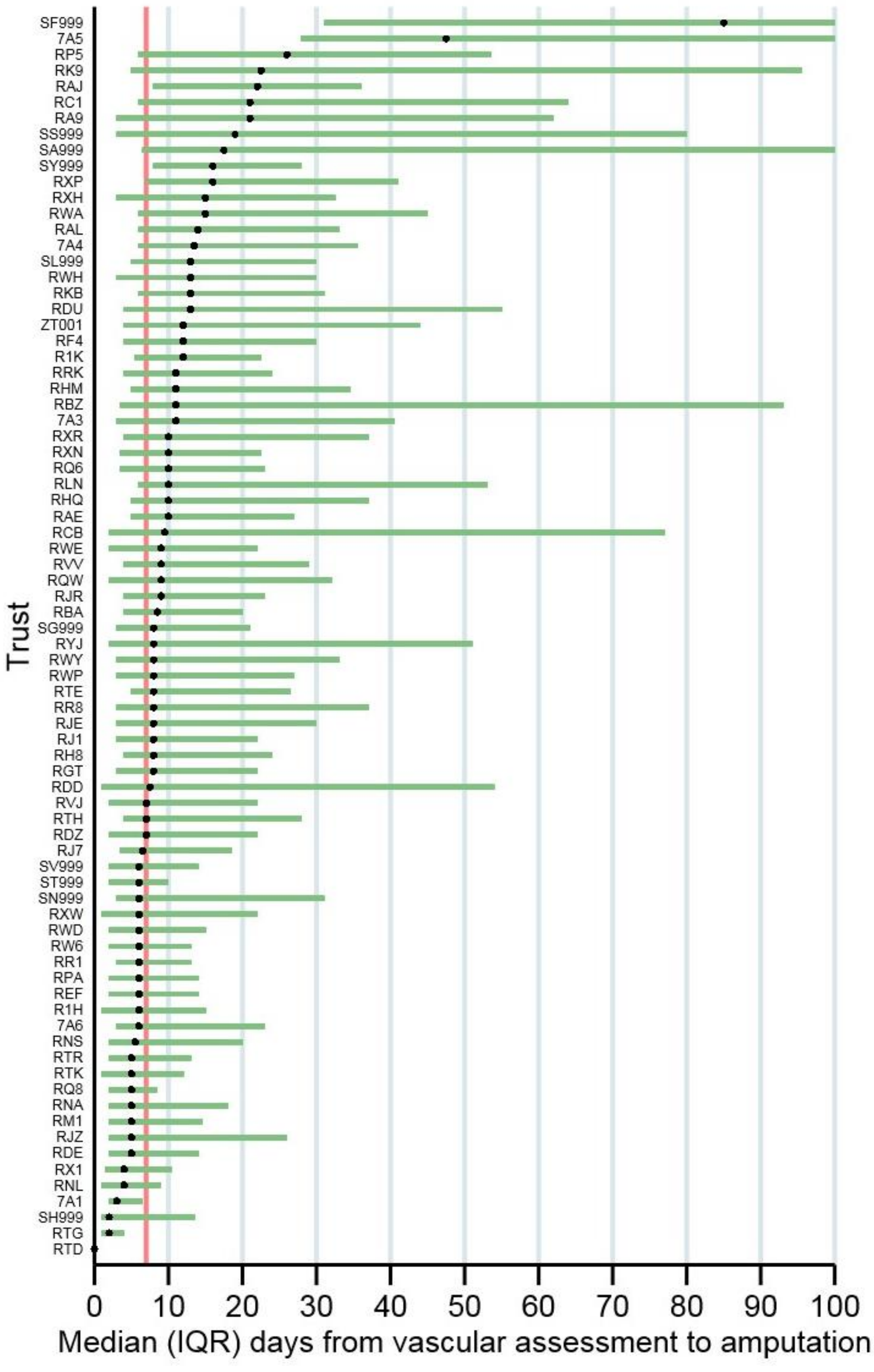
Characteristics of patients undergoing major unilateral lower limb amputations are shown in Appendix 3, Table A3.8. Briefly, BKAs were more common in patients under 60 years of age and AKAs more common in patients older than 80 years. Most patients in both amputation groups were men and either current or ex-smokers. Tissue loss was the most common presenting problem for both amputation types. Among the BKA patients, the second most common presenting problem was uncontrolled infection, whereas for the AKA patients, acute or chronic limb ischaemia were common. Over half of the patients had undergone a previous ipsilateral limb procedure. This may indicate that a less invasive procedure, such as angioplasty, had been attempted prior to amputation. However, due to the low case-ascertainment for lower limb angioplasty (see Chapter 8), this cannot be explored further in the currently available data. The most common comorbidities in both the 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.

9.2 Care pathways

National and organisation-level results on time from vascular assessment to amputation are shown in Figure 9.2. The overall median time from assessment to amputation was 8 days (interquartile range: 3 to 26 days). However, there was considerable variation in these timelines across the NHS trusts. Further detail of the pre-operative assessment of amputation patients is provided by the organisational audit in Chapter 2 (section 2.5).

In terms of improving patient outcomes following major lower limb amputation, it is often important to perform the procedures as soon as possible once the decision to operate has been made [NCEPOD, 2014]. Consequently, within the constraints of needing to balance urgency with pre-operative optimisation of the patient's condition, vascular units should, as much as possible, attempt to reduce the time patients wait for their operation.

Figure 9.2: Median (IQR) time from vascular assessment to amputation, by NHS trust



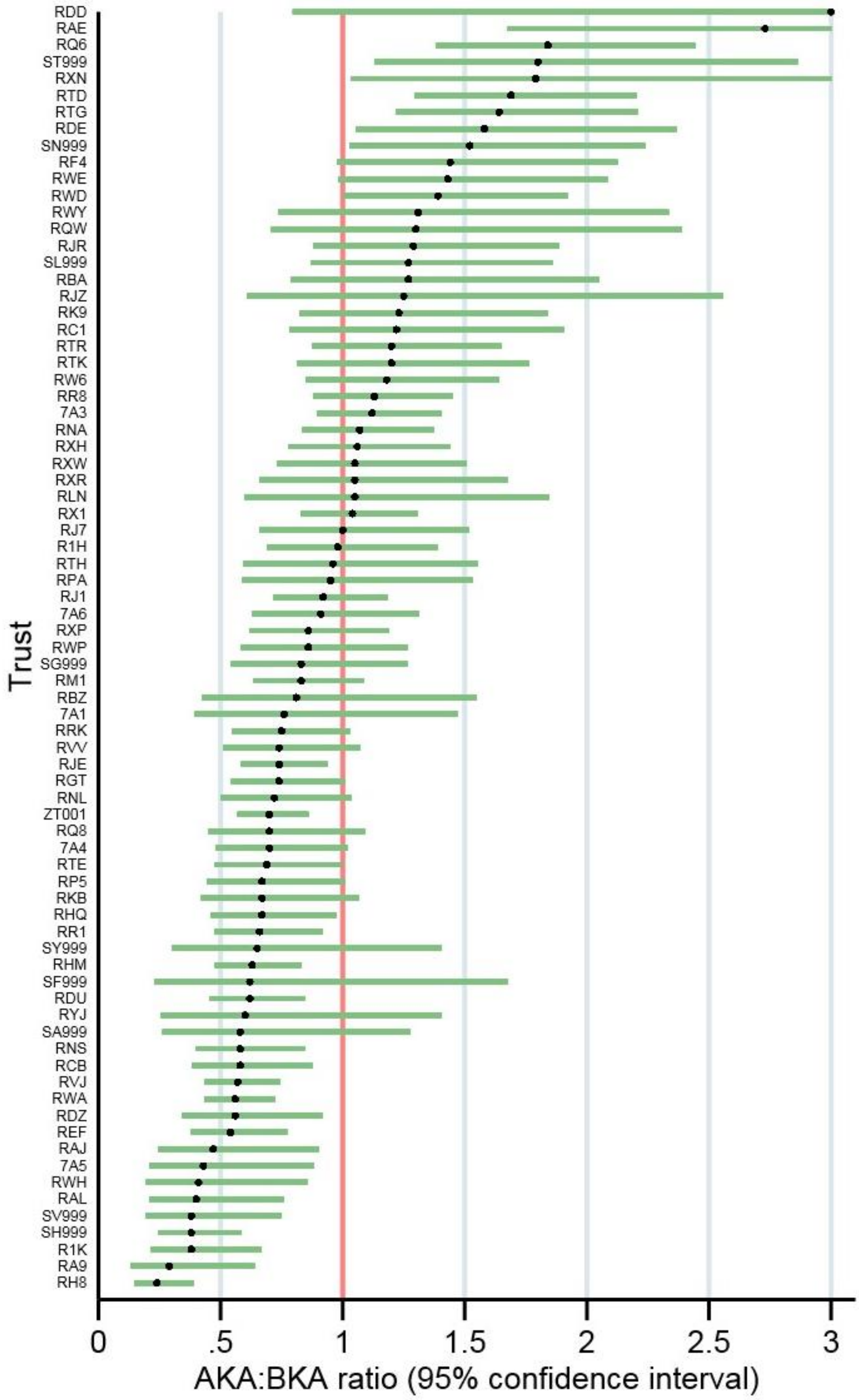
Note: The black dots represent NHS trust-specific medians and the horizontal green lines represent interquartile ranges (IQRs).The vertical line shows the national median (8 days).

9.3 Procedure characteristics

Major amputations were typically performed under general (6,553 amputations, 70.5%) or regional (2,684 amputations, 28.9%) anaesthetic. The most commonly used wound closure method was primary closure (7,470 amputations, 82.6%); skin flap was used in 1,271 amputations (14.1%) and skin graft in 20 procedures (0.2%). In 278, amputations (3.1%) the wound was left open.

National clinical care recommendations outline that below the knee amputation should be undertaken where appropriate and that, at each vascular unit, the above knee to below knee amputation ratio should ideally be below one [NCEPOD 2014; VSGBI 2016]. The AKA to BKA ratio, nationally and by NHS trust, is shown in Figure 9.3. Nationally, over the three-year data collection period, the AKA:BKA ratio was 0.90. The ratio varied from 0.90 in 2015 to 0.91 in 2016 and 0.87 in 2017. At NHS trust-level, most of the NHS trusts had a ratio of less than one, indicating that the NCEPOD recommendation is generally being met.

Figure 9.3: Ratio of above knee to below knee amputations by NHS trust between 2015 and 2017[1]



[1] These estimates based on data from NHS trusts reporting at least 10 amputations over the audit period.

9.4 Perioperative care

Some of the key recommendations for improving perioperative amputation care in NHS hospitals concern the timing of the procedure. The following key recommendations have been made:

- 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 [VSGBI 2016].

Characteristics of perioperative care for BKA and AKA patients, summarised in Table 9.2, suggest that these recommendations are often not met. A large proportion of amputations were performed as emergency rather than elective procedures. Over 80% of major amputations (both BKAs and AKAs) were performed during the day but a number of procedures were undertaken out-of-hours. A consultant surgeon was present at approximately three-quarters of the procedures. Prophylactic antibiotics and DVT medication were used for only just over 60% of patients, although is possible that these figures represent an artefact of incompletely filled data fields in the NVR, and that the true figures are higher. None of these changed markedly from 2015 to 2017.

Table 9.2: Perioperative care of patients undergoing lower limb amputation

	Below knee	**%**	**Above knee**	**%**
Procedures	4,895	52.7	4,398	47.3
Admission				
Emergency	3,684	75.3	3,598	81.8
Elective	1,211	24.7	800	18.2
Time procedure started				
Day (8am-6pm)	4,217	86.2	3,620	82.4
Evening (6pm-midnight)	586	12.0	638	14.5
Night (midnight-8am)	88	1.8	137	3.1
Consultant present in theatre	2,961	81.8	2,544	77.1
Prophylactic medication				
Antibiotic prophylaxis	2,336	64.5	2,073	62.7
DVT prophylaxis	2,330	64.3	2,067	62.5

Figures 9.4 and 9.5 shows the proportions of major amputations with a consultant present in theatre and prophylactic antibiotics given, by NHS trusts. The VSGBI best practice recommendation is that a consultant should operate or be present in the theatre for 100% of major lower limb amputations and that prophylactic antibiotics should be given, according to local policy, to all patients undergoing major lower limb amputations [VSGBI 2016]. Figures 9.4 and 9.5 highlight that although many NHS trusts are following the recommendations, there is variation in practice and not all providers met the guideline recommendations.

Figure 9.4 Percentage of amputations where a consultant surgeon was present in theatre, by NHS trust

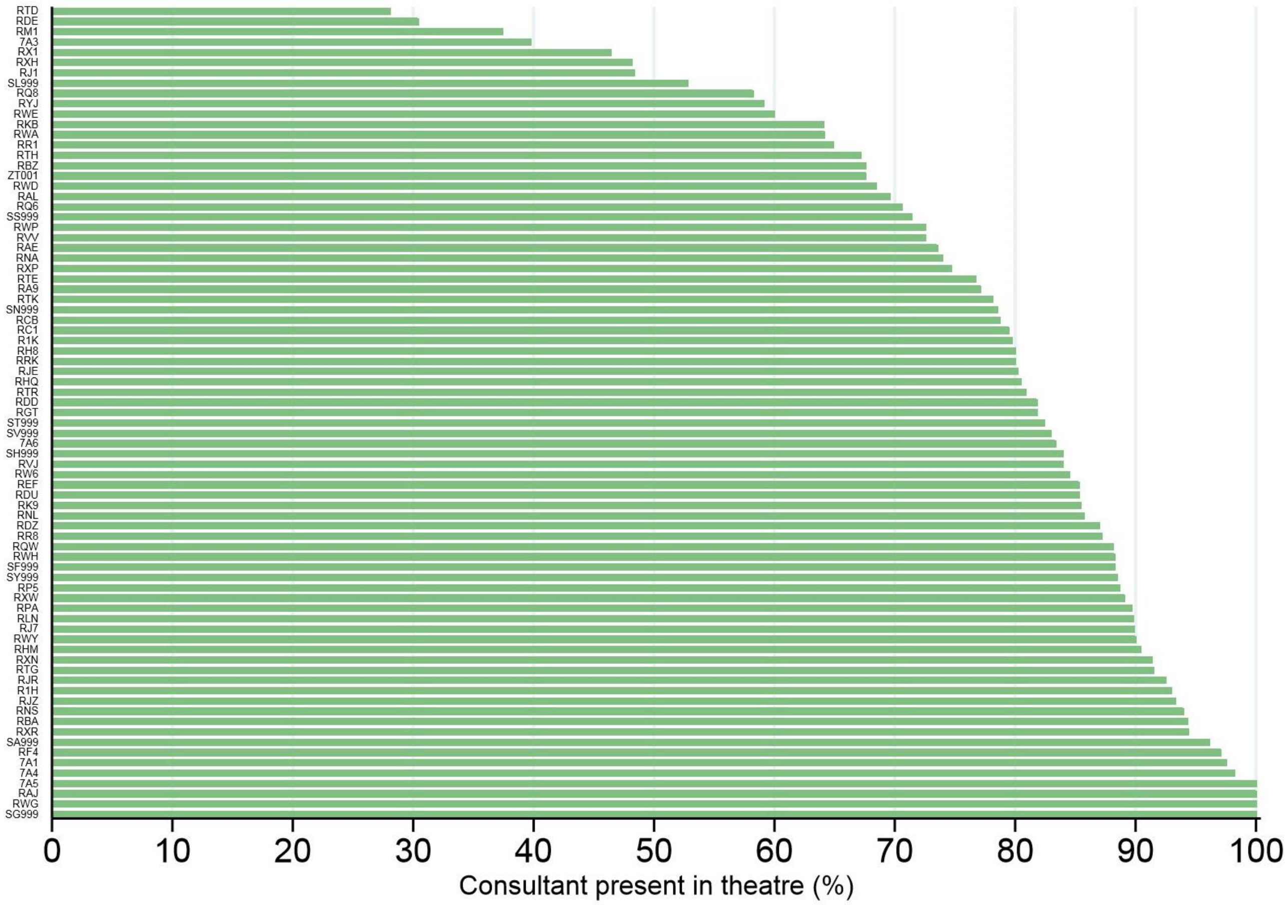
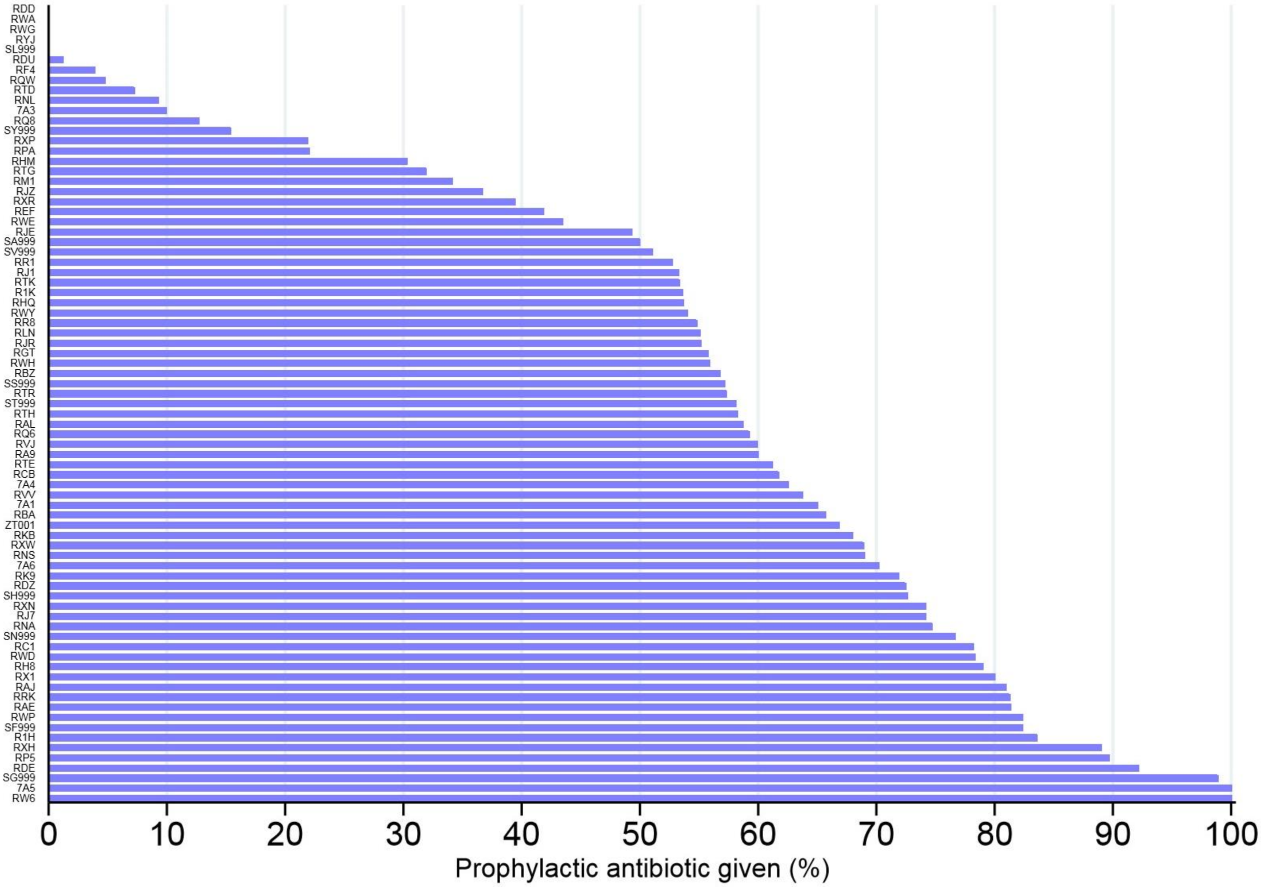


Figure 9.5 Percentage of major lower limb amputations where the patient received prophylactic antibiotics, by NHS trust



9.5 In-hospital outcomes following amputation

Patient outcomes immediately following major lower limb amputation are summarised in Table 9.3. Overall, most patients were returned to the ward following amputation. Approximately 13% of BKA patients and 24% of AKA patients went to intensive care (level 2 or level 3). On average, amputation patients spent 1-7 days in intensive care. The overall median length of hospital stay associated with major amputations was 23 days (IQR: 14 to 40 days).

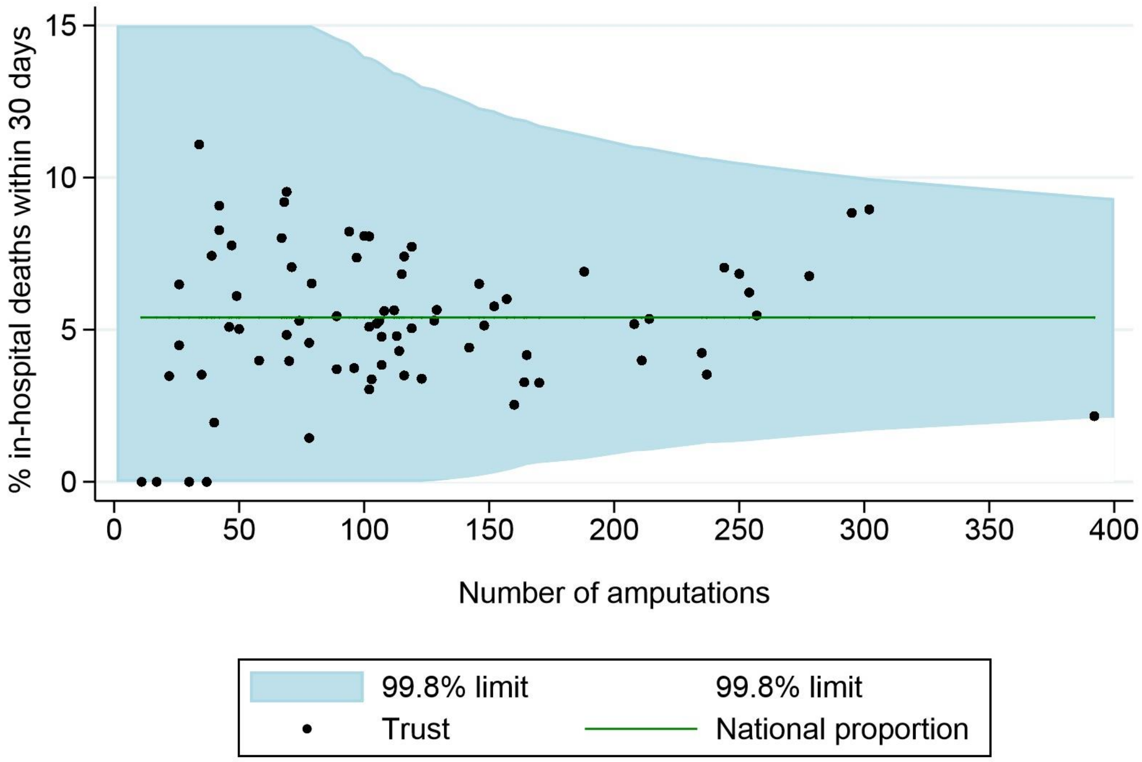
Most major amputations did not have reported complications. The most common complications were respiratory problems, which occurred in 6.6% of BKAs and 11.2% of AKAs. Cardiac complications were also common among AKA patients (7.7%). Rates of return to theatre within the admission were 10.9% for BKA and 7.6% for AKA patients. Most patients were discharged alive, but 5.4% of BKA patients and 11.5% of AKA patients died in hospital.

Table 9.3: Patient outcomes following major lower limb amputation

	Below knee		Above knee	
Procedures	4,895		4,398	
	No. pats	**%**	**No. pats**	**%**
Destination after procedure				
Ward	4,270	87.2	3,369	76.6
Level 2 unit	473	9.7	706	16.1
Level 3 unit	151	3.1	321	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 6	3	2 to 7
Length of stay (days)	24	14 to 41	22	13 to 39
Post-operative length of stay (days)	15	9 to 28	15	8 to 27
	Rate	**95% CI**	**Rate**	**95% CI**
Overall in-hospital mortality	5.4	4.8 to 6.0	11.5	10.6 to 12.5
30 day in-hospital mortality	3.0	2.6 to 3.6	8.0	7.2 to 8.9
Procedure complications				
Cardiac	4.3	3.8 to 4.9	7.7	6.9 to 8.5
Respiratory	6.6	5.9 to 7.4	11.2	10.3 to 12.2
Cerebral	0.7	0.5 to 0.9	0.7	0.4 to 0.9
Haemorrhage	0.7	0.5 to 0.9	0.7	0.5 to 1.0
Limb ischaemia	4.5	3.9 to 5.1	3.3	2.8 to 3.9
Renal failure	3.1	2.7 to 3.7	4.5	3.9 to 5.1
None of predefined complications	83.8	82.8 to 84.8	79.2	77.9 to 80.4
Return to theatre	10.9	10.0 to 11.8	7.6	6.8 to 8.4
Readmission to higher level care	3.3	2.8 to 3.8	3.5	3.0 to 4.1

Adjusted 30 day in-hospital mortality following major unilateral lower limb amputation is shown, by NHS trust, in Figure 9.6. The rates were adjusted for age, ASA grade (>=4 vs. < 4) and amputation level (below or above the knee) for elective cases; for emergency cases, additional adjustment was also made for chronic lung disease, ischaemic heart disease and chronic renal disease as comorbidities. The overall rate of in-hospital death in AKA and BKA patients analysed together was 8.3% (95% CI: 7.7 to 8.9) and the 30 day in-hospital mortality was 5.4% (95% CI: 5.0 to 5.9; Figure 9.6). All NHS trusts' adjusted mortality rates were estimated to be within the 99.8% control limits.

Figure 9.6: Risk-adjusted 30 day in-hospital mortality rate following major amputation, shown in comparison to the overall average of 5.4%



Note to Figure 9.6: this figure is based on data from Trusts with ≥ 10 amputations.

9.6 Discharge and follow-up

Discharge and follow-up of patients undergoing lower limb amputations, among patients discharged alive, are summarised in Table 9.4. The wounds of just over half of patients had healed by 30 days, and this increased slightly by the time of discharge. 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 9.4: Discharge and follow-up of patients undergoing lower limb amputations, among patients discharged alive

	Below knee	%	Above knee	%
Wound healed at discharge *	3,139	71.2	2,737	74.4
Referred to rehabilitation or limb fitting at discharge *	3,699	83.8	2,630	71.5
Wound healed at 30 days **	2,445	81.4	2,088	87.6
Readmission to hospital within 30 days **	407	10.9	282	9.1

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

9.7 Conclusion

While the case-ascertainment for lower limb amputations has improved marginally over the data collection period, the overall figure masks considerable variation in the case-ascertainment estimates for individual NHS trusts. Too many NHS trusts are not submitting data on a high proportion of all major amputations, despite progress by a few organisations to record all amputations in the NVR.

Overall, 53% of the major lower limb amputations recorded in the NVR between 2015 and 2017 were below knee amputations and 47% were above knee amputations. Most NHS trusts had an AKA to BKA ratio smaller than one, which suggests the recommendation to perform BKA wherever appropriate is being met. However, the ratio-estimates were not adjusted for case-mix at these trusts, so it is possible that the high ratios relate to some trusts treating more severely ill patients.

The NVR data suggests that a large proportion of amputations were performed during the daytime, but many were still undertaken as emergency operations. Furthermore, whilst many NHS trusts are following the recommendations that a consultant should be present in theatre and antibiotic and DVT prophylaxis be provided to all patients, there is variation in practice and not all providers meet these care guidelines. It would be worth exploring locally what the reasons for this variation are, and ensuring that the information on prophylaxis is accurately recorded in the NVR.

The overall in-hospital death rate was 8.3% (95% CI: 7.7 to 8.9) and the 30 day in-hospital mortality rate was 5.4% (95% CI: 5.0 to 5.9; Figure 9.6). Based on the available data, it seems that most NHS trusts have safe practice. However, due to the low case-ascertainment it is difficult to draw conclusions from these findings.

Appendix 1: Organisation of the Registry

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	Vascular Society of GB&I
Mr M Brooks		Vascular Society of GB&I
Mr M Clarke		Vascular Society of GB&I
Mr D Harkin		Vascular Society of GB&I
Prof R Fisher		Vascular Society of GB&I
Mr J J Earnshaw		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	Vascular Society of GB&I
Prof J van der Meulen, Outgoing Chair	Royal College of Surgeons of England
Miss S Renton	Vascular Society of GB&I
Ms S Hewitt	HQIP
Ms V Seagrove	HQIP
Ms Caroline Junor	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	Org	CEA	AAA	Bypass	Angio	Amp
7A1	Betsi Cadwaladr University Health Board	No	Yes	Yes	Yes	Yes	Yes
7A3	Abertawe Bro Morgannwg University Health Board	Yes	Yes	Yes	Yes	Yes	Yes
7A4	Cardiff and Vale University Health Board	Yes	Yes	Yes	Yes	Yes	Yes
7A5	Cwm Taf University Health Board	Yes	Yes	Yes	Yes	Yes	Yes
7A6	Aneurin Bevan University Health Board	Yes	Yes	Yes	Yes	Yes	Yes
R0A	Manchester University NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
R1H	Barts Health NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
R1K	London North West Healthcare NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RA9	Torbay and South Devon NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RAE	Bradford Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RAJ	Southend University Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RAL	Royal Free London NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RBA	Taunton and Somerset NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RBD	Dorset County Hospital NHS Foundation Trust	Yes	No	No	No	Yes	No
RBN	St Helens & Knowsley Teaching Hospitals NHS Trust	Yes	No	No	No	Yes	No
RBZ	Northern Devon Healthcare NHS Trust	Yes	No	No	Yes	Yes	Yes
RC1	Bedford Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RCB	York Teaching Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RDD	Basildon and Thurrock University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RDE	Colchester Hospital University NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RDU	Frimley Health NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RDZ	Royal Bournemouth and Christchurch Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
REF	Royal Cornwall Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
REM	Aintree University Hospital NHS Foundation Trust	Yes	No	No	No	Yes	No
RF4	Barking, Havering And Redbridge University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RGN	North West Anglia NHS Foundation Trust	No	No	No	No	Yes	No
RGR	West Suffolk NHS Foundation Trust	Yes	No	No	No	Yes	No
RGT	Cambridge University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RH8	Royal Devon and Exeter NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes

Code	Organisation Name	Org	CEA	AAA	Bypass	Angio	Amp
RHM	University Hospital Southampton NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RHQ	Sheffield Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RHU	Portsmouth Hospitals NHS Trust	No	No	No	No	Yes	No
RHW	Royal Berkshire NHS Foundation Trust	Yes	No	No	No	Yes	No
RJ1	Guy's and St Thomas' NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RJ7	St George's University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RJE	University Hospital of North Midlands NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RJR	Countess of Chester Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RJZ	King's College Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RK9	Plymouth Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RKB	University Hospitals Coventry and Warwickshire NHS Trust	No	Yes	Yes	Yes	Yes	Yes
RL4	Royal Wolverhampton Hospitals NHS Trust	Yes	No	No	No	Yes	No
RLN	City Hospitals Sunderland NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RM1	Norfolk and Norwich University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RMC	Bolton NHS Foundation Trust	Yes	No	No	No	Yes	No
RNA	The Dudley Group NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RNL	North Cumbria University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RNS	Northampton General Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RP5	Doncaster and Bassetlaw Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RPA	Medway NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RQ6	Royal Liverpool and Broadgreen University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RQ8	Mid Essex Hospital Services NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RQW	Princess Alexandra Hospital NHS Trust	No	Yes	Yes	Yes	Yes	Yes
RR1	Heart of England NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RR7	Gateshead Health NHS Foundation Trust	No	Yes	No	Yes	Yes	Yes
RR8	Leeds Teaching Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RRK	University Hospitals Birmingham NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RRV	University College London Hospitals NHS Foundation Trust	No	Yes	No	Yes	Yes	No
RT3	Royal Brompton & Harefield NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	No
RTD	Newcastle upon Tyne Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RTE	Gloucestershire Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RTG	Derby Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RTH	Oxford University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes

Code	Organisation Name	Org	CEA	AAA	Bypass	Angio	Amp
RTK	Ashford And St Peter's Hospitals NHS Foundation Trust	No	Yes	Yes	Yes	Yes	Yes
RTR	South Tees Hospitals NHS Foundation Trust	No	Yes	Yes	Yes	Yes	Yes
RVJ	North Bristol NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RVV	East Kent Hospitals University NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RW6	Pennine Acute Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RWA	Hull and East Yorkshire Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RWD	United Lincolnshire Hospitals NHS Trust	No	Yes	Yes	Yes	Yes	Yes
RWE	University Hospitals of Leicester NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RWG	West Hertfordshire Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RWH	East and North Hertfordshire NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RWP	Worcestershire Acute Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RWY	Calderdale and Huddersfield NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RX1	Nottingham University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RXF	Mid Yorkshire Hospitals NHS Trust	No	No	No	No	Yes	No
RXH	Brighton and Sussex University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RXN	Lancashire Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RXP	County Durham and Darlington NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes	Yes
RXR	East Lancashire Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RXW	Shrewsbury and Telford Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
RYJ	Imperial College Healthcare NHS Trust	Yes	Yes	Yes	Yes	Yes	Yes
SA999	NHS Ayrshire & Arran	Yes	Yes	Yes	Yes	Yes	Yes
SF999	NHS Fife	Yes	Yes	No	Yes	Yes	Yes
SG999	NHS Greater Glasgow and Clyde	Yes	Yes	Yes	Yes	Yes	Yes
SH999	NHS Highland	Yes	Yes	Yes	Yes	Yes	Yes
SL999	NHS Lanarkshire	Yes	Yes	Yes	Yes	Yes	Yes
SN999	NHS Grampian	Yes	Yes	Yes	Yes	Yes	Yes
SS999	NHS Lothian	Yes	Yes	Yes	Yes	Yes	Yes
ST999	NHS Tayside	Yes	Yes	Yes	Yes	Yes	Yes
SV999	NHS Forth Valley	No	Yes	Yes	Yes	Yes	Yes
SY999	NHS Dumfries and Galloway	No	Yes	No	Yes	Yes	Yes
ZT001	Belfast Health and Social Care Trust	Yes	Yes	Yes	Yes	Yes	Yes

Appendix 3: Summary of procedures and patient characteristics

Carotid endarterectomy

The carotid arteries are the main vessels that supply blood to the brain, head and neck. As people age, these arteries can become narrow because of a build-up of plaque on the arterial wall. The plaque may cause turbulent blood flow and blood clotting. Material breaking off can lodge in the blood vessels of the brain causing either transient symptoms or a stroke. Those with transient symptoms have the highest risk of stroke in the period immediately following the onset of symptoms.

The risk of stroke can be reduced if surgery is performed quickly following the onset of symptoms. An analysis of pooled data from several randomised clinical trials showed that maximum reduction in the risk of stroke was achieved if surgery was performed within 14 days of randomisation [Rothwell et al 2004], a result that is reflected in the NICE guideline for the management of stroke. It recommended that surgery to remove the plaque (carotid endarterectomy) is performed within 2 weeks of an ischaemic cerebrovascular event (Transient ischaemic attack (TIA) or minor stroke) in symptomatic patients with ipsilateral high- (70-99%) or moderate-degree (50-69%) carotid artery stenosis [NICE 2008].

More information about carotid endarterectomy can be found on the Circulation Foundation website: https://www.circulationfoundation.org.uk/help-advice/carotid

Table A3.1: Characteristics of patients who had carotid endarterectomy between 1 Jan 2015 and 31 Dec 2017, compared with characteristics from previous two years

Patient characteristics	**No. of procedures**	**2017 %**	**2016 %**	**2015 %**
Total procedures	4,148			
Age (years), (n=4,133)				
Under 66	1,031	24.9	26.6	25.0
66 to 75	1,503	36.4	35.5	35.3
76 to 85	1,379	33.4	31.7	34.2
86 and over	220	5.3	6.3	5.4
Male	2,729	65.8	65.8	67.8
Female	1,419	34.2	34.2	32.2
Patients symptomatic for carotid disease				
Index symptom if symptomatic: (n=3,856)				
Stroke	1,403	36.4	35.8	34.9
TIA	1,792	46.5	47.3	47.9
Amaurosis fugax	582	15.1	14.7	15.4
None of the three above	79	2.0	2.2	1.8
Grade of ipsilateral carotid stenosis* (n=4,144)				
<50%	58	1.4	1.6	1.5
50-69%	1,083	26.1	25.9	24.4
70-89%	1,752	42.3	42.4	42.9
90-99%	1,244	30.0	29.9	31.1
Occluded	7	0.2	0.2	0.2
Rankin score prior to surgery (n=4,145)				
0-2	3,777	91.1	91.8	92.4
3	320	7.7	6.8	6.4
4-5	48	1.2	1.3	1.2
Co-morbidities (n=4,148)				
Diagnosed diabetic	991	23.9	22.5	23.6
Current symptoms / treatment Ischaemic heart disease	1,293	31.2	31.6	34.0

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

Table A3.2 summarises the operative details of unilateral carotid endarterectomies performed during 2017:

Operation details		Procedures (n=4,144)	(%)
Anaesthetic	General only	2,403	58.0
	Local only	919	22.2
	Other	821	19.8
Type of Endarterectomy	Standard	427	10.3
	Standard + patch	3,457	83.4
	Eversion	260	6.3
Carotid shunt used		2,260	54.6
Ipsilateral patency check		2,483	61.2

Abdominal aortic aneurysms

An abdominal aortic aneurysm is the local expansion of the abdominal aorta, a large artery that takes blood from the heart to the abdomen and lower parts of the body. Most aneurysms occur below the kidneys (i.e., are infra-renal), but they can occur around the location where blood vessels branch off from the aorta to the kidneys or even higher up towards the chest.

The condition tends not to produce symptoms until the aneurysm ruptures. A rupture can occur without warning, causing sudden collapse, or the death of the patient. A ruptured AAA requires emergency surgery.

Screening and intervening to treat larger AAAs reduces the risk of rupture. An aneurysm may be detected incidentally when a patient is treated for another condition, and is then kept under surveillance. However, to provide a more comprehensive preventative service, the National Abdominal Aortic Aneurysm Screening Programme (NAAASP) was introduced in 2010. This invites men for AAA screening (a simple ultrasound scan) in the year they turn 65 years old (the condition is much less common in women). Once detected, treatment to repair the aorta before it ruptures can be planned with the patient, and surgery is typically performed as an elective procedure.

Aneurysms may be treated by either open surgery or by an endovascular repair (EVAR). In open surgery, the AAA is repaired through an incision in the abdomen. An EVAR procedure involves the insertion of a stent graft through the groin. Both are major operations. The decision on whether EVAR is preferred over an open repair is made jointly by the patient and the clinical team, taking into account characteristics of the aneurysm as well as the patient's age and fitness.

More information about abdominal aortic aneurysms and their treatment can be found on the Circulation Foundation website at: https://www.circulationfoundation.org.uk/help-advice/abdominal-aortic-aneurysm

Elective repair of infra-renal AAAs

The characteristics of patients who underwent an elective repair of an infra-renal AAA during 2017 are summarised in Table A3.3.

Table A3.3: Characteristics of patients who had elective infra-renal AAA repair between January and December 2017. Column percentages

		Open AAA	%	EVAR	%	Total
Total procedures		1,338		2,870		4,208
Age group (years)	Under 66	351	26.3	229	8.0	580
	66 to 75	637	47.7	1,105	38.6	1,742
	76 to 85	338	25.3	1,301	45.4	1,639
	86 and over	9	0.7	229	8.0	238
Male		1,192	89.1	2,571	89.6	3,763
Female		146	10.9	299	10.4	445
Current smoker		375	28.0	543	18.9	918
Previous AAA surgery		134	10.0	351	12.2	485
Indication	Screen detected	488	36.5	832	29.0	1,320
	Non-screen	705	52.7	1,626	56.7	2,331
	Other	144	10.8	411	14.3	555
AAA diameter (cm)	Under 4.5	48	3.6	104	3.6	152
	4.5 to 5.4	78	5.8	201	7.0	279
	5.5 to 6.4	887	66.3	1,884	65.6	2,771
	6.5 to 7.4	190	14.2	416	14.5	606
	7.5 and over	135	10.1	265	9.2	400
ASA fitness grade	1,2	459	34.3	681	23.7	1,140
	3	840	62.8	2,016	70.3	2,856
	4,5	39	2.9	172	6.0	211
Comorbidities	Hypertension	898	67.1	2,019	70.3	2,917
	Ischemic heart disease	358	26.8	1,156	40.3	1,514
	Chronic heart failure	25	1.9	162	5.6	187
	Stroke	74	5.5	201	7.0	275
	Diabetes	163	12.2	518	18.0	681
	Chronic renal failure	147	11.0	419	14.6	566
	Chronic lung disease	291	21.7	791	27.6	1,082

Repair of ruptured abdominal aortic aneurysms

Ruptured abdominal aortic aneurysm is a common vascular emergency. For a long time, the only surgical technique for a ruptured AAA was open repair. Recently, it has been possible to take an endovascular approach, and some observational studies have reported that EVAR procedures might have lower short-term mortality rates than open repairs. However, many patients with ruptured aneurysms are unsuitable for conventional EVAR, and so these results might reflect differences in the patients selected for each technique. Indeed, the results of the IMPROVE trial [Powell et al 2014], which compared the outcomes of EVAR and open repair among patients with ruptured AAAs reported 30 day mortality of 35.4% and 37.4%, respectively. It concluded that endovascular repair was not associated with any significant reduction in short-term mortality. It is likely that some patients will benefit most from open repair, while others could benefit from EVAR, given their anatomical and physiological characteristics.

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 75 years at the time of surgery and tended to have a larger diameter of the aneurysm (Table A3.4). 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.

Peripheral artery disease

Peripheral artery disease (PAD) is a restriction of the blood flow in the lower limb arteries that 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.

Patients with PAD have various treatment options [Peach et al 2012]. Endovascular or open surgical interventions (such as bypass) become options when conservative therapies have proved to be ineffective. The indication for either procedure depends upon the site(s) and length of the diseased arteries as well as vessel size but there is a degree of overlap between the two therapies, and they are increasingly used in combination. More information about peripheral artery disease and its treatment can be found on the Circulation Foundation website at:

https://www.circulationfoundation.org.uk/help-advice/peripheral-arterial-disease

Table A3.4: Characteristics of patients who had a repair of a ruptured AAA between January 2015 and December 2017

		Open AAA	%	EVAR	%	Total
Total procedures		1,892		790		2,682
Age group (years)	Under 66	223	11.8	60	7.6	283
	66 to 75	678	35.8	227	28.7	905
	76 to 85	847	44.8	367	46.5	1,214
	86 and over	144	7.6	136	17.2	280
Male		1,580	83.5	674	85.3	2,254
Female		312	16.5	116	14.7	428
Previous AAA surgery		155	8.2	166	21.0	321
AAA diameter (cm)	<4.5	27	1.4	43	5.5	70
	4.5 to 5.4	70	3.7	41	5.2	111
	5.5 to 6.4	308	16.3	166	21.1	474
	6.5 to 7.4	365	19.4	177	22.5	542
	7.5 and over	1,114	59.1	361	45.8	1,475
ASA fitness grade	1 or 2	73	3.9	27	3.4	100
	3	151	8.0	107	13.5	258
	4	1,150	60.8	527	66.7	1,677
	5	517	27.3	129	16.3	646

Lower limb bypass

Table A3.5 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 A3.6 summarises the length of stay of patients by the type of procedure that they underwent and admission mode.

Table A3.5: Patient characteristics of patients undergoing lower limb bypass between January 2015 and December 2017

	Bypass	
	No. of procs	%
Total procedures	17,475	
Age group (years)		
Under 60	3,584	20.6
60 to 64	2,325	13.3
65 to 69	3,021	17.3
70 to 74	3,026	17.4
75 to 79	2,647	15.2
80 and over	2,813	16.2
Men	12,827	73.4
Women	4,648	26.6
Smoking		
Current smoker	5,936	34.0
Ex-smoker	9,654	55.3
Never smoked	1,878	10.8
Previous ipsilateral limb procedure	6,636	38.0
% Emergency admissions	6,372	36.5
Fontaine score		
1 Asymptomatic	242	1.5
2 Intermittent claudication	4,788	29.5
3 Nocturnal &/or resting pain	5,956	36.7
4 Necrosis &/or gangrene	5,226	32.2
Comorbidities		
None	2,306	13.2
Hypertension	11,892	68.1
Ischaemic heart disease	6,464	37.0
Diabetes	5,810	33.2
Stroke	1,288	7.4
Chronic lung disease	3,968	22.7
Chronic renal disease	1,749	10.0
Chronic heart failure	972	5.6
Medication		
None	457	2.6
Anti-platelet	15,030	86.0
Statin	14,410	82.5
Beta blocker	4,098	23.5
ACE inhibitor/ARB	6,565	37.6

Table A3.6: Length of stay of patients undergoing lower limb bypass between January 2015 and December 2017 by type of procedure

	Bypass			
	Elective		Emergency	
Total procedures	11,103		6,372	
Length of stay (days)	***Median***	***IQR***	***Median***	***IQR***
Bypass only	6	4 to 10	15	9 to 26
Adjunct to bypass	4	3 to 7	15	9 to 27
Endarectomy alone	4	2 to 5	13	8 to 26

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 A3.7 Characteristics of patients undergoing endovascular lower limb revascularisation

	No. of procs	%
Total procedures	19,009	
Age group (years)		
Under 60	3,100	16.3
60 to 64	2,243	11.8
65 to 69	2,927	15.4
70 to 74	3,220	16.9
75 to 79	2,928	15.4
80 and over	4,591	24.2
Men	12,752	67.1
Women	6,257	32.9
Smoking		
Current smoker	4,705	25.4
Ex-smoker	10,412	56.2
Never smoked	3,418	18.4
Previous ipsilateral limb procedure	6,129	32.3
Admitted as an emergency	5,179	27.2
Fontaine score		
1 Asymptomatic	752	4.1
2 Intermittent claudication	7,769	42.5
3 Nocturnal &/or resting pain	3,850	21.0
4 Necrosis &/or gangrene	5,929	32.4
Comorbidities		
None	2,584	13.6
Hypertension	11,565	60.8
Diabetes	7,888	41.5
Ischaemic heart disease	6,386	33.6
Chronic lung disease	2,947	15.5
Chronic renal disease	2,576	13.6
Stroke	1,472	7.7
Chronic heart failure	1,271	6.7
Medication		
None	1,178	6.2
Anti-platelet	14,973	78.8
Statin	14,128	74.3
ACE inhibitor/ARB	6,835	36.0
Beta blocker	4,749	25.0

Lower limb major amputation

Characteristics of patients undergoing major unilateral amputations are summarised in Table A3.8, 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 most frail, 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 8) this cannot be explored further.

Table A3.8: Characteristics of patients undergoing major unilateral lower limb amputation

	Below knee	%	Above knee	%
Procedures	4,895	52.7	4,398	47.3
Age group (years)				
Under 60	1,367	27.9	785	17.9
60 to 64	636	13.0	422	9.6
65 to 69	656	13.4	603	13.7
70 to 74	682	13.9	71	16.2
75 to 79	658	13.5	691	15.7
80 and over	895	18.3	1,186	27.0
Men	3,610	73.8	2,970	67.5
Women	1,285	26.3	1,428	32.5
Smoking				
Current smoker	1,289	26.4	1,455	33.2
Ex-smoker	2,449	50.2	2,197	50.1
Never smoked	1,414	23.4	736	16.8
Presenting problem				
Acute limb ischaemia	506	10.3	937	21.3
Chronic limb ischaemia	1,008	20.6	969	22.0
Neuropathy	81	1.7	53	1.2
Tissue loss	1,894	38.7	1,588	36.1
Uncontrolled infection	1,399	28.6	803	18.3
Aneurysm	5	0.1	47	1.1
Previous ipsilateral limb procedure	3,188	65.5	2,556	58.7

Pre-operative risk factors are summarised in Table A3.9. 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 A3.9: Pre-operative risk factors among patients undergoing lower limb amputation

	Below knee	**%**	**Above knee**	**%**
Procedures	4,895	52.7	4,398	47.3
ASA grade				
1 Normal	39	0.8	30	0.7
2 Mild disease	423	8.7	258	5.9
3 Severe, not life-threatening	3,449	70.5	2,605	59.3
4-5 Severe, life-threatening, or moribund patient	980	20.0	1,499	34.1
Comorbidities				
None	409	8.4	495	11.3
Hypertension	2,993	61.1	2,674	60.8
Ischaemic heart disease	1,912	39.1	1,823	41.5
Diabetes	3,424	66.2	1,860	42.3
Stroke	470	9.6	590	13.4
Chronic lung disease	883	18.0	1,136	25.8
Chronic renal disease	1,141	23.3	855	19.4
Chronic heart failure	465	9.5	532	12.1
Medication				
None	252	5.2	315	7.2
Anti-platelet	3,600	73.5	3,054	69.4
Statin	3,559	72.7	2,962	67.4
Beta blocker	1,338	27.3	1,145	26.0
ACE inhibitor/ARB	1,638	33.5	1,364	31.0

Appendix 4: Organisational Survey (Services at July 2018)

(See key at end for values in last two columns)

NHS Trust	Role in vascular network (Hub, Spoke, Not in network)	If hub, number of spoke hospitals	Consultant Vascular surgeons	Consultant Interventional radiologists	Vascular Nurse specialists	Inpatient vascular beds	Complex Aortic Repairs	Complex Aortic MDT	Types of Complex Aortic Procedures Performed	Facilities for Complex Aortic Procedures
7A1	Did not complete survey									
7A3	Hub	7	8	4	2	38	No			
7A4	Hub	5	3	3	2	32	Yes	No	T,B,TH,R	F,O,B,C
7A5	Hub	2	2	2	2	15	No			
7A6	Hub	3	4	2	3	30	No			
R0A	Hub	3	5	6	3	26	Yes	Yes	T,F,R	F,O,B,C
R1H	Hub	4	7	9	3	23	Yes	Yes	T,B,F,TH,R	F,O,,C
R1K	Hub	3	6	5	1	20	Yes	No	T,B,F	
RA9	Spoke		2	2	2	5	No			
RAE	Hub	1	4	2	1	28	No			
RAJ	Not in Network		3	4	2	18	No			
RAL	Hub	7	11	9	2	32	Yes	Yes	T,B,F,TH,R	F,O
RBA	Hub	2	6	5	4	32	No			
RBD	Spoke		2	2	1	0	No			
RBN	Spoke		2	2	1	0	No			
RC1	Hub	2	6	3	1	15	Yes	Yes	T,B,F	F
RCB	Hub	5	7	5	3	30	Yes	Yes	F	
RDD	Not in Network		4	3	0	15	Yes	Yes	T,B,F,R	F,O,B,C
RDE	Hub	1	7	4	3	20	Yes	Yes	B,F	
RDU	Hub	3	7	2	5	17	Yes	Yes	F	F
RDZ	Hub	4	7	5	3	22	Yes	No	F	F

NHS Trust	Role in vascular network (Hub, Spoke, Not in network)	If hub, number of spoke hospitals	Consultant Vascular surgeons	Consultant Interventional radiologists	Vascular Nurse specialists	Inpatient vascular beds	Complex Aortic Repairs	Complex Aortic MDT	Types of Complex Aortic Procedures Performed	Facilities for Complex Aortic Procedures
REF	Not in Network		6	5	2	16	No			
REM	Spoke		2	5	2	0	Yes	No	T	O
RF4	Hub	1	5	5	1	28	Yes	Yes	F	F,O
RGR	Spoke		1	2	0	0	No			
RGT	Hub	6	9	6	6	26	Yes	Yes	T,B,F,TH,R	F,O,B,C
RH8	Hub	1	Did not fully complete survey							
RHM	Hub	4	8	7	1	22	Yes	Yes	T,B,F,TH,R	F,O,B,C
RHQ	Hub	3	5	6	2	28	Yes	Yes	T,B,F,R	F,O,B,C
RHW	Spoke		0	5	2	0	No	No	T	
RJ1	Hub	6	12	9	11	47	Yes	Yes	T,B,F,TH,R	F,O,B,C
RJ7	Hub	6	8	7	2	22	Yes	Yes	T,B,F,TH,R	F,O,B,C
RJE	Hub	3	10	8	4		Yes	Yes	T,TH,R	F,O,B,C
RJR	Hub	2	11	7	5	28	Yes	Yes	T,B,F,TH,R	C
RJZ	Spoke		6	6	3	14	Yes	Yes	T,B,F,TH,R	F,O,B,C
RK9	Hub	0	6	4	1	9	Yes	No	T,B,TH,R	F,O,B,C
RKB	Did not complete survey									
RL4	Spoke		2	3	2	0	No			
RLN	Hub	2	5	3	2	14	Yes	Yes	T,B,F	F
RM1	Hub	2	7	5	3	27	Yes	Yes	T,B,F	F,O
RMC	Spoke		1	2	1	0	No			
RNA	Hub	2	8	6	2	42	No			
RNL	Hub	2	6	2	4	15	No			
RNS	Hub	1	6	2	4	30	Yes	Yes	TH	
RP5	Hub	2	6	4	3	19	No			
RPA	Not in Network		5	4	2	24	Yes	Yes	F	F

NHS Trust	Role in vascular network (Hub, Spoke, Not in network)	If hub, number of spoke hospitals	Consultant Vascular surgeons	Consultant Interventional radiologists	Vascular Nurse specialists	Inpatient vascular beds	Complex Aortic Repairs	Complex Aortic MDT	Types of Complex Aortic Procedures Performed	Facilities for Complex Aortic Procedures
RQ6	Hub	3	10	4	1	37	Yes	No	T,B,F	F
RQ8	Not in Network		3	3	2	12	Yes	Yes	F	
RQW	Spoke		3	2	2	10	Yes	Yes	F	F,O
RR1	Hub	2	6	2	3	12	Yes	Yes	T,B,F,TH,R	F,O
RR7	Spoke						No			
RR8	Hub	3	10	10	2	38	Yes	Yes	T,B,F,TH,R	F,O,B,C
RRK	Hub	2	7	8	3	18	Yes	Yes	T,B,F,TH,R	F,O,B,C
RRV	Did not complete survey									
RT3	Not in Network		2	1	0		Yes	Yes	T,B,F,TH,R	F,O,B,C
RTD	Hub	5	5	5	1	31	Yes	Yes	T,B,F,TH,R	F,O,B,C
RTE	Hub	2	7	5	5	35	No			
RTG	Hub	1	8	7	2	28	Yes	No	F	O
RTH	Hub	3	6	7	3	22	Yes	Yes	T,B,F,TH,R	F,O,B,C
RTK	Did not complete survey									
RTR	Hub	3	Did not fully complete survey				No			
RVJ	Hub	3	10	4	2	34	Yes	Yes	T,B,F,R	F
RVV	Hub	2	5	4	5	24	Yes	Yes	F	F,O
RW6	Not in Network		6	4	3	28	No			
RWA	Hub	5	6	6	3	28	No	Yes	T,B,F,TH,R	F,O,B,C
RWD	Hub	Did not fully complete survey					No			
RWE	Not in Network		8	6	4	28	Yes	Yes	T,B,F,TH	F,O,B,C
RWG	Not in Network		4	3	1	0	No			
RWH	Not in Network		4	3	0	9	No			
RWP	Hub	Did not fully complete survey								
RWY	Hub	1	4	1	1	15	No			

NHS Trust	Role in vascular network (Hub, Spoke, Not in network)	If hub, number of spoke hospitals	Consultant Vascular surgeons	Consultant Interventional radiologists	Vascular Nurse specialists	Inpatient vascular beds	Complex Aortic Repairs	Complex Aortic MDT	Types of Complex Aortic Procedures Performed	Facilities for Complex Aortic Procedures
RX1	Hub	2	6	7	2	22	Yes	Yes	T,B,F	F,O,B
RXH	Hub	6	10	6	2	37	Yes	Yes	T,B,F,TH,R	F,O,B,C
RXN	Hub	3	11	10	8	26	No			
RXP	Hub	3	8	2	4	16	No			
RXR	Hub	1	6	5	4	16	No			
RXW	Hub	1	5	3	2	18	No			
RYJ	Hub	2	8	6	4	30	Yes	Yes	T,B,F,TH,R	F,O,B,C
SA999	Not in Network		4	2	2	24	No			
SF999	Spoke		2	0	2	0	No			
SG999	Hub	Did not fully complete survey								
SH999	Hub	2	3	1	1	12	Yes	Yes		
SL999	Not in Network		5	6	1	24	Yes	No	T,B	F
SN999	Hub	4	5	2	1	18	Yes	Yes	T,F,R,	F,O,B,C
SS999	Hub	0	6	6	6		Yes	Yes	T,B,F,TH,R	F,O,B,C
ST999	Hub	1	4	5	1	24	Yes	Yes	T,B,F	F
SV999	Did not complete survey									
SY999	Did not complete survey									
ZT001	Hub	3	9	9	4	26	Yes	Yes	T,B,F,TH,R	F,O,B,C

Key

Indicator	Value	Response
Type of Complex Aortic Procedures Performed	T	TEVAR
	B	BEVAR
	F	FEVAR
	TH	Open thraco-abdominal AAA repairs
	R	Open aortic root and arch repair

Indicator	Value	Response
Facilities for Complex Aortic Procedures	F	Cerebrospinal fluid drainage
	O	Open thoracotomy
	B	Cardiac bypass surgery
	C	Complex combined open aortic arch surgery and TEVAR

NHS Trust	Total number of vascular surgeon lists (half-day)	Total number of interventional radiology lists (half-day)	Hybrid theatre	Hybrid theatre for combined peripheral vascular procedures	% lists staffed by consultant vascular anaesthetist	24/7 interventional radiologist cover for vascular	24/7 interventional radiologist cover for non-vascular	Out-hours diagnostic services	Extended level of care on normal ward
7A1	Did not complete survey								
7A3	9	6	No		75%-99%	No	No	C	No
7A4	6	9	No		100%	No	No	C	No
7A5	4	4	No		75%-99%	No	No	C	No
7A6	8	4	No		100%	No	No	C	No
R0A	16	20	Yes	Yes	100%	Yes	Yes	DC	No
R1H	16	39	Yes	Yes	100%	Yes	Yes	C	No
R1K	17	9	Yes	Yes	75%-99%	Yes	Yes	C	Yes
RA9	4	8	Yes	Yes	<50%	Yes	Yes	C	No
RAE	9	8	No		75%-99%	Yes	Yes	DC	No
RAJ	8	7	Yes	Yes	75%-99%	No	No	C	Yes
RAL	9	10	Yes	Yes	100%	Yes	Yes	DCM	No
RBA	8	7	No		75%-99%	Yes	Yes	CM	Yes
RBD	4	5	No		50%-74%	Yes	Yes	CM	No
RBN	2	4	No		N/A	Yes	Yes	C	No
RC1	10	4	No		100%	No	No	C	Yes
RCB	16	10	No		50%-74%	Yes	Yes	DC	No
RDD	9	6	Yes	Yes	50%-74%	No	No	C	No
RDE	10	11	Yes	Yes	75%-99%	Yes	Yes	C	No
RDU	3	12	Yes	Yes	75%-99%	Yes	Yes	CM	No
RDZ	9	10	No		75%-99%	Yes	Yes	C	No
REF	9	10	Yes	Yes	100%	Yes	Yes	CM	No
REM	2	5	Yes	No	<50%	Yes	Yes	C	No
RF4	11	10	Yes	Yes	100%	Yes	Yes	C	Yes

NHS Trust	Total number of vascular surgeon lists (half-day)	Total number of interventional radiology lists (half-day)	Hybrid theatre	Hybrid theatre for combined peripheral vascular procedures	% lists staffed by consultant vascular anaesthetist	24/7 interventional radiologist cover for vascular	24/7 interventional radiologist cover for non-vascular	Out-hours diagnostic services	Extended level of care on normal ward
RGR	3	4	No		N/A	No	No	C	No
RGT	15	20	Yes	Yes	<50%	Yes	Yes	CM	No
RH8	Did not fully complete survey								
RHM	14	11	Yes	Yes	100%	Yes	Yes	DC	No
RHQ	12	19	Yes	Yes	75%-99%	Yes	Yes	C	No
RHW	2	8	No		N/A	Yes	No	CM	Yes
RJ1	28	4	Yes	Yes	100%	Yes	Yes	CM	Yes
RJ7	16	1	Yes	Yes	100%	Yes	Yes	C	No
RJE	18	20	Yes	Yes	75%-99%	Yes	Yes	CM	No
RJR	17	10	No		100%	Yes	Yes	DCM	No
RJZ	18	8	Yes	Yes	100%	Yes	Yes	DC	Yes
RK9	10	12	No		75%-99%	Yes	Yes	C	Yes
RKB	Did not complete survey								
RL4	3	10	No		<50%	Yes	Yes	C	No
RLN	8	5	Yes	Yes	100%	No	No	C	Yes
RM1	12	12	No		100%	Yes	Yes	C	No
RMC	1	4	No		<50%	Yes	No	C	Yes
RNA	2	7	No		100%	Yes	Yes	C	Yes
RNL	11	3	No		100%	No	No	C	No
RNS	11	8	No		75%-99%	Yes	No	DCS	Yes
RP5	8	10	No		100%	Yes	Yes	DC	No
RPA	6	8	Yes	Yes	100%	Yes	Yes	C	No
RQ6	25	10	Yes	Yes	75%-99%	Yes	Yes	C	No
RQ8	8	4	Yes	Yes	75%-99%	No	Yes	C	Yes

NHS Trust	Total number of vascular surgeon lists (half-day)	Total number of interventional radiology lists (half-day)	Hybrid theatre	Hybrid theatre for combined peripheral vascular procedures	% lists staffed by consultant vascular anaesthetist	24/7 interventional radiologist cover for vascular	24/7 interventional radiologist cover for non-vascular	Out-hours diagnostic services	Extended level of care on normal ward
RQW	6	5	Yes	Yes	100%	No	No	C	No
RR1	11	4	Yes	Yes	100%	Yes	Yes	C	No
RR7	Did not fully complete survey								
RR8	17	15	Yes	Yes	75%-99%	Yes	Yes	DCM	No
RRK	11	8	Yes	Yes	100%	Yes	Yes	CM	No
RRV	Did not complete survey								
RT3	3	0	Yes	No	100%	Yes	Yes	DCM	No
RTD	18	10	Yes	Yes	75%-99%	Yes	Yes	DC	No
RTE	13	1	Yes	Yes	100%	No	No	C	No
RTG	19	5	No		75%-99%	Yes	Yes	CM	No
RTH	10	4	No		75%-99%	Yes	Yes	C	No
RTK	Did not complete survey								
RTR	Did not fully complete survey								
RVJ	20	10	Yes	Yes	75%-99%	Yes	Yes	C	No
RVV	12	10	Yes	Yes	75%-99%	No	No	C	No
RW6	14	12	Yes	Yes	75%-99%	Yes	Yes	C	No
RWA	20	20	Yes	Yes	50%-74%	Yes	Yes	C	No
RWD	Did not fully complete survey								
RWE	16	10	Yes	Yes	100%	Yes	Yes	DC	Yes
RWG	15	2	No		75%-99%	Yes	No	CM	Yes
RWH	3	6	No		100%	No	No	C	No
RWP	Did not fully complete survey								
RWY	7	8	No		75%-99%	Yes	Yes	C	No
RX1	8	12	Yes	Yes	75%-99%	Yes	Yes	C	

NHS Trust	Total number of vascular surgeon lists (half-day)	Total number of interventional radiology lists (half-day)	Hybrid theatre	Hybrid theatre for combined peripheral vascular procedures	% lists staffed by consultant vascular anaesthetist	24/7 interventional radiologist cover for vascular	24/7 interventional radiologist cover for non-vascular	Out-hours diagnostic services	Extended level of care on normal ward
RXH	15	14	Yes	Yes	75%-99%	Yes	Yes	CM	No
RXN	27	27	Yes	Yes	75%-99%	Yes	Yes	DCM	No
RXP	12	1	Yes	Yes	75%-99%	No	No	C	No
RXR	17	10	Yes	Yes	75%-99%	No	No	CM	Yes
RXW	10	7	No		75%-99%	No	No	C	Yes
RYJ	14	10	Yes	No	100%	Yes	Yes		Yes
SA999	9	6	Yes	Yes	50%-74%	No	No	C	No
SF999	4	6			100%	No	No	C	Yes
SG999	Did not fully complete survey								
SH999	6	6	Yes	Yes	50%-74%	No	No	C	No
SL999	9	10	No		75%-99%	No	No	DC	Yes
SN999	10	5	No		75%-99%	Yes	Yes	C	No
SS999	4	10	No		100%	Yes	Yes	C	Yes
ST999	10	10	No		100%	Yes	Yes	C	No
SV999	Did not complete survey								
SY999	Did not complete survey								
ZT001	18	10	Yes	Yes	75%-99%	Yes	Yes	CM	Yes

Key

Indicator	Value	Response
Out-hours diagnostic services	D	Duplex
	C	CT
	M	MR Angiography
	S	Specialist vascular physiology assessments

NHS Trust	Amputation Patients Assessed by Consultant Vascular Patients	Amputation Patients Discussed at MDT	Amputation Patients Usually Assessed by	% of CLI patients waiting >48 hrs for transfer from spoke to hub	% of CLI patients waiting >48 hrs for angio	% of CLI patients waiting >48 hrs for bypass	% of CLI patients waiting >48 hrs for repatriation from hub to spoke
7A1	Did not complete survey						
7A3	90%	60%	RP,OT	40%	60%	30%	60%
7A4	100%	100%	RP,OT	20%	50%	60%	100%
7A5	100%	70%	OT,PR	50%	50%	50%	50%
7A6	100%	90%	RP,OT,PO,PR	80%	10%	50%	100%
R0A	100%	90%	RP,OT,PO,PR	50%	50%	50%	100%
R1H	100%	30%	RP,OT	70%	70%	70%	70%
R1K	100%	100%	RP	10%	80%	70%	100%
RA9	90%	10%	OT,PO			50%	100%
RAE	100%	90%	RP,OT,PO	10%	80%	80%	100%
RAJ	100%	80%	RP,OT				
RAL	100%	80%	RP,EP,OT,PO	20%	50%	50%	80%
RBA	100%	100%		10%	20%	30%	0%
RBD	Trust does not carry out major amputations				10%	10%	10%
RBN	Trust does not carry out major amputations			80%	30%	100%	100%
RC1	100%	100%	RP,OT	10%	40%	40%	90%
RCB	100%	10%	RP,OT	10%	80%	30%	60%
RDD	100%	40%	RP,EP,OT,PR				
RDE	90%	30%	RP	10%	80%	50%	100%
RDU	100%	90%	RP,EP,OT	10%	40%	50%	90%
RDZ	100%	90%	RP,EP,OT,PR	10%	70%	70%	100%
REF	100%	100%	RP,OT		50%	50%	
REM	Trust does not carry out major amputations			90%	50%	90%	100%
RF4	100%	100%	RP,OT	10%	30%	10%	
RGR	Trust does not carry out major amputations			60%	90%	80%	100%

NHS Trust	Amputation Patients Assessed by Consultant Vascular Patients	Amputation Patients Discussed at MDT	Amputation Patients Usually Assessed by	% of CLI patients waiting >48 hrs for transfer from spoke to hub	% of CLI patients waiting >48 hrs for angio	% of CLI patients waiting >48 hrs for bypass	% of CLI patients waiting >48 hrs for repatriation from hub to spoke
RGT	90%	30%	RM,RP,EP,OT,PO,PR	30%	80%	80%	100%
RH8	Did not fully complete survey						
RHM	100%	80%	RP,OT	20%	20%	20%	80%
RHQ	100%	70%	RP	50%	90%	90%	100%
RHW	Trust does not carry out major amputations			20%	10%	20%	40%
RJ1	90%	90%	RP,EP,OT,PO	20%	80%	80%	100%
RJ7	90%	70%	RP,EP,OT,PO	40%	40%	10%	80%
RJE	100%	70%	RP,OT,PO	10%	30%	50%	100%
RJR	80%	50%	RM,RP,OT,PR	20%	40%	40%	90%
RJZ	100%	100%	RM,RP,EP,PO	10%	10%	10%	10%
RK9	100%	70%	RP,OT		30%	10%	
RKB	Did not complete survey						
RL4	Trust does not carry out major amputations			10%	80%	80%	100%
RLN	100%	80%		10%	40%	50%	70%
RM1	100%	50%	RP,OT,PR	20%	90%	10%	90%
RMC	Trust does not carry out major amputations			90%	90%	90%	90%
RNA	100%	30%	RP,EP,OT,PO,PR	10%	50%	90%	100%
RNL	100%	60%	RP,OT,PR	10%	50%	40%	80%
RNS	100%	80%	RP,OT,PO				
RP5	100%	100%	RP,OT,PO	10%	30%	30%	30%
RPA	100%	80%	RP,OT,PO		50%	50%	
RQ6	100%	80%	RP,EP,OT	80%	90%	90%	100%
RQ8	100%	50%	RP,OT,PO	10%	20%	10%	20%
RQW	100%	100%	RM,EP		20%	10%	
RR1	100%	90%	RP,OT	50%	80%	80%	90%

NHS Trust	Amputation Patients Assessed by Consultant Vascular Patients	Amputation Patients Discussed at MDT	Amputation Patients Usually Assessed by	% of CLI patients waiting >48 hrs for transfer from spoke to hub	% of CLI patients waiting >48 hrs for angio	% of CLI patients waiting >48 hrs for bypass	% of CLI patients waiting >48 hrs for repatriation from hub to spoke
RR7	Did not fully complete survey						
RR8	100%	10%	RP,OT				
RRK	100%	10%	RP,EP,OT,PO	20%	50%	20%	
RRV	Did not complete survey						
RT3	Trust does not carry out major amputations						
RTD	100%	10%	RP,EP,OT,PO,PR				
RTE	100%	20%		10%	30%	10%	70%
RTG	100%	90%	RP,OT	10%	30%	30%	50%
RTH	90%	10%	RP,OT	30%	60%	70%	90%
RTK	Did not complete survey						
RTR	Did not fully complete survey						
RVJ	90%	90%	RP,EP,OT	10%	20%	30%	30%
RVV	100%	90%	RP,EP,OT,PR	10%	20%	20%	30%
RW6	100%	80%	RM,RP,OT,PO,PR	10%	50%	10%	
RWA	100%	80%	RP,OT	90%	50%	50%	90%
RWD	Did not fully complete survey						
RWE	100%	100%	RP,OT,PR	10%	10%	10%	10%
RWG	100%	100%	EP	10%	40%	70%	10%
RWH	100%	90%	RP,OT,PO	10%	30%	30%	10%
RWP	Did not fully complete survey						
RWY	100%	70%	RP,PO	10%	10%	10%	10%
RX1	100%	80%	RM,RP,OT,PR		10%	10%	20%
RXH	100%	90%	RP,OT	10%	40%	40%	60%
RXN	100%	90%	RP	50%	50%	50%	100%
RXP	100%	10%	RP,EP,OT,PO	10%	20%	30%	50%

NHS Trust	Amputation Patients Assessed by Consultant Vascular Patients	Amputation Patients Discussed at MDT	Amputation Patients Usually Assessed by	% of CLI patients waiting >48 hrs for transfer from spoke to hub	% of CLI patients waiting >48 hrs for angio	% of CLI patients waiting >48 hrs for bypass	% of CLI patients waiting >48 hrs for repatriation from hub to spoke
RXR	100%	50%	RP,OT,PO	10%	20%	50%	10%
RXW	100%	80%	RP,OT		70%	70%	
RYJ	100%	50%	RP,EP	60%	80%	90%	100%
SA999	100%	90%	RP,PR		80%	90%	
SF999	Trust does not carry out major amputations			10%	50%	70%	30%
SG999	Did not fully complete survey						
SH999	100%	50%	RP,PR	50%	50%	50%	50%
SL999	30%	50%	RP,EP,OT,PO	10%	10%	10%	10%
SN999	100%	80%	RP,OT	20%	90%	90%	30%
SS999	100%	80%	RM,RP		70%	70%	
ST999	100%	80%	RP,OT	10%	70%	70%	50%
SV999	Did not complete survey						
SY999	Did not complete survey						
ZT001	100%	90%	RM,RP,OT,PO	90%	90%	90%	90%

Key

Indicator	Value	Response
Amputation patients usually assessed by	RM	Consultant in rehabilitation medicine
	RP	Rehabilitation physiotherapist
	EP	Care for the elderly physician
	OT	Occupational therapist
	PO	Podiatrist (for care of contralateral limb, if applicable)
	PR	Representative from prosthetics service

Appendix 5: Carotid endarterectomy (2017 unless specified)

Trust code	NVR cases	Symptomatic cases	Patients referred within 7 days of symptom	Patients receiving surgery within 7 days of referral	Patients receiving surgery within 14 days of symptom	% Adjusted Stroke and/or death rate (2015-2017)	Median delay and IQR from index symptom to surgery (days)	Median(IQR) length of stay (days)
7A1	26	26	69%	46%	62%	2.2%	13 (9 - 27)	3 (2 - 6)
7A3	88	82	67%	52%	52%	2.6%	14 (8 - 27)	5 (3 - 8)
7A4	0	No Data	No Data	No Data	No Data	(2015-2016) 1.6%	No Data	No Data
7A5	21	21	86%	33%	67%	1.5%	12 (9 - 20)	2 (2 - 4)
7A6	45	38	61%	56%	63%	2.8%	13 (8 - 21)	1 (1 - 6)
R0A	111	94	73%	64%	73%	2.0%	8 (5 - 18)	2 (1 - 3)
R1H	19	18	67%	67%	67%	3.8%	10 (7 - 21)	4 (3 - 13)
R1K	38	35	91%	84%	94%	4.2%	5 (3 - 8)	6 (3 - 9)
RA9	11	10	80%	73%	80%	0.0%	8 (3 - 13)	2 (1 - 2)
RAE	48	38	70%	44%	61%	1.6%	12 (8 - 19)	3 (3 - 4)
RAJ	26	25	76%	69%	72%	2.4%	10 (8 - 15)	11 (5 - 16)
RAL	12	12	64%	83%	83%	5.2%	11 (8 - 13)	3 (2 - 4)
RBA	69	68	74%	67%	69%	1.4%	12 (8 - 19)	2 (1 - 4)
RC1	26	24	46%	15%	8%	1.2%	25 (18 - 47)	1 (1 - 2)
RCB	107	101	82%	88%	91%	3.1%	4 (3 - 8)	3 (2 - 6)
RDD	15	15	67%	67%	60%	0.0%	12 (8 - 23)	7 (1 - 12)
RDE	71	59	79%	38%	54%	2.6%	11 (7 - 54)	2 (2 - 3)
RDU	45	42	60%	76%	67%	3.3%	11 (6 - 18)	2 (1 - 6)
RDZ	37	36	82%	68%	78%	0.0%	10 (5 - 14)	2 (1 - 3)
REF	45	43	56%	55%	63%	3.5%	13 (8 - 36)	2 (1 - 3)

Trust code	NVR cases	Symptomatic cases	Patients referred within 7 days of symptom	Patients receiving surgery within 7 days of referral	Patients receiving surgery within 14 days of symptom	% Adjusted Stroke and/or death rate (2015-2017)	Median delay and IQR from index symptom to surgery (days)	Median(IQR) length of stay (days)
RF4	39	39	41%	16%	18%	4.6%	24 (17 - 43)	2 (1 - 5)
RGT	82	74	67%	32%	47%	1.1%	15 (10 - 30)	2 (2 - 4)
RH8	24	24	83%	83%	79%	2.5%	7 (4 - 13)	2 (1 - 4)
RHM	74	74	84%	49%	78%	1.5%	12 (7 - 14)	2 (1 - 3)
RHQ	29	27	59%	41%	52%	2.3%	14 (9 - 24)	3 (2 - 4)
RJ1	67	55	57%	62%	64%	1.6%	10 (7 - 24)	3 (2 - 4)
RJ7	49	48	77%	86%	85%	0.6%	9 (6 - 12)	4 (3 - 6)
RJE	73	72	68%	57%	64%	2.1%	11 (8 - 22)	2 (1 - 4)
RJR	96	94	67%	15%	22%	1.6%	26 (16 - 33)	2 (2 - 4)
RJZ	83	63	67%	51%	56%	2.4%	10 (5 - 23)	5 (3 - 9)
RK9	59	49	76%	34%	43%	1.4%	18 (10 - 25)	1 (1 - 2)
RKB	56	55	75%	63%	65%	0.0%	10 (7 - 22)	3 (2 - 5)
RLN	30	28	68%	53%	64%	2.7%	11 (8 - 36)	1 (1 - 2)
RM1	89	77	85%	69%	82%	1.8%	8 (5 - 10)	3 (2 - 6)
RNA	55	55	64%	67%	65%	2.5%	12 (8 - 16)	2 (1 - 3)
RNL	27	26	75%	67%	65%	1.2%	11 (7 - 20)	2 (2 - 10)
RNS	53	51	69%	51%	57%	3.9%	13 (6 - 33)	2 (2 - 4)
RP5	34	34	68%	47%	56%	1.0%	12 (8 - 26)	2 (1 - 6)
RPA	23	21	67%	30%	29%	1.5%	17 (13 - 30)	1 (1 - 1)
RQ6	110	106	65%	17%	25%	3.2%	24 (14 - 39)	1 (1 - 3)
RQ8	40	33	67%	35%	52%	1.7%	14 (8 - 61)	2 (1 - 6)
RQW	<5	xx	xx	xx	xx	xx	xx	xx
RR1	36	34	68%	53%	71%	3.1%	11 (9 - 18)	3 (2 - 8)
RR7	10	10	50%	30%	20%	1.6%	25 (15 - 29)	3 (3 - 6)
RR8	46	45	67%	78%	71%	4.2%	9 (6 - 16)	5 (2 - 9)
RRK	48	40	64%	17%	23%	1.5%	26 (15 - 35)	2 (2 - 3)

Trust code	NVR cases	Symptomatic cases	Patients referred within 7 days of symptom	Patients receiving surgery within 7 days of referral	Patients receiving surgery within 14 days of symptom	% Adjusted Stroke and/or death rate (2015-2017)	Median delay and IQR from index symptom to surgery (days)	Median(IQR) length of stay (days)
RRV	36	31	83%	61%	71%	1.1%	7 (5 - 16)	3 (1 - 6)
RTD	80	78	70%	35%	46%	1.7%	15 (10 - 23)	2 (2 - 3)
RTE	56	52	62%	47%	44%	2.0%	16 (10 - 30)	2 (1 - 3)
RTG	44	44	58%	80%	68%	1.7%	11 (7 - 29)	5 (3 - 9)
RTH	144	117	61%	51%	63%	1.4%	12 (8 - 22)	2 (1 - 2)
RTK	26	21	57%	38%	48%	1.0%	15 (8 - 103)	3 (1 - 5)
RTR	29	28	67%	34%	39%	2.0%	18 (11 - 25)	2 (2 - 3)
RVJ	103	101	77%	35%	65%	2.0%	13 (9 - 17)	1 (1 - 3)
RVV	77	68	76%	68%	74%	2.1%	8 (5 - 19)	3 (2 - 7)
RW6	108	90	72%	62%	69%	0.8%	8 (5 - 20)	4 (2 - 6)
RWA	84	80	58%	51%	51%	0.9%	14 (9 - 24)	3 (2 - 6)
RWD	38	38	46%	82%	61%	2.1%	13 (8 - 20)	4 (2 - 7)
RWE	79	77	83%	77%	86%	0.0%	9 (5 - 12)	4 (3 - 7)
RWG	45	44	77%	49%	70%	2.7%	10 (7 - 18)	4 (3 - 9)
RWH	44	38	84%	75%	84%	3.3%	5 (4 - 9)	3 (2 - 3)
RWP	67	67	67%	70%	67%	1.9%	10 (7 - 21)	2 (2 - 4)
RWY	45	42	67%	53%	60%	0.0%	14 (10 - 19)	2 (2 - 3)
RX1	56	54	80%	66%	74%	2.0%	10 (7 - 15)	2 (1 - 4)
RXH	43	43	74%	74%	65%	0.0%	8 (6 - 17)	2 (1 - 3)
RXN	79	74	58%	30%	36%	1.6%	20 (12 - 61)	1 (1 - 2)
RXP	45	42	57%	29%	43%	4.6%	17 (12 - 34)	2 (2 - 3)
RXR	59	55	65%	58%	50%	3.4%	15 (7 - 45)	2 (1 - 7)
RXW	33	33	73%	64%	73%	0.0%	11 (9 - 15)	2 (1 - 2)
RYJ	44	40	85%	68%	80%	2.1%	8 (6 - 13)	5 (2 - 10)
SA999	47	45	77%	57%	77%	4.7%	11 (9 - 13)	2 (2 - 3)
SF999	9	9	78%	0%	11%	0.0%	18 (18 - 45)	3 (3 - 4)

Trust code	NVR cases	Symptomatic cases	Patients referred within 7 days of symptom	Patients receiving surgery within 7 days of referral	Patients receiving surgery within 14 days of symptom	% Adjusted Stroke and/or death rate (2015-2017)	Median delay and IQR from index symptom to surgery (days)	Median(IQR) length of stay (days)
SG999	93	93	56%	85%	65%	2.5%	12 (7 - 18)	2 (2 - 5)
SH999	20	17	41%	20%	18%	0.0%	21 (15 - 40)	3 (2 - 5)
SL999	45	45	63%	55%	58%	5.7%	13 (9 - 22)	3 (3 - 5)
SN999	17	15	80%	88%	87%	5.7%	6 (4 - 8)	4 (2 - 6)
SS999	37	37	70%	62%	70%	1.8%	12 (9 - 15)	3 (2 - 3)
ST999	11	11	55%	36%	36%	1.6%	15 (13 - 16)	4 (3 - 9)
SV999	20	18	61%	45%	56%	5.5%	14 (11 - 22)	2 (1 - 3)
SY999	27	27	63%	15%	15%	1.0%	36 (16 - 52)	4 (2 - 12)
ZT001	159	155	56%	40%	43%	1.9%	19 (10 - 54)	3 (3 - 5)

xx – value not shown, due to small numbers

Appendix 6: Elective infra-renal AAA repairs (2017 unless specified)

Trust code	NVR Cases	No. of EVAR	% patients with date of assessment	% patients with anaesthetic review	% patients undergoing pre-op CT/MR angiogram assessment	%patients discussed at MDT	Median delay and IQR from assessment to surgery (days)	Median (IQR) length of stay for open repairs (days)	Median (IQR) length of stay for EVAR (days)	Adjusted in-hospital mortality (2015-2017)
7A1	42	31	100%	100%	100%	98%	64 (33 - 99)	6 (6 - 9)	5 (1 - 9)	1.9%
7A3	47	23	100%	98%	100%	89%	123 (63 - 186)	9 (8 - 14)	2 (2 - 4)	1.6%
7A4	38	25	89%	100%	93%	87%	95 (62 - 166)	9 (8 - 12)	4 (3 - 7)	3.9%
7A5	23	18	100%	96%	100%	100%	54 (36 - 105)	13 (10 - 20)	3 (2 - 5)	2.8%
7A6	49	37	94%	100%	93%	92%	66 (38 - 91)	11 (7 - 17)	1 (1 - 1)	0.0%
R0A	117	69	94%	97%	94%	97%	74 (44 - 119)	8 (6 - 13)	2 (1 - 3)	0.7%
R1H	29	20	62%	100%	63%	52%	55 (41 - 113)	7 (7 - 8)	3 (2 - 6)	2.2%
R1K	29	27	90%	97%	89%	83%	35 (19 - 71)	8 (7 - 9)	3 (2 - 6)	4.3%
RA9	28	19	100%	100%	100%	96%	46 (36 - 64)	5 (4 - 8)	1 (1 - 1)	1.2%
RAE	37	26	97%	100%	97%	97%	62 (37 - 81)	9 (8 - 12)	5 (4 - 7)	1.6%
RAJ	34	25	97%	100%	97%	94%	90 (43 - 133)	8 (8 - 22)	2 (1 - 4)	1.1%
RAL	58	43	59%	100%	58%	83%	129 (56 - 250)	7 (4 - 8)	3 (2 - 5)	0.6%
RBA	72	50	97%	96%	99%	97%	69 (34 - 92)	8 (7 - 9)	2 (1 - 3)	2.7%
RC1	65	61	89%	100%	92%	75%	49 (28 - 111)	5 (4 - 7)	1 (1 - 2)	2.5%
RCB	60	21	73%	98%	73%	73%	61 (34 - 101)	8 (7 - 14)	3 (3 - 4)	1.1%
RDD	23	21	57%	100%	60%	35%	92 (50 - 138)	xx	2 (1 - 3)	0.0%
RDE	56	34	84%	95%	85%	45%	61 (38 - 87)	9 (7 - 11)	3 (2 - 3)	1.0%
RDU	87	63	99%	100%	99%	99%	57 (25 - 96)	7 (6 - 7)	2 (2 - 4)	1.9%
RDZ	78	47	81%	100%	82%	77%	93 (56 - 147)	7 (6 - 11)	2 (1 - 3)	3.8%

Trust code	NVR Cases	No. of EVAR	% patients with date of assessment	% patients with anaesthetic review	% patients undergoing pre-op CT/MR angiogram assessment	%patients discussed at MDT	Median delay and IQR from assessment to surgery (days)	Median (IQR) length of stay for open repairs (days)	Median (IQR) length of stay for EVAR (days)	Adjusted in-hospital mortality (2015-2017)
REF	41	28	88%	93%	86%	54%	77 (48 - 165)	12 (9 - 13)	2 (1 - 2)	2.0%
RF4	39	35	97%	100%	100%	100%	68 (49 - 113)	xx	3 (2 - 5)	0.0%
RGT	125	91	70%	100%	71%	77%	77 (47 - 124)	9 (7 - 12)	2 (1 - 3)	0.0%
RH8	19	10	100%	100%	100%	89%	64 (36 - 120)	7 (6 - 12)	1 (1 - 3)	0.0%
RHM	95	61	96%	99%	98%	97%	72 (46 - 105)	6 (5 - 13)	1 (1 - 1)	0.8%
RHQ	50	20	80%	94%	80%	74%	86 (45 - 138)	8 (6 - 12)	2 (1 - 5)	1.2%
RHU	15	10	93%	100%	92%	33%	76 (53 - 107)	11 (8 - 16)	1 (1 - 1)	0.0%
RJ1	112	90	71%	96%	72%	55%	80 (38 - 138)	9 (8 - 11)	3 (2 - 4)	0.3%
RJ7	83	80	69%	98%	70%	70%	30 (13 - 63)	xx	3 (2 - 4)	0.0%
RJE	131	72	100%	99%	100%	98%	78 (35 - 121)	7 (5 - 10)	2 (1 - 3)	2.2%
RJR	76	67	86%	100%	86%	80%	78 (41 - 113)	9 (7 - 11)	2 (1 - 4)	1.2%
RJZ	<5	<5	xx	xx	xx	xx	xx	xx	xx	xx
RK9	30	20	97%	97%	95%	100%	61 (32 - 83)	6 (5 - 12)	2 (2 - 3)	4.4%
RKB	46	30	87%	100%	86%	83%	66 (44 - 98)	7 (6 - 8)	2 (1 - 3)	2.0%
RLN	24	20	75%	100%	75%	100%	40 (31 - 65)	xx	1 (1 - 3)	1.1%
RM1	85	38	79%	99%	77%	76%	52 (31 - 111)	7 (6 - 9)	2 (1 - 3)	0.6%
RNA	76	51	84%	99%	85%	83%	54 (36 - 88)	6 (5 - 7)	1 (1 - 2)	0.0%
RNL	39	25	79%	97%	79%	72%	74 (53 - 104)	8 (4 - 9)	3 (2 - 5)	5.4%
RNS	46	37	93%	96%	95%	78%	54 (33 - 115)	6 (6 - 9)	2 (1 - 4)	0.7%
RP5	45	31	87%	96%	93%	84%	71 (28 - 128)	9 (7 - 17)	4 (2 - 5)	1.4%
RPA	23	21	87%	96%	94%	70%	81 (37 - 104)	xx	1 (1 - 2)	0.0%
RQ6	102	54	82%	98%	82%	59%	146 (73 - 196)	8 (7 - 14)	2 (1 - 3)	2.0%
RQ8	32	22	100%	97%	100%	94%	149 (86 - 185)	12 (7 - 15)	4 (3 - 5)	1.0%
RQW	29	24	100%	97%	100%	83%	77 (52 - 135)	5 (5 - 6)	3 (2 - 7)	5.1%

Trust code	NVR Cases	No. of EVAR	% patients with date of assessment	% patients with anaesthetic review	% patients undergoing pre-op CT/MR angiogram assessment	%patients discussed at MDT	Median delay and IQR from assessment to surgery (days)	Median (IQR) length of stay for open repairs (days)	Median (IQR) length of stay for EVAR (days)	Adjusted in-hospital mortality (2015-2017)
RR1	41	35	90%	100%	92%	83%	82 (57 - 122)	5 (4 - 7)	2 (2 - 3)	0.0%
RR8	78	67	85%	99%	84%	97%	82 (59 - 139)	7 (6 - 8)	1 (1 - 2)	0.4%
RRK	63	54	98%	100%	100%	97%	75 (47 - 125)	7 (5 - 8)	3 (2 - 3)	2.2%
RTD	62	25	92%	65%	92%	92%	49 (34 - 106)	7 (7 - 13)	2 (2 - 4)	0.9%
RTE	65	27	88%	100%	89%	71%	58 (32 - 96)	7 (6 - 10)	3 (2 - 4)	1.1%
RTG	83	63	100%	100%	100%	96%	58 (28 - 98)	8 (8 - 15)	5 (3 - 7)	2.0%
RTH	87	46	93%	99%	93%	89%	77 (42 - 140)	6 (5 - 7)	2 (1 - 2)	1.3%
RTK	47	39	96%	100%	95%	94%	121 (82 - 163)	11 (7 - 14)	2 (1 - 4)	1.8%
RTR	45	30	98%	98%	100%	96%	65 (36 - 118)	8 (7 - 9)	2 (2 - 3)	0.0%
RVJ	72	47	86%	100%	87%	83%	56 (36 - 99)	9 (7 - 14)	1 (1 - 3)	2.2%
RVV	74	62	78%	100%	79%	73%	48 (35 - 71)	7 (6 - 8)	1 (1 - 2)	0.5%
RW6	51	44	98%	100%	100%	100%	72 (42 - 119)	7 (7 - 8)	3 (3 - 5)	1.0%
RWA	70	34	100%	0%	100%	99%	84 (46 - 137)	9 (7 - 14)	4 (4 - 5)	2.5%
RWD	29	14	100%	100%	100%	97%	47 (34 - 73)	6 (5 - 12)	5 (4 - 6)	5.4%
RWE	61	38	62%	100%	66%	34%	64 (35 - 118)	8 (7 - 10)	3 (3 - 5)	0.6%
RWG	45	33	96%	100%	94%	87%	57 (33 - 86)	7 (6 - 8)	3 (2 - 5)	1.7%
RWH	26	23	100%	100%	100%	100%	45 (23 - 83)	xx	3 (2 - 4)	0.0%
RWP	77	49	100%	100%	100%	66%	50 (27 - 97)	7 (7 - 9)	3 (2 - 5)	1.0%
RWY	30	21	83%	100%	92%	87%	28 (14 - 54)	8 (8 - 11)	3 (2 - 4)	0.0%
RX1	68	62	99%	100%	98%	97%	66 (48 - 117)	10 (9 - 10)	2 (1 - 3)	0.4%
RXH	73	51	97%	100%	97%	64%	116 (49 - 168)	7 (6 - 8)	2 (1 - 3)	0.0%
RXN	67	49	91%	96%	92%	79%	84 (36 - 143)	8 (6 - 13)	2 (2 - 4)	2.4%
RXP	43	24	93%	98%	93%	86%	76 (49 - 109)	8 (6 - 9)	3 (3 - 6)	3.0%
RXR	45	34	93%	100%	92%	98%	57 (34 - 92)	7 (5 - 8)	2 (1 - 4)	1.0%

Trust code	NVR Cases	No. of EVAR	% patients with date of assessment	% patients with anaesthetic review	% patients undergoing pre-op CT/MR angiogram assessment	%patients discussed at MDT	Median delay and IQR from assessment to surgery (days)	Median (IQR) length of stay for open repairs (days)	Median (IQR) length of stay for EVAR (days)	Adjusted in-hospital mortality (2015-2017)
RXW	42	30	93%	100%	100%	86%	48 (30 - 106)	8 (6 - 11)	2 (2 - 3)	0.0%
RYJ	41	27	98%	100%	96%	98%	41 (19 - 102)	8 (7 - 10)	3 (2 - 5)	0.0%
SA999	20	15	95%	95%	95%	100%	98 (77 - 181)	8 (8 - 9)	1 (1 - 2)	2.2%
SG999	60	38	95%	85%	95%	93%	56 (40 - 100)	9 (6 - 19)	3 (2 - 5)	3.9%
SH999	24	8	100%	96%	100%	96%	71 (39 - 107)	9 (7 - 15)	3 (2 - 4)	0.0%
SL999	41	31	98%	98%	97%	98%	81 (41 - 129)	10 (7 - 12)	3 (2 - 4)	0.0%
SN999	28	25	68%	100%	67%	64%	61 (29 - 119)	xx	3 (3 - 5)	0.0%
SS999	42	18	90%	100%	89%	86%	66 (29 - 95)	8 (7 - 11)	4 (3 - 6)	0.8%
ST999	24	18	25%	100%	24%	21%	120 (103 - 134)	15 (9 - 20)	3 (3 - 5)	0.0%
SV999	11	5	100%	91%	100%	100%	79 (50 - 102)	7 (7 - 8)	3 (2 - 4)	0.0%
ZT001	137	86	95%	99%	95%	93%	108 (58 - 162)	9 (7 - 13)	3 (3 - 4)	1.2%

xx – value not shown, due to small numbers

Appendix 7: Repair of complex AAAs (2015-2017)

Trust code	NVR Cases	No. of EVAR	Median (IQR) length of stay (days)
7A3	<5	0	xx
7A4	14	7	12 (8 - 42)
7A5	<5	0	xx
R0A	56	49	6 (5 - 9)
R1H	21	17	8 (5 - 14)
R1K	8	8	5 (3 - 10)
RAE	<5	0	xx
RAJ	<5	<3	xx
RAL	150	146	4 (3 - 7)
RBA	<5	<5	xx
RC1	26	26	6 (3 - 8)
RCB	21	17	4 (3 - 9)
RDD	6	3	3 (1 - 5)
RDE	15	13	6 (4 - 9)
RDU	55	54	5 (3 - 8)
RDZ	14	10	5 (2 - 8)
REF	<5	0	xx
RF4	<5	<5	xx
RGT	64	62	4 (2 - 8)
RH8	<5	<5	xx
RHM	40	34	4 (2 - 6)
RHQ	21	20	3 (2 - 5)
RJ1	306	281	6 (4 - 9)
RJ7	100	99	7 (5 - 10)
RJE	29	22	3 (2 - 8)
RJR	15	13	3 (2 - 6)
RJZ	10	7	18 (4 - 20)
RK9	<5	0	xx
RKB	25	24	5 (2 - 7)
RLN	13	12	4 (3 - 12)
RM1	36	35	7 (5 - 14)
RNA	11	10	3 (2 - 7)
RNL	<5	<5	3 (2 - 6)
RNS	<5	0	xx
RP5	5	<5	5 (3 - 8)
RPA	9	8	1 (1 - 3)
RQ6	111	90	7 (4 - 14)
RQ8	11	9	6 (4 - 10)

Trust code	NVR Cases	No. of EVAR	Median (IQR) length of stay (days)
RQW	5	5	6 (5 - 6)
RR1	252	247	5 (3 - 8)
RR8	44	41	4 (2 - 6)
RRK	17	17	3 (2 - 5)
RT3	26	25	10 (6 - 18)
RTD	98	98	5 (3 - 8)
RTE	5	<5	7 (3 - 9)
RTG	44	44	5 (3 - 9)
RTH	29	27	3 (2 - 5)
RTK	14	10	15 (5 - 28)
RTR	23	21	5 (3 - 8)
RVJ	98	98	4 (3 - 5)
RVV	20	18	2 (1 - 4)
RW6	5	<5	12 (5 - 17)
RWA	27	27	7 (6 - 8)
RWE	35	29	6 (5 - 9)
RWH	10	<5	8 (3 - 37)
RWP	<5	<5	xx
RWY	<5	0	xx
RX1	34	34	2 (1 - 3)
RXH	52	41	4 (2 - 8)
RXN	9	8	4 (3 - 6)
RXR	<5	<5	xx
RXW	<5	<5	xx
RYJ	92	69	10 (6 - 17)
SA999	<5	<5	xx
SG999	19	13	6 (5 - 14)
SH999	<5	<5	xx
SL999	<5	<5	xx
SN999	26	26	7 (4 - 10)
SS999	16	5	8 (7 - 10)
ST999	34	34	7 (5 - 9)
SV999	<5	<5	xx
ZT001	33	27	4 (3 - 8)

xx – value not shown, due to small numbers

Appendix 8: Emergency repair of ruptured AAA (2015-2017)

Trust code	NVR Cases	No. of EVAR	Median (IQR) length of stay (days)	% Adjusted in-hosp mortality
7A1	32	<5	10 (4 - 15)	48.6%
7A3	73	<3	12 (7 - 26)	30.3%
7A4	32	<5	11 (2 - 29)	53.1%
7A5	11	<5	11 (6 - 18)	16.6%
7A6	30	9	10 (2 - 15)	39.3%
R0A	44	13	12 (7 - 23)	30.8%
R1H	17	<5	7 (1 - 9)	46.5%
R1K	26	22	13 (7 - 26)	58.6%
RA9	14	6	9 (6 - 15)	38.9%
RAE	25	<5	11 (3 - 17)	32.1%
RAJ	19	7	9 (4 - 23)	42.3%
RAL	46	20	7 (1 - 17)	49.0%
RBA	39	10	8 (3 - 13)	31.8%
RC1	26	8	7 (1 - 15)	37.9%
RCB	41	11	10 (4 - 20)	39.9%
RDD	8	0	7 (3 - 22)	37.6%
RDE	39	17	8 (1 - 15)	48.0%
RDU	61	14	10 (2 - 20)	40.2%
RDZ	41	7	9 (6 - 15)	22.8%
REF	19	5	12 (3 - 20)	32.4%
RF4	18	6	13 (1 - 21)	47.6%
RGT	77	43	10 (5 - 18)	18.2%
RH8	21	0	13 (7 - 20)	34.7%
RHM	50	10	13 (4 - 19)	22.6%
RHQ	35	7	12 (5 - 33)	12.0%
RHU	5	<5	10 (10 - 21)	0.0%
RJ1	96	60	12 (6 - 27)	27.3%
RJ7	57	46	10 (6 - 20)	34.3%
RJE	70	38	9 (2 - 14)	51.1%
RJR	52	22	14 (8 - 24)	43.1%
RJZ	6	6	10 (8 - 11)	85.3%
RK9	17	0	9 (4 - 16)	24.8%
RKB	27	<5	8 (2 - 13)	49.5%
RLN	18	6	4 (1 - 11)	57.4%
RM1	74	15	12 (7 - 21)	19.6%
RNA	56	7	12 (7 - 24)	22.0%
RNL	35	<5	7 (1 - 17)	45.6%
RNS	45	<5	8 (1 - 19)	43.3%

Trust code	NVR Cases	No. of EVAR	Median (IQR) length of stay (days)	% Adjusted in-hosp mortality
RP5	32	9	13 (7 - 25)	39.3%
RPA	22	14	8 (1 - 23)	52.0%
RQ6	60	17	12 (7 - 20)	30.9%
RQ8	10	0	8 (1 - 13)	34.0%
RQW	13	6	8 (5 - 19)	47.9%
RR1	36	14	10 (7 - 15)	39.0%
RR8	54	23	8 (3 - 13)	46.1%
RRK	25	5	9 (5 - 16)	47.4%
RTD	41	12	12 (3 - 22)	35.5%
RTE	36	<5	11 (6 - 18)	39.6%
RTG	50	16	10 (5 - 21)	28.2%
RTH	52	9	10 (2 - 15)	36.8%
RTK	13	<5	22 (8 - 36)	33.1%
RTR	32	12	9 (5 - 21)	39.1%
RVJ	64	8	14 (5 - 25)	34.2%
RVV	38	22	8 (2 - 10)	42.1%
RW6	36	14	12 (4 - 24)	34.2%
RWA	60	10	8 (2 - 16)	46.1%
RWD	22	0	6 (2 - 19)	69.2%
RWE	50	8	13 (4 - 21)	30.6%
RWG	20	8	4 (0 - 13)	65.5%
RWH	29	14	12 (3 - 23)	42.0%
RWP	42	10	11 (2 - 21)	36.7%
RWY	21	<5	10 (7 - 24)	42.9%
RX1	52	25	7 (2 - 17)	51.9%
RXH	31	10	8 (2 - 16)	31.2%
RXN	26	19	6 (3 - 19)	30.9%
RXP	34	0	12 (3 - 18)	41.9%
RXR	20	<5	6 (2 - 24)	54.6%
RXW	25	7	11 (4 - 21)	42.6%
RYJ	11	5	7 (1 - 18)	47.1%
SA999	4	Xx	xx	xx
SG999	46	6	11 (5 - 22)	40.0%
SH999	15	0	17 (6 - 30)	34.4%
SL999	7	<5	6 (3 - 20)	43.0%
SN999	23	7	8 (2 - 17)	51.3%
SS999	19	<5	8 (6 - 14)	21.1%
ST999	29	10	12 (7 - 21)	21.4%
SV999	7	0	11 (1 - 21)	32.0%
ZT001	72	13	11 (7 - 15)	25.7%

xx – value not shown, due to small numbers

Appendix 9: Lower limb bypass (2015-2017)

Trust code	NVR cases	Median (IQR) length of stay (days)	% Adjusted in-hospital mortality
7A1	87	5 (4 - 8)	2.3%
7A3	357	13 (7 - 22)	2.8%
7A4	45	8 (6 - 25)	11.2%
7A5	53	11 (6 - 22)	1.5%
7A6	231	9 (4 - 22)	2.3%
R0A	183	11 (6 - 32)	3.1%
R1H	212	9 (6 - 17)	3.7%
R1K	197	10 (4 - 23)	2.4%
RA9	90	5 (3 - 11)	0.0%
RAE	249	10 (7 - 19)	2.5%
RAJ	164	12 (6 - 21)	2.9%
RAL	81	8 (5 - 22)	2.3%
RBA	428	5 (3 - 10)	1.8%
RBD	35	5 (3 - 9)	0.0%
RBZ	70	4 (2 - 11)	3.6%
RC1	141	5 (2 - 12)	3.4%
RCB	410	8 (4 - 16)	3.1%
RDD	29	6 (3 - 9)	10.2%
RDE	331	5 (4 - 8)	3.7%
RDU	453	5 (3 - 12)	2.3%
RDZ	190	7 (3 - 13)	1.7%
REF	157	8 (5 - 13)	3.1%
RF4	85	9 (6 - 28)	10.7%
RGT	310	7 (4 - 15)	1.1%
RH8	187	5 (2 - 10)	1.9%
RHM	270	6 (3 - 12)	1.8%
RHQ	176	7 (4 - 12)	1.5%
RHU	8	4 (2 - 10)	0.0%
RJ1	509	8 (4 - 19)	2.7%
RJ7	247	10 (6 - 17)	2.2%
RJE	338	5 (3 - 13)	4.9%
RJR	287	7 (4 - 17)	4.4%
RJZ	283	15 (8 - 27)	2.3%
RK9	166	7 (4 - 14)	0.0%
RKB	164	7 (4 - 22)	0.5%
RLN	54	8 (3 - 26)	1.3%
RM1	115	8 (5 - 18)	0.0%
RMC	23	9 (5 - 19)	0.0%
RNA	602	6 (3 - 12)	2.5%
RNL	215	7 (4 - 13)	3.1%
RNS	165	8 (5 - 16)	2.6%

Trust code	NVR cases	Median (IQR) length of stay (days)	% Adjusted in-hospital mortality
RP5	173	6 (3 - 11)	2.8%
RPA	132	6 (4 - 15)	7.0%
RQ6	495	7 (4 - 17)	1.7%
RQ8	185	6 (4 - 10)	3.0%
RQW	61	5 (3 - 10)	7.0%
RR1	235	7 (3 - 13)	2.8%
RR8	330	7 (3 - 16)	2.5%
RRK	396	7 (4 - 15)	3.3%
RRV	11	4 (2 - 12)	0.0%
RT3	<5	xx	xx
RTD	130	11 (4 - 22)	1.0%
RTE	199	8 (5 - 17)	2.9%
RTG	288	7 (4 - 15)	4.5%
RTH	106	5 (3 - 11)	2.6%
RTK	200	7 (4 - 13)	5.2%
RTR	232	8 (4 - 18)	1.5%
RVJ	669	5 (3 - 12)	2.7%
RVV	118	7 (3 - 11)	2.0%
RW6	566	6 (4 - 12)	1.7%
RWA	277	10 (6 - 19)	5.2%
RWD	195	9 (5 - 18)	3.2%
RWE	300	8 (5 - 15)	0.9%
RWG	45	8 (5 - 24)	2.5%
RWH	98	10 (6 - 20)	3.8%
RWP	288	7 (5 - 14)	3.1%
RWY	159	9 (5 - 17)	2.6%
RX1	352	4 (2 - 11)	3.2%
RXH	235	11 (5 - 21)	1.9%
RXN	132	6 (4 - 15)	1.8%
RXP	97	8 (4 - 17)	0.0%
RXR	205	5 (3 - 11)	1.6%
RXW	240	4 (2 - 7)	4.4%
RYJ	79	10 (5 - 18)	3.3%
SA999	22	21 (6 - 38)	12.7%
SF999	41	7 (4 - 9)	0.0%
SG999	116	10 (6 - 16)	1.6%
SH999	157	8 (4 - 17)	3.3%
SL999	11	13 (7 - 22)	0.0%
SN999	209	9 (7 - 15)	3.3%
SS999	42	7 (5 - 15)	2.4%
ST999	168	14 (8 - 24)	2.0%
SV999	321	5 (3 - 11)	1.3%
SY999	46	9 (6 - 17)	3.9%
ZT001	666	6 (4 - 11)	2.4%

xx – value not shown, due to small numbers

Appendix 10: Lower limb angioplasty/stent (2015-2017)

Trust code	NVR cases	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
7A1	0	No Data	No Data
7A3	595	7 (2 - 20)	1.3%
7A4	98	2 (0 - 11)	2.2%
7A5	128	0 (0 - 13)	1.3%
7A6	71	0 (0 - 5)	7.8%
R0A	732	1 (0 - 7)	1.2%
R1H	462	8 (0 - 28)	3.2%
R1K	555	3 (1 - 12)	2.6%
RA9	<5	xx	xx
RAE	19	**	**
RAJ	125	4 (0 - 19)	0.6%
RAL	408	4 (1 - 15)	0.9%
RBA	839	0 (0 - 1)	1.7%
RBD	0	No Data	No Data
RBN	27	0 (0 - 0)	0.0%
RBZ	29	0 (0 - 0)	0.0%
RC1	301	0 (0 - 0)	0.0%
RCB	1434	0 (0 - 5)	1.6%
RDD	17	2 (2 – 2)	1.6%
RDE	15	**	**
RDU	269	1 (0 - 2)	0.8%
RDZ	<5	xx	xx
REF	6	xx	xx
REM	28	0 (0 - 0)	0.0%
RF4	428	2 (0 - 14)	2.9%
RGN	26	**	**
RGR	8	**	**
RGT	30	**	**
RH8	302	1 (0 - 9)	2.7%
RHM	<5	xx	xx
RHQ	125	0 (0 - 3)	0.0%
RHU	<5	xx	xx
RHW	222	0 (0 - 1)	0.0%
RJ1	407	2 (1 - 6)	0.4%
RJ7	665	3 (1 - 10)	1.3%
RJE	644	2 (0 - 16)	2.2%
RJR	5	xx	xx

Trust code	NVR cases	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
RJZ	19	**	**
RK9	32	**	**
RKB	181	2 (0 - 15)	1.3%
RL4	246	0 (0 - 0)	1.8%
RLN	<5	xx	xx
RM1	6	xx	xx
RMC	211	0 (0 - 1)	4.7%
RNA	831	2 (0 - 11)	2.1%
RNL	514	0 (0 - 4)	1.1%
RNS	7	**	**
RP5	40	**	**
RPA	111	0 (0 - 6)	1.1%
RQ6	30	**	**
RQ8	505	1 (0 - 4)	1.3%
RQW	12	**	**
RR1	528	1 (0 - 6)	0.4%
RR7	411	0 (0 - 1)	2.1%
RR8	152	2 (0 - 15)	1.0%
RRK	215	0 (0 - 2)	0.6%
RRV	14	**	**
RTD	145	0 (0 - 9)	2.8%
RTE	15	**	**
RTG	878	1 (1 - 8)	1.0%
RTH	129	0 (0 - 1)	0.0%
RTK	126	2 (1 - 6)	4.1%
RTR	<5	xx	xx
RVJ	80	**	**
RVV	294	2 (1 - 10)	1.4%
RW6	248	1 (0 - 4)	0.6%
RWA	65	**	**
RWD	0	No Data	No Data
RWE	0	No Data	No Data
RWG	103	2 (1 - 6)	1.3%
RWH	121	0 (0 - 10)	1.5%
RWP	661	2 (2 - 8)	1.0%
RWY	0	No Data	No Data
RX1	72	**	**
RXF	178	0 (0 - 1)	0.0%
RXH	0	No Data	0.0%
RXN	616	1 (0 - 14)	1.7%
RXP	10	**	**
RXR	304	0 (0 - 3)	1.3%
RXW	116	0 (0 - 0)	1.4%

Trust code	NVR cases	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
RYJ	150	0 (0 - 5)	0.9%
SA999	20	2 (1 - 5)	0.0%
SF999	0	No Data	No Data
SG999	196	4 (1 - 12)	2.2%
SH999	359	2 (0 - 9)	0.2%
SL999	0	No Data	No Data
SN999	81	1 (0 - 2)	5.3%
SS999	<5	xx	xx
ST999	108	8 (1 - 20)	1.9%
SV999	63	0 (0 - 0)	4.5%
SY999	194	3 (1 - 9)	4.0%
ZT001	481	0 (0 - 4)	0.7%

xx – value not shown, due to small numbers

** - value not shown, due to poor case-ascertainment

No data – no data available for indicators

Appendix 11: Major lower limb amputation (2015-2017)

Trust code	NVR Cases	Median (IQR) delay from vascular assessment to surgery (days)	Median (IQR) length of stay (days)	AKA:BKA	% Consultant Present in Theatre	% Prophylactic Antibiotics	Adjusted 30 day in-hospital mortality
7A1	40	3 (2 - 7)	16 (13 - 22)	0.76	97.5%	65.0%	1.9%
7A3	302	11 (3 - 41)	21 (14 - 31)	1.12	39.7%	9.9%	9.0%
7A4	112	14 (6 - 36)	43 (24 - 78)	0.70	98.2%	62.5%	5.6%
7A5	39	48 (28 - 183)	25 (17 - 50)	0.43	100.0%	100.0%	7.4%
7A6	114	6 (3 - 23)	28 (15 - 40)	0.91	83.3%	70.2%	4.3%
R0A	67	6 (2 - 22)	31 (18 - 51)	1.26	52.2%	79.1%	1.9%
R1H	128	6 (1 - 15)	23 (8 - 42)	0.98	93.0%	83.6%	5.3%
R1K	69	12 (6 - 23)	28 (20 - 46)	0.38	79.7%	53.6%	4.8%
RA9	35	21 (3 - 62)	14 (9 - 20)	0.29	77.1%	60.0%	3.5%
RAE	102	10 (5 - 27)	23 (16 - 45)	2.73	73.5%	81.4%	3.0%
RAJ	42	22 (8 - 36)	29 (15 - 43)	0.47	100.0%	81.0%	9.1%
RAL	46	14 (6 - 33)	29 (15 - 48)	0.40	69.6%	58.7%	5.1%
RBA	70	9 (4 - 20)	17 (10 - 23)	1.27	94.3%	65.7%	4.0%
RBZ	37	11 (4 - 93)	18 (11 - 31)	0.81	67.6%	56.8%	0.0%
RC1	78	21 (6 - 64)	21 (13 - 30)	1.22	79.5%	78.2%	4.6%
RCB	94	10 (2 - 77)	26 (14 - 41)	0.58	78.7%	61.7%	8.2%
RDD	11	**	**	**	**	**	**
RDE	102	5 (2 - 14)	15 (9 - 26)	1.58	30.4%	92.2%	5.1%
RDU	170	13 (4 - 55)	21 (12 - 39)	0.62	85.3%	1.2%	3.3%
RDZ	69	7 (2 - 22)	19 (11 - 30)	0.56	87.0%	72.5%	9.5%
REF	129	6 (2 - 14)	19 (14 - 29)	0.54	85.3%	41.9%	5.7%
RF4	103	12 (4 - 30)	42 (24 - 63)	1.44	97.1%	3.9%	3.4%

Trust code	NVR Cases	Median (IQR) delay from vascular assessment to surgery (days)	Median (IQR) length of stay (days)	AKA:BKA	% Consultant Present in Theatre	% Prophylactic Antibiotics	Adjusted 30 day in-hospital mortality
RGT	165	8 (3 - 22)	19 (12 - 33)	0.74	81.8%	55.8%	4.2%
RH8	100	8 (4 - 24)	21 (16 - 37)	0.24	80.0%	79.0%	8.1%
RHM	208	11 (5 - 35)	18 (11 - 30)	0.63	90.4%	30.3%	5.2%
RHQ	123	10 (5 - 37)	29 (17 - 47)	0.67	80.5%	53.7%	3.4%
RJ1	244	8 (3 - 22)	33 (20 - 59)	0.92	48.4%	53.3%	7.0%
RJ7	89	7 (4 - 19)	26 (14 - 44)	1.00	89.9%	74.2%	5.4%
RJE	278	8 (3 - 30)	25 (14 - 42)	0.74	80.2%	49.3%	6.8%
RJR	107	9 (4 - 23)	27 (16 - 43)	1.29	92.5%	55.1%	3.8%
RJZ	30	5 (2 - 26)	54 (44 - 79)	1.25	93.3%	36.7%	0.0%
RK9	96	23 (5 - 96)	15 (11 - 23)	1.23	85.4%	71.9%	3.7%
RKB	78	13 (6 - 31)	30 (16 - 46)	0.67	64.1%	67.9%	1.4%
RLN	49	10 (6 - 53)	30 (18 - 47)	1.05	89.8%	55.1%	6.1%
RM1	214	5 (2 - 15)	18 (11 - 32)	0.83	37.4%	34.1%	5.4%
RNA	257	5 (2 - 18)	22 (13 - 40)	1.07	73.9%	74.7%	5.5%
RNL	119	4 (1 - 9)	19 (9 - 30)	0.72	85.7%	9.2%	5.0%
RNS	116	6 (2 - 20)	26 (16 - 48)	0.58	94.0%	69.0%	7.4%
RP5	97	26 (6 - 54)	25 (12 - 43)	0.67	88.7%	89.7%	7.4%
RPA	68	6 (2 - 14)	40 (19 - 61)	0.95	89.7%	22.1%	9.2%
RQ6	211	10 (4 - 23)	34 (19 - 56)	1.84	70.6%	59.2%	4.0%
RQ8	79	5 (2 - 9)	21 (14 - 34)	0.70	58.2%	12.7%	6.5%
RQW	42	9 (2 - 32)	29 (16 - 48)	1.30	88.1%	4.8%	8.3%
RR1	148	6 (3 - 13)	21 (12 - 35)	0.66	64.9%	52.7%	5.1%
RR7	0	No Data	No Data	No Data	No Data	No Data	No Data
RR8	250	8 (3 - 37)	20 (11 - 34)	1.13	87.2%	54.8%	6.8%
RRK	160	11 (4 - 24)	28 (18 - 45)	0.75	80.0%	81.3%	2.5%

Trust code	NVR Cases	Median (IQR) delay from vascular assessment to surgery (days)	Median (IQR) length of stay (days)	AKA:BKA	% Consultant Present in Theatre	% Prophylactic Antibiotics	Adjusted 30 day in-hospital mortality
RTD	235	0 (0 - 0)	26 (15 - 46)	1.69	28.1%	7.2%	4.2%
RTE	116	8 (5 - 27)	19 (13 - 31)	0.69	76.7%	61.2%	3.5%
RTG	188	2 (1 - 4)	20 (12 - 36)	1.64	91.5%	31.9%	6.9%
RTH	67	7 (4 - 28)	18 (10 - 32)	0.96	67.2%	58.2%	8.0%
RTK	105	5 (1 - 12)	18 (11 - 29)	1.20	78.1%	53.3%	5.2%
RTR	157	5 (2 - 13)	19 (13 - 34)	1.20	80.9%	57.3%	6.0%
RVJ	237	7 (2 - 22)	27 (14 - 44)	0.57	84.0%	59.9%	3.5%
RVV	113	9 (4 - 29)	23 (14 - 30)	0.74	72.6%	63.7%	4.8%
RW6	142	6 (2 - 13)	24 (13 - 36)	1.18	84.5%	100.0%	4.4%
RWA	254	15 (6 - 45)	19 (12 - 29)	0.56	64.2%	0.0%	6.2%
RWD	152	6 (2 - 15)	26 (16 - 38)	1.39	68.4%	78.3%	5.8%
RWE	115	9 (2 - 22)	18 (12 - 27)	1.43	60.0%	43.5%	6.8%
RWG	<5	xx	xx	xx	xx	xx	xx
RWH	34	13 (3 - 30)	26 (18 - 46)	0.41	88.2%	55.9%	11.1%
RWP	102	8 (3 - 27)	20 (13 - 35)	0.86	72.5%	82.4%	8.1%
RWY	50	8 (3 - 33)	22 (11 - 37)	1.31	90.0%	54.0%	5.0%
RX1	295	4 (2 - 11)	20 (12 - 33)	1.04	46.4%	80.0%	8.8%
RXH	164	15 (3 - 33)	20 (14 - 31)	1.06	48.2%	89.0%	3.3%
RXN	58	10 (4 - 23)	24 (15 - 38)	1.79	91.4%	74.1%	4.0%
RXP	146	16 (7 - 41)	26 (14 - 47)	0.86	74.7%	21.9%	6.5%
RXR	71	10 (4 - 37)	22 (11 - 58)	1.05	94.4%	39.4%	7.1%
RXW	119	6 (1 - 22)	20 (11 - 32)	1.05	89.1%	68.9%	7.7%
RYJ	22	8 (2 - 51)	37 (22 - 59)	0.60	59.1%	0.0%	3.5%
SA999	26	18 (7 - 122)	34 (23 - 73)	0.58	96.2%	50.0%	6.5%
SF999	17	85 (31 - 117)	23 (18 - 30)	0.62	88.2%	82.4%	0.0%

Trust code	NVR Cases	Median (IQR) delay from vascular assessment to surgery (days)	Median (IQR) length of stay (days)	AKA:BKA	% Consultant Present in Theatre	% Prophylactic Antibiotics	Adjusted 30 day in-hospital mortality
SG999	89	8 (3 - 21)	36 (25 - 50)	0.83	100.0%	98.9%	3.7%
SH999	106	2 (1 - 14)	37 (21 - 58)	0.38	84.0%	72.6%	5.3%
SL999	108	13 (5 - 30)	34 (20 - 53)	1.27	52.8%	0.0%	5.6%
SN999	107	6 (3 - 31)	40 (22 - 64)	1.52	78.5%	76.6%	4.8%
SS999	7	**	**	**	**	**	**
ST999	74	6 (2 - 10)	34 (20 - 53)	1.80	82.4%	58.1%	5.3%
SV999	47	6 (2 - 14)	25 (18 - 49)	0.38	83.0%	51.1%	7.8%
SY999	26	16 (8 - 28)	37 (20 - 66)	0.65	88.5%	15.4%	4.5%
ZT001	392	12 (4 - 44)	15 (8 - 26)	0.70	67.6%	66.8%	2.2%

xx – value not shown, due to small numbers

** - value not shown, due to poor case ascertainment

Appendix 12: 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 early July 2018. 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 14 (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 (eg, 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.
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.

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
NHS	National Health Service
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 (eg, 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 SHA.
Vascular Society of Great Britain and Ireland (VSGBI)	The VSGBI is a registered charity founded to relieve sickness and to preserve, promote and protect the health of the public by advancing excellence and innovation in vascular health, through education, audit and research. The VSGBI represents and provides professional support for over 600 members and focuses on non-cardiac vascular disease.

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

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