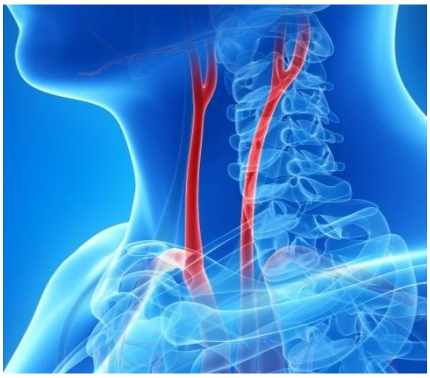
NATIONAL VASCULAR REGISTRY

2016 Annual Report



November 2016

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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 2016 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.

Commissioned By

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 manage and develop the NCA Programme, comprising more than 30 clinical audits 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, DHSSPS Northern Ireland and the Channel Islands.

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Acknowledgements

The National Vascular Registry is commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part of the National Clinical Audit Programme (NCA). 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 manage and develop the NCA Programme, comprising more than 30 clinical audits 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, DHSSPS Northern Ireland and the Channel Islands.

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 (VSGBI), it gives me great pleasure to introduce the 2016 Annual Report of the National Vascular Registry (NVR).

We are indebted to the Vascular Society Audit and Quality Improvement Committee, chaired by Ian Loftus, and to the team at the Clinical Effectiveness Unit (CEU) at the RCSE for once more pulling together the large amount of data collected by vascular specialists into a meaningful report.

The NVR grew out of the original National Vascular Database (NVD) run by the Society. It is pleasing to see how the NVR has developed since it was commissioned by the Healthcare Quality Improvement Partnership (HQIP). The NVR is due for re-commissioning next year and the VSGBI is keen to see the Registry maintain its role as the foundation of clinical audit and quality improvement for NHS vascular services.

This 2016 report provides more unit level information than previously and the Society believes that, in these days of joint Consultant working, it is these unit level results that are important as we continue with our programme of service reconfiguration. The results show that vascular units are delivering comparable outcomes for each of the operations presented. However, there are still improvements to be made in the process of care. The report highlights considerable variation in the time from diagnosis to surgery for both AAA repair and carotid surgery.

The data entered for lower limb re-vascularisation and amputation is incomplete, and consequently, the figures do not provide as rich a picture of practice across all NHS trusts as they might. The VSGBI and the BSIR need to encourage their members to submit all data to the NVR, and to support quality improvement (and research) in the management of patient with vascular disease.

We are moving in the right direction, but there is much work still to be done if all of our patients are to receive excellent and equivalent care in all parts of the UK.

Michael Wyatt

President, Vascular Society of Great Britain and Ireland

Executive Summary

The National Vascular Registry (NVR) aims to provide comparative information on the performance of NHS vascular units and so support local quality improvement. It also aims to inform patients about major vascular interventions delivered in the NHS. All NHS hospitals in England, Wales, Scotland and Northern Ireland are encouraged to participate in the Registry.

This report provides a description of the care provided by NHS vascular units, and contains information on the process and outcomes of care for: (i) patients undergoing carotid endarterectomy, (ii) patients undergoing abdominal aortic aneurysm (AAA) repair, (iii) patients undergoing a revascularisation procedure (angioplasty/stent or bypass) or major amputation for lower limb peripheral arterial disease (PAD). Since last year, we have expanded the information on ruptured aortic aneurysms and major lower limb amputation. The measures used to describe the patterns and outcomes of care are drawn from various national guidelines including: the "Provision of Services for Patients with Vascular Disease" document and the Quality Improvement Frameworks published by the Vascular Society, and the National Institute for Health and Care Excellence (NICE) guidelines on stroke and peripheral arterial disease.

Carotid endarterectomy

People who have suffered a minor stroke or transient ischemic attack (TIA) may have their risk of a further stroke reduced by having a carotid endarterectomy (CEA). The benefit from surgery is time-dependent and the National Institute for Health and Clinical Excellence recommends a two week target time from the initial symptom to surgery.

In 2015, there were 4,620 procedures reported to the Registry. This is a 12% drop from the 5,162 procedures reported in 2013, and seems to represent a change in the level of activity within NHS trusts / Health Boards. Whether this reflects a change in the underlying epidemiology of the disease is currently unclear.

There has been a steady reduction in the times from the index symptom to operation for symptomatic patients over recent years, with the median delay falling from 20 days in 2009 to 13 days in 2012. Since then, the median time in each year has remained stable. In 2015, the median time for symptomatic patients in 2015 being 13 days (IQR 7-28) days and the proportion 57% of patients were treated within the 14 day target.

In terms of the various components of the pathway, the median times in 2015 were:

- 4 days (IQR 1-10) from symptom to first medical referral
- 1 day (IQR 0-5) from first medical referral to being seen by the vascular team, and
- 6 days (IQR 2-13) from being seen by a vascular surgeon to undergoing CEA.

Despite the steady improvement over time, there was still considerable variation in the times from symptom to procedure across the English NHS trust and Welsh Health Boards. For procedures performed during 2015, the median was 14 days or less for 56 organisations, but it exceeded 20 days for 10 vascular units.

Carotid endarterectomy is a relatively safe procedure. For the nearly 15,000 procedures performed in NHS hospitals between 2013 and 2015, the rates of the different complications tended to be around 2% (see table below). The primary measure of safety for carotid endarterectomy is the rate of death/stroke within 30 days of the procedure. The comparative, risk-adjusted 30-day death/stroke rates for individual NHS trusts / Health Boards found that all NHS organisations had rates within the expected range of the overall national average rate of 2.1%.

Complication	Procedures in 2013-2015	Complication rate (%)	95% Confidence interval
Myocardial Infarct within admission	14,766	1.2	1.0-1.4
Bleeding within admission	14,766	2.6	2.3-2.8
Death and/or stroke within 30 days	14,787	2.1	1.9-2.3
Cranial nerve injury within admission	14,696	1.7	1.5-1.9

Elective repair of infra-renal abdominal aortic aneurysm

The elective repair of an infra-renal abdominal aortic aneurysm (AAA) is an important aspect of vascular services work, and the VSGBI AAA Quality Improvement Framework [VSGBI 2012] has made various recommendations about the standard of care that organisations undertaking this procedure should meet.

The NVR received the details of 4,198 elective AAA repairs performed in 2015, of which 1,316 were open repairs and 2,882 were endovascular (EVAR) procedures. In relation the VSGBI standards on pre-operative assessment, we found that the majority of patients had care that was consistent with these:

- 74.4% of elective patients were discussed at Multidisciplinary Team meetings

- 84.1% of patients with an AAA diameter ≥ 5.5cm deemed suitable for repair had a pre-operative angiography assessment
- 96.0% of patients underwent a formal anaesthetic review
- 92.2% of patients who had an anaesthetic review had one by a consultant vascular anaesthetist
- 82.2% of patients had their fitness measured, the most common assessment method being Cardiopulmonary Exercise Testing (47.6% of measurements)

The time from vascular assessment to surgery covers an important component of the referral process that is under the direct control of vascular services. The median delay at most vascular units was typically between 60 and 90 days. Nonetheless, at 29 of 78 vascular units performing elective AAA repair in 2015, 25% of patients waited more than 120 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 120 days is well over the National AAA Screening Programme target of 8 weeks from date of referral to surgery and the analysis also only covers the period from vascular assessment to surgery.

We examined the postoperative in-hospital mortality rate across NHS organisations undertaking elective infra-renal AAA repairs performed between 1 January 2013 and 31 December 2015. The comparative, risk-adjusted mortality rates for individual NHS trusts were all within the expected range given the number of procedures performed. The overall in-hospital mortality for this procedure was 1.5%.

Repair of ruptured abdominal aortic aneurysms

This report contains the second set of results published by the NVR on the outcomes of patients with a ruptured AAA, and the first by NHS trust / Health Board. The emergency repair of a ruptured AAA remains a common procedure, and between 1 January 2013 and 31 December 2015, the NVR received details of 2,761 operations.

In contrast to the two-thirds of elective infra-renal AAA repairs being performed with EVAR, only 25% of repairs for a ruptured AAA were performed in this way. This suggests that EVAR is being introduced cautiously in patients for whom it is most clearly appropriate. Nonetheless, it is also possible that the restricted use of EVAR reflects limitations in the availability of endovascular facilities and skills in some vascular units.

In-hospital postoperative mortality is the principal outcome measure for emergency repair of ruptured AAAs. We examined in-hospital mortality for NHS organisations undertaking ruptured AAA repairs during the period from 1 January 2014 to 31 December 2015 (the period limited to two years because the process of risk-adjustment required data items only introduced in the NVR dataset in January 2014).

All the NHS trusts had a risk-adjusted rate of in-hospital mortality that fell within the expected range given the number of procedures performed. The rates typically ranged from 20-60% but this reflects the relatively low surgical volumes at an organisational level, and we would not recommend over-interpreting these figures. The funnel plot gives no evidence that the underlying mortality rate for any organisation was different from the national average of 36.6% over this period. In coming years, we will have a larger sample sizes and be able to give more precise estimates of an organisation's performance

Repair of complex aortic conditions

The term complex AAA is used to describe those aneurysms that occur at or above the point where arteries branch from the aorta to the kidneys. Until recently, open surgery was the standard technique to repair these complex aneurysms. However, EVAR procedures have become more popular and the care given to patients with complex AAA has been changing rapidly. This poses a challenge for the commissioning of vascular services and the results in this report are primarily provided to support this activity.

During 2014-15, there were 1,290 records for complex AAA procedures submitted to the NVR. These were submitted by 74 vascular units, and the volume of activity within these units ranged from 1 to 172 procedures (median=7). Of these procedures, 1,152 (89%) were endovascular. The common EVAR procedure was a fenestrated EVAR (FEVAR; n=593).

The in-hospital postoperative mortality rates for complex open and EVAR procedures were around six-times greater than the rates for infra-renal AAA for both open repair and EVAR. The rates were 19.6% (95% CI 13.3 to 27.2) and 3.6% (2.6 to 4.8), respectively. This reflects the complex nature of the disease and surgery. Further interpretation of the figures is difficult however because the level of case-ascertainment for these procedures is uncertain. We would recommend 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, and that NHS trusts should focus on ensuring the care for these patients is delivered safely.

Lower limb revascularisation for peripheral arterial disease

This is the second time that national figures have been presented together for lower limb endovascular and bypass procedures. It describes how interventional radiologists and vascular surgeons have responded to the clinical evidence on the two procedures and reveals the differences in the selection of patients for the two interventions.

The outcomes of lower limb revascularisation procedures were generally good. In-hospital postoperative mortality rates were low: 1.6% (95% CI 1.4 to 1.9) after endovascular procedures and 3.0% (95% CI 2.7 to 3.3) after lower limb bypass. Post-operative complications were also relatively uncommon and over 90% of patients did not require further unplanned intervention. Nonetheless, 1 in 10 patients required re-admission within 30 days for both bypass and endovascular procedures. The NVR does not have information on the reasons for readmission but local services should review their local data and seek ways to reduce these re-admission rates.

Risk-adjusted rates of in-hospital death for lower limb bypasses and endovascular procedures were calculated for each NHS trust / Health Board. For both procedures, all NHS organisations had a risk adjusted rate of in-hospital death that fell within the expected range given the number of procedures an organisation performed.

The results presented in the current report are based on data from 7,614 endovascular and 11,389 bypass procedures recorded in 2014 and 2015. The estimated case-ascertainment for lower limb bypass was 90%. The case-ascertainment for endovascular procedures, however, remained low at 17% in 2014 and 21% in 2015. This low case-ascertainment curtails the ability of the NVR to make any firm statements about the endovascular procedures at the national level. It is important that the NHS trusts adopt a more active approach to submitting data on endovascular procedures to the NVR, as the results from the NVR should be used to inform hospital governance, medical revalidation and commissioning.

Lower limb major amputation for peripheral arterial disease

Information on 5,318 major unilateral lower limb amputations was recorded in the NVR between 1 January 2014 and 31 December 2015, of which 3,190 were below knee and 2,128 were above knee amputations.

In 2014, the National Confidential Enquiry into Patient Outcomes and Deaths (NCEPOD) published its review of the care received by patients who underwent major lower limb amputation [NCEPOD 2014]. It highlighted a number of areas related to the preoperative pathway that varied between NHS hospitals, something that the data submitted to the NVR also highlights. For procedures performed between January 2014 and December 2015, there was considerable variation among NHS trusts / Health Boards in the time patients waited from vascular assessment to surgery. Nationally, the median time from vascular assessment to amputation was seven days (interquartile range: 2 to 23 days), but 34 of 99 NHS trusts / Health Boards had a median above 14 days. There may be legitimate clinical reasons for patients to wait different times for an amputation, although this is unlikely to explain the extent of the variation we observed. Vascular units should investigate the causes of this variation in delays before surgery.

Approximately 60% of the major lower limb amputations recorded in the NVR were below knee amputations (n=3,190) and 40% were above knee amputations (n=2,128). The VSGBI recommends the below knee amputation should be undertaken where appropriate, and vascular units should aim to have a AKA:BKA ratio below one. Approximately two thirds of the NHS trusts had a ratio less than one and the remaining third had a ratio of one or above.

The in-hospital mortality rates for above and below knee amputations were 12.4% (95% CI 11.0 to 13.8) and 5.6% (95% CI 4.8 to 6.4). Risk-adjusted rates of in-hospital mortality after major amputation were calculated for each NHS trust / Health Board. All NHS organisations had a risk adjusted rate that fell within the expected range given the number of procedures an organisation performed.

From routine hospital data, we estimate that there were approximately 2,300 below knee and 2500 above knee amputations performed in UK hospitals for peripheral arterial disease each year. In last year's report, the estimated case-ascertainment for major amputation was approximately 50%. This year, the estimated case-ascertainment is slightly higher, at 53% for 2014 and 57% for 2015, but it is still disappointing that the increase during the year has not been greater, particularly given the publication of the 2014 NCEPOD report on lower limb amputation. NHS hospitals and commissioners must encourage more complete data submission to the NVR for these high risk vascular procedures.

Conclusion

The results across all major arterial procedures demonstrate that vascular units are achieving good clinical outcomes in general. No vascular units were identified as outliers for the major surgical procedures, in terms of higher than expected postoperative mortality rates. Yet, there are various areas where improvements could be made.

First, services with long times from diagnosis to surgery for carotid endarterectomy and aortic aneurysms should review their practice to identify how these times can be reduced. For aortic aneurysms, the NVR is running a national 'snapshot' audit which is investigating whether particular aspects of the care pathway are causing delays. The results of this will be reported in 2017.

Second, we note that 75% of these patients with a ruptured AAA had an open emergency repair. The fact that EVAR procedures only constituted 25% of patients may reflect limitations in the availability of endovascular facilities and skill sets in some vascular units. NHS organisations should establish what factors are limiting the use of EVAR for ruptured AAA patients.

Third, the results on organisational-level outcomes after lower limb amputation and endovascular revascularisation must be interpreted with caution because of the low case-ascertainment rates. This is especially the case for lower limb endovascular revascularisation procedures. Better case-ascertainment will allow for more useful analysis of unit activity, pathways and outcomes, which are essential for any quality improvement measures.

Recommendations

Vascular units within NHS trusts / Health Boards

Vascular units should review the results for their organisation to ensure care is consistent with the recommendations in national clinical guidance on patients requiring major arterial surgery with vascular conditions.

- There remain considerable variations between NHS vascular units with regard to the provision of carotid endarterectomy within 14 days of symptoms. NHS trusts should optimise referral pathways within their networks and implement improvements to drive down the waiting times
- All staff involved in organising and delivering care to patients who require carotid surgery need to examine their data and assess their performance against standards within NICE Guideline CG68
- Vascular units are encouraged to adopt the care pathway and standards outlined in the Vascular Society's AAA quality improvement programme. This can be accessed at the Vascular Society's website. A clinical lead should be nominated to monitor and report on the adoption of the pathway and this should be reflected in their job planning
- There is wide variation in the time patients take from vascular assessment to elective AAA repair. The National AAA Screening Programme has set a target of 8 weeks and, for non-complex aneurysms, this should be a target for all units for both screen and non-screen detected AAA
- The mortality rates for emergency repair of ruptured aneurysms remain high. One factor might be the lack of availability of endovascular repair out of hours. We recommend NHS vascular units examine their local practice to determine reasons behind the low proportion of endovascular cases
- The case-ascertainment for major amputation and endovascular procedures needs to be improved. All clinicians within vascular units (surgeons and interventional radiologists) should review how data can be routinely entered into the NVR
- Vascular units should undertake a detailed analysis of the pathways of care and outcomes for lower limb amputation, and are encouraged to adopt the care pathway and standards outlined in the Vascular Society's Quality Improvement Framework

For Medical Directors of NHS trusts / Health Boards

Medical Directors should review the results for their organisation and ensure that sufficient resources are available for vascular units to provide high quality care to patients requiring elective and emergency arterial procedures. In addition, there needs to be support for improved case-ascertainment, and we recommend data submission to the NVR becomes an essential part of yearly appraisal for all vascular interventionists.

For Commissioners / Regional Networks

There is variation between NHS vascular units in the provision of various elements of care along the care pathway for patients undergoing major arterial surgery. Commissioners (in England) and Regional Health Boards should review the results for organisations within their regions to assure themselves of the quality of care provided to their patients, and should work with NHS providers to develop strategies for addressing areas of variation. In particular, the low numbers for many units of ruptured AAA repairs, as well as the falling numbers of carotid endarterectomies means further centralisation or collaboration between networks to ensure highest standards of care for these patient groups.

Commissioners / Health Boards should encourage their local providers to adopt the care pathway and standards outlined in the Vascular Society's Quality Improvement Frameworks and Provision of Vascular Services documents, including submission of data to the NVR.

For Vascular Society of GB&I / British Society of Interventional Radiology

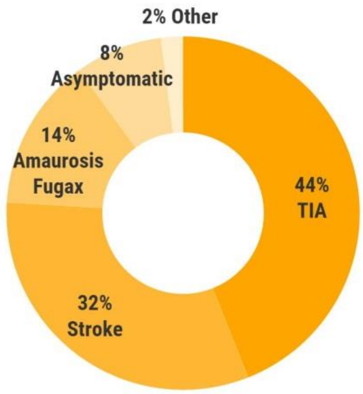
The Vascular Society of Great Britain & Ireland and the British Society of Interventional Radiology should encourage their members to collect and submit the data requested by the National Vascular Registry, in particular, the details of patients who undergo lower limb procedures. There should also be greater engagement and liaison between the Medical Societies associated with cardiovascular disease to develop datasets, improve case-ascertainment and ensure Registry data supports potential research.

Carotid Endarterectomy (CEA)

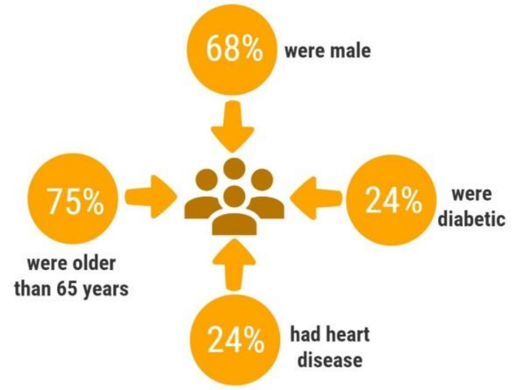
A surgical procedure in which build-up is removed from the carotid artery in the neck.

There were 4,620 carotid endarterectomies submitted to the NVR in 2015, which is approximately 89% of all procedures in the UK.

What were the reasons patients had surgery?

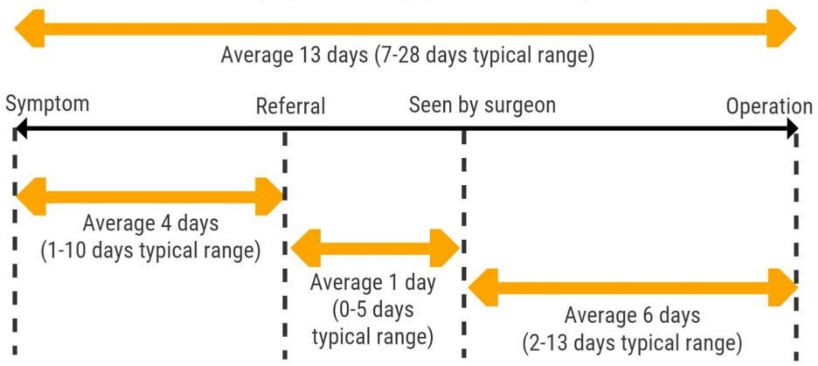


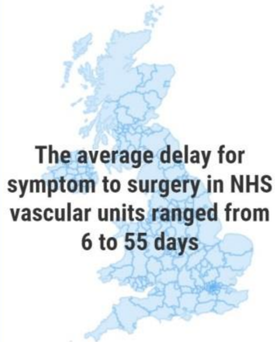
Which people had surgery?



Treatment times for symptomatic patients

Recommended time from symptom to surgery is within 14 days





Outcomes of surgery

The average length of stay for carotid endarterectomy was **3** days (typical stay between 2 and 5 days).

For patients who had a carotid endarterectomy, 2.1% had a stroke and/or died within 30 days

Recommendations

There remains considerable variations between NHS vascular units with regard to the provision of carotid endarterectomy within 14 days of symptoms. NHS trusts should optimise referral pathways within their networks and implement improvements to drive down the waiting times.

All staff involved in organising and delivering care to patients who require carotid surgery need to examine their data and assess their performance against standards within NICE Guideline CG68.

The average is the median; "typically between" is the interquartile range.
TIA stands for transient ischaemic attack. Amaurosis fugax is the loss of vision in one eye due to an interruption of blood flow to the retina.

Elective repair of infra-renal abdominal aortic aneurysm (AAA)

AAA is an abnormal expansion of the aorta. 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 4,198 elective infra-renal AAA repairs submitted to the NVR in 2015, which is approximately 86% of all procedures carried out in the UK.

Of these **4,198**

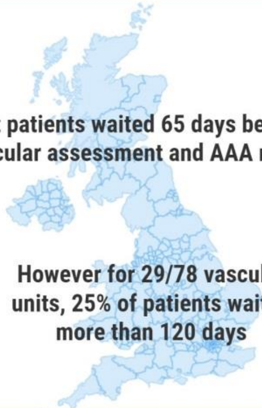
- **1,316 (31%)** were open repair
- **2,882 (69%)** were endovascular repair (EVAR)

Which people had surgery?

- **89%** were male
- **86%** were older than 65 years
- **69%** had hypertension
- **84%** were a current or ex-smoker

How were patients assessed?

- **74%** Discussed at multi-disciplinary team meeting
- **82%** Had fitness measured
- **84%** Had pre-operative angiography assessment
- **96%** Had formal anaesthetic review
  - **92%** Of these had review by consultant vascular anaesthetist



Most patients waited 65 days between vascular assessment and AAA repair

However for 29/78 vascular units, 25% of patients waited more than 120 days

Patient outcomes after surgery

	Open	EVAR
Died in hospital	3.0%	0.4%
were readmitted within 30 days	5.8%	6.0%
Average length of stay (typical range)	8 days (7-11 days)	3 days (2-5 days)

Recommendations

Vascular units are encouraged to adopt the care pathway and standards outlined in the Vascular Society's AAA quality improvement programme. This can be accessed at the Vascular Society's website. A clinical lead should be nominated to monitor and report on the adoption of the pathway and this should be reflected in their job planning.

There is wide variation in the time patients take from vascular assessment to elective AAA repair. Time to surgery from diagnosis to surgery for patient with aortic aneurysms. The National AAA Screening Programme has set a target of 8 weeks and, for non-complex aneurysms, this should be a target for all units for both screen and non screen detected AAA.

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

Repair of elective complex aortic aneurysms (AAA)

The term complex is used to describe those aneurysms that occur above the level of the renal (kidney) arteries.

There were 1,290 repairs of elective complex AAAs carried out in 2014-2015.

Of these

1,290

138 (11%) were open repair

1,152 (89%) were endovascular repair (EVAR)

Which people had surgery?

Open

74% **were older than 65 years**

83% **were male**

EVAR

85% **were older than 65 years**

85% **were male**

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

- 19.6% Died in hospital
- 2.1% were readmitted within 30 days
- 9 days (7-16 days) Average length of stay (typical range)

EVAR

- 3.6% Died in hospital
- 8.3% were readmitted within 30 days
- 6 days (3-9 days) Average length of stay (typical range)

Recommendations

The high postoperative mortality rate, particularly for open repairs, suggests that NHS trusts and Commissioners should be focused on ensuring the care for these patients is delivered safely.

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.

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

Lower limb revascularisation 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 or open surgical (bypass) interventions become options when conservative therapies have proved to be ineffective. In 2014 and 2015, the total number of revascularisation procedures submitted to the NVR was 19,003:

19,003

Endovascular **7,614**

19% of procedures carried out in the UK

11,389 Bypass

90% of procedures carried out in the UK

Which people had a lower limb revascularisation procedure?

Endovascular

- 66% were male
- 73% were older than 65 years
- 39% were diabetic
- 82% were current or ex-smokers

Bypass

- 72% were male
- 67% were older than 65 years
- 32% were diabetic
- 89% were current or ex-smokers

Patient outcomes after their procedure

Endovascular

- 1.7% Died in hospital
- 8.8% were readmitted within 30 days
- 1 day (0-7 days) Average length of stay (typical range)

Bypass

- 3.0% Died in hospital
- 10.5% were readmitted within 30 days
- 8 days (4-16 days) Average length of stay (typical range)

Recommendations

The low number of endovascular procedures submitted to the NVR is disappointing and it prevents the us from making firm statements about the national picture. It is vital for hospital governance, medical revalidation and commissioning of vascular services that NHS trusts encourage a more active approach to submitting data on endovascular lower limb procedures to the NVR.

Outcomes for lower limb bypass are in line with recent evidence, with a postoperative in-hospital mortality of 3.0%. However, for both bypass and endovascular procedures, the observed 10% unplanned readmission rate suggests this is an area for improvement. local services should review their local readmission rates to determine the cause of these readmissions.

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

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.

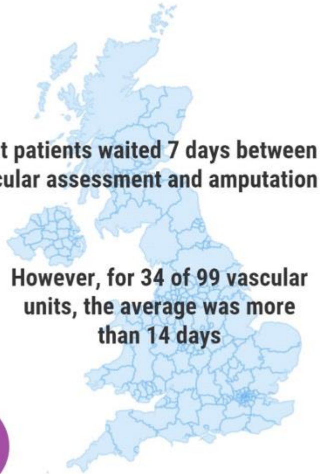
Despite open and endovascular revascularisation procedures, PAD can gradually progress in some patients to critical limb ischaemia. In these situations, patients will require amputation of the lower limb.

In 2014-2015 there were 5,318 major lower limb amputations submitted to the NVR, which is only about 55% of the actual cases performed across the UK.

5,318
amputations

3,190
Above Knee

2,128
Below Knee



Most patients waited 7 days between vascular assessment and amputation

However, for 34 of 99 vascular units, the average was more than 14 days

Which people had surgery?

Above Knee:

- 74% were male
- 62% were older than 65 years
- 24% were diabetic
- 75% were current or ex-smokers

Below Knee:

- 69% were male
- 74% were older than 65 years
- 41% were diabetic
- 84% were current or ex-smokers

Patient outcomes after surgery

Below Knee

- 5.6% Died in hospital
- 9.1% were readmitted within 30 days
- 22 days (12-39 days) Average length of stay (typical range)

Above Knee

- 12.4% Died in hospital
- 7.2% were readmitted within 30 days
- 23 days (13-39 days) Average length of stay (typical range)

Recommendations

At present, the proportion of lower limb amputations entered into the NVR is just over 50% and it is essential that this improves. NHS trusts should focus their attention on ensuring that all major amputations are recorded within the NVR: this will ensure that the Registry is able to provide accurate and precise information on amputation care in NHS hospitals, and the NHS trusts will be able to better monitor their own performance against the VSGBI's recommendations for best practice

Vascular units should undertake a detailed analysis of the pathways of care and outcomes for amputation, and are encouraged to adopt the care pathway and standards outlined in the Vascular Society's Quality Improvement Framework

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

1. Introduction

Hospital-based vascular services are established to treat patients who suffer from serious atherosclerotic (ie, thickening, narrowing and occlusion of arteries and veins) or aneurysmal disease outside of the heart and brain. These services provide care for a variety of conditions that affect blood circulation (conditions which are part of the broad spectrum of cardiovascular disease) and treatments are typically aimed at reducing the risk of cardiovascular events such as a heart attack, stroke or rupture of an artery. The diversity of vascular disease presents a challenge for vascular services. Treatment options will depend upon the severity of a patient's condition as well as the extent of other co-existing conditions. Some patients may only require a combination of advice on lifestyle change and medication. However, many patients have severe arterial disease that requires surgery or an invasive procedure like angioplasty.

The National Vascular Registry (NVR) was established in 2013 to measure the quality and outcomes of care for patients who undergo major vascular procedures in NHS hospitals. It was commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP).

The NVR captures data 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.

The primary purpose of the Registry is to provide comparative figures on the performance of vascular services in NHS hospitals to support local benchmarking and quality improvement. While NHS hospitals in England and Wales are required to report on their participation in the Registry as part of their Quality Account, all NHS hospitals in England, Wales, Scotland and Northern Ireland are encouraged 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.

In this report, we provide information on a range of process and outcome measures for each of the five types of arterial procedure. Being a procedure-based clinical audit, the primary focus is on 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 [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]

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. Surgeons were able to submit data on carotid endarterectomy, AAA repair, lower limb bypass and major amputation procedures for peripheral arterial occlusive disease (PAD) to the National Vascular Database, but this facility was not promoted to the same degree as the components for AAA repair and carotid interventions. The NVR has encouraged the submission of these procedures since the introduction of the new datasets for lower limb bypass and amputation in 2014. In addition, the Registry has worked with the

British Society of Interventional Radiology (BSIR) on the introduction of a dataset for lower limb angioplasty.

1.1 Aim of the 2016 Annual Report

The aim of this report is to give an overall picture of the care provided by NHS vascular units. It provides information on the process and outcomes of care for:

- patients having a carotid endarterectomy
- patients undergoing the elective repair of abdominal aortic aneurysms (AAA), both infra-renal (below the kidneys) and juxta-/supra-renal (adjacent / above)
- patients undergoing emergency repair of a ruptured AAA
- patients having a revascularisation procedure (angioplasty/stent or bypass) for lower limb
- patients having major lower limb amputation for PAD

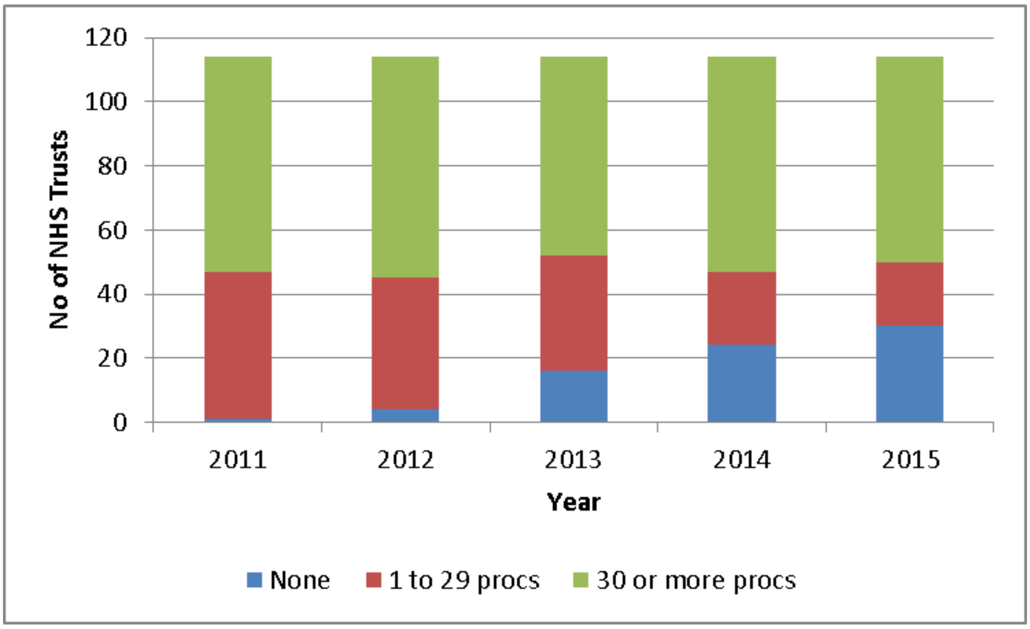
The report is primarily aimed at vascular surgeons and their teams working within hospital vascular units. Nonetheless, the information contained in the report on patterns of care is relevant to other health care professionals, patients and the public who are interested in having an overall picture of the organisation of services within the NHS.

1.2 Organisation of NHS hospital vascular services

The organisation of hospital vascular services within the UK has been evolving over the last decade. In response to the accumulating evidence about the benefits of delivering major vascular surgery in hospitals with high caseloads, it is recommended that vascular services are organised 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, and rehabilitation [VSGBI 2016].

Achieving this network organisation of services has required the extensive reconfiguration of vascular services within regions and a programme of investment. The changes can be illustrated by looking at the number of NHS trusts providing elective repair of infra-renal AAA in England over the last six years (Figure 1.1). In 2011, this procedure was performed in 114 NHS trusts. By 2015, 30 of the NHS trusts had stopped performing elective AAA repairs, and in the remaining 84, the number of NHS trusts performing fewer than 30 operations had fallen to 20.

Figure 1.1: Number of English NHS trusts performing elective infra-renal AAA surgery



Within NHS hospitals, there have also been major changes. There has been investment 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 weekly vascular operating lists. Working within multi-disciplinary teams has also become common practice.

This process of reconfiguration is still ongoing. In the 2015 NVR organisational survey, 48 (76%) of the responding NHS trusts / Health Boards reported that they were a part of a completely or near-completely reconfigured network. Respondents from another eight NHS organisations stated that reconfiguration was planned within the next two years.

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 2014 and 31 December 2015. To allow for 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 August 2016. Only records that were locked (ie, 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 (eg, 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 9.

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.

1.4 Outcome information on the VSQIP website

For the last two years, the Registry has been publishing outcome information on the www.vsqip.org.uk website for elective infra-renal AAA repairs and carotid endarterectomy procedures website 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. For English NHS trusts, the same information was also published for individual consultants currently working at the organisation, as part of NHS England's "Everyone Counts: Planning for Patients 2013/4" initiative. Consultant-level information was also published for NHS hospitals in Wales, Scotland and Northern Ireland for surgeons who consented.

This report complements the figures on the VSqip website and provides additional information at an NHS trust level on these two procedures. The report focuses on NHS providers, which enables the analysis to be based on a shorter period of time because there are still sufficient cases to produce robust statistics.

2. Carotid Endarterectomy

2.1 Introduction

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

In the UK, around 4,000-5,000 patients undergo a carotid endarterectomy (CEA) each year. Information about the quality of care given to patients having CEA has been available since 2008, with results published by the National Carotid Interventions Audit prior to the NVR being established in 2013 [Rudarakanchana et al 2012].

The information in this report primarily concerns the carotid procedures performed between 1 January 2015 and 31 December 2015. During this period, data were submitted by 473 surgeons, who were working at 91 NHS trusts and Health Boards in England, Wales, Scotland and Northern Ireland. Data were submitted to the Registry on a total of 4,620 interventions, which covered:

- 4,256 symptomatic patients
- 4,620 cases with complete 30 day survival information
- 3,322 cases for whom information was submitted on a follow-up appointment

The number of carotid endarterectomies reported to the NVR in 2015 was considerably lower than in the previous two years (Table 2.1). This seems to reflect an overall reduction in the number of procedures being performed (a 12% drop in two years) rather than a drop in case-ascertainment, which has been consistently high for all three years. The 2015 estimated case-ascertainment figures for the four nations were: 90% for England, 97% for Northern Ireland, 71% for Scotland and 100% for Wales.

Table 2.1: Estimated case-ascertainment of carotid endarterectomy in the UK

	2013	**2014**	**2015**	**Total**
Audit procedures	5,162	5,005	4,620	14,787
Expected procedures	5,869	5,578	5,171	16,618
Estimated case-ascertainment	88%	90%	89%	89%

2.2 Characteristics of patients and treatment pathways

The characteristics of patients who underwent carotid endarterectomy during 2015 are summarised in Table 2.2, and are compared to the distributions observed in the previous two years. Despite the reduction in the level of activity over time, the characteristics of the cohort has remained fairly stable. 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 92.1% were symptomatic. Among the 4,256 patients with symptomatic disease, TIA was the most common symptom (47.8%) followed by stroke (34.8%). Only 1.3% of patients had a previous ipsilateral treatment.

Medication for cardiovascular conditions was common among patients prior to surgery. Overall, 93.3% were on antiplatelet medication, while 87.5% were taking statins. ACE inhibitors and beta blockers were being taken by 39.6% and 26.2% of patients, respectively.

Patients may be referred for carotid endarterectomy from various medical practitioners. The stroke physician is the increasingly common source of referral, increasing from 75.8% in 2013 to 79.7% in 2015. The next most common referral sources in 2015 were: neurologists (5.1%), general practitioners (4.0%) and vascular surgeons (2.8%)

Table 2.2: Characteristics of patients who had carotid endarterectomy between 1 Jan 2015 and 31 Dec 2015, compared with characteristics from previous two years

Patient characteristics	No. of procedures	2015 %	2014 %	2013 %
Total procedures	4,620			
Age (years), (n=4,608)				
Under 66	1,157	25.1	27.2	25.9
66 to 75	1,622	35.2	34.9	36.9
76 to 85	1,580	34.3	31.8	31.2
86 and over	249	5.4	6.1	6.0
Male	3,139	67.9	66.1	67.8
Female	1,481	32.1	33.9	32.2
Patients symptomatic for carotid disease				
Index symptom if symptomatic: (n=4,256)				
Stroke	1,481	34.8	34.1	33.2
TIA	2,034	47.8	47.9	46.6
Amaurosis fugax	662	15.6	15.3	16.6
None of the three above	79	1.9	2.7	3.6
Grade of ipsilateral carotid stenosis* (n=4,620)				
<50%	68	1.5	2.0	0.9
50-69%	1,132	24.5	23.8	25.8
70-89%	1,982	42.9	45.0	44.1
90-99%	1,429	30.9	28.9	28.8
Occluded	9	0.2	0.3	0.5
Rankin score prior to surgery (n=4,620)				
0-2	4,275	92.5	91.0	89.8
3	290	6.3	7.8	8.9
4-5	55	1.2	1.2	1.2
Co-morbidities (n=4620)				
Diagnosed diabetic	1,088	23.5	23.3	21.3
Current symptoms / treatment ischaemic heart disease	1,576	34.1	32.8	27.2

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

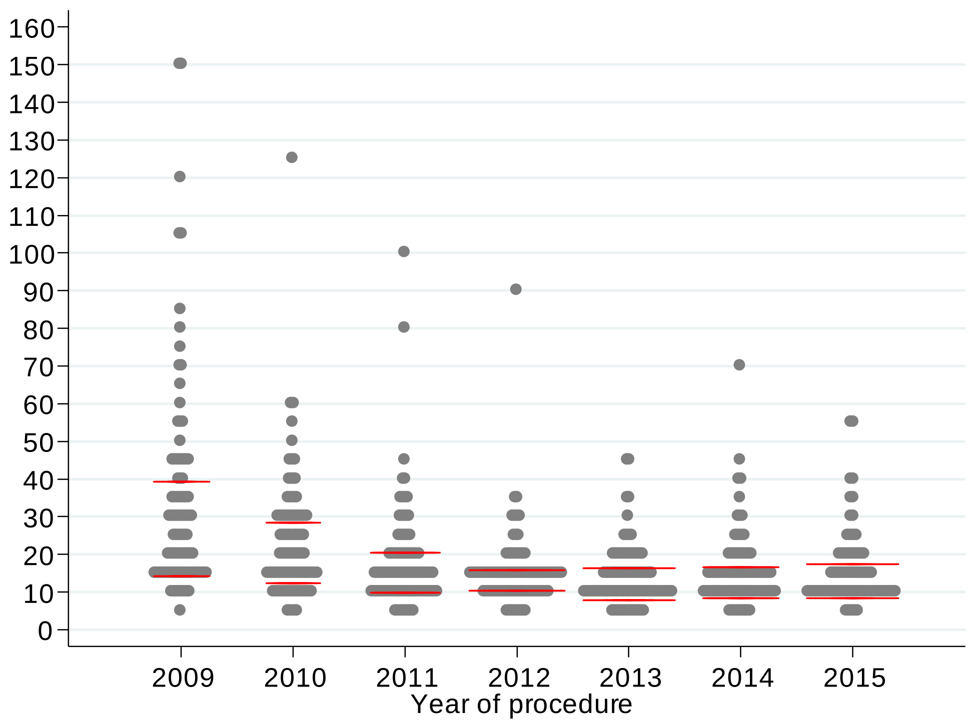
The current NICE guideline recommends two weeks as the target time from symptom to operation in order to minimise the chance of a high risk patient developing a stroke [NICE 2008]. In the years from 2009 to 2012, there was a steady decline in the median time from the index symptom to operation for symptomatic 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%. It has been relatively stable since then, with the median time for symptomatic patients in 2015 being 13 days (IQR 7-28) days and 57% of patients being treated within 14 days.

There has been a corresponding reduction in the time delay through the various components of the patient pathway:

- from symptom to first medical referral
- from first medical referral to being seen by the vascular team, and
- from being seen by a vascular surgeon to undergoing CEA.

In 2009, the median time delays for each component were: 7 days (IQR 3-20), 1 day (IQR 0-7) and 8 days (IQR 3-20), respectively. In 2015, the median time delays were: 4 days (IQR 1-10), 1 day (IQR 0-5) and 6 days (IQR 2-13), respectively. Figure 2.1 shows the changes over time in median delays from symptom onset to undergoing CEA for every UK NHS hospital performing CEA, stratified by year of the procedure.

Figure 2.1: The median time from index symptom to carotid surgery for each NHS trusts by year of procedures*. Red lines show the 25th & 75th percentile of NHS trust medians



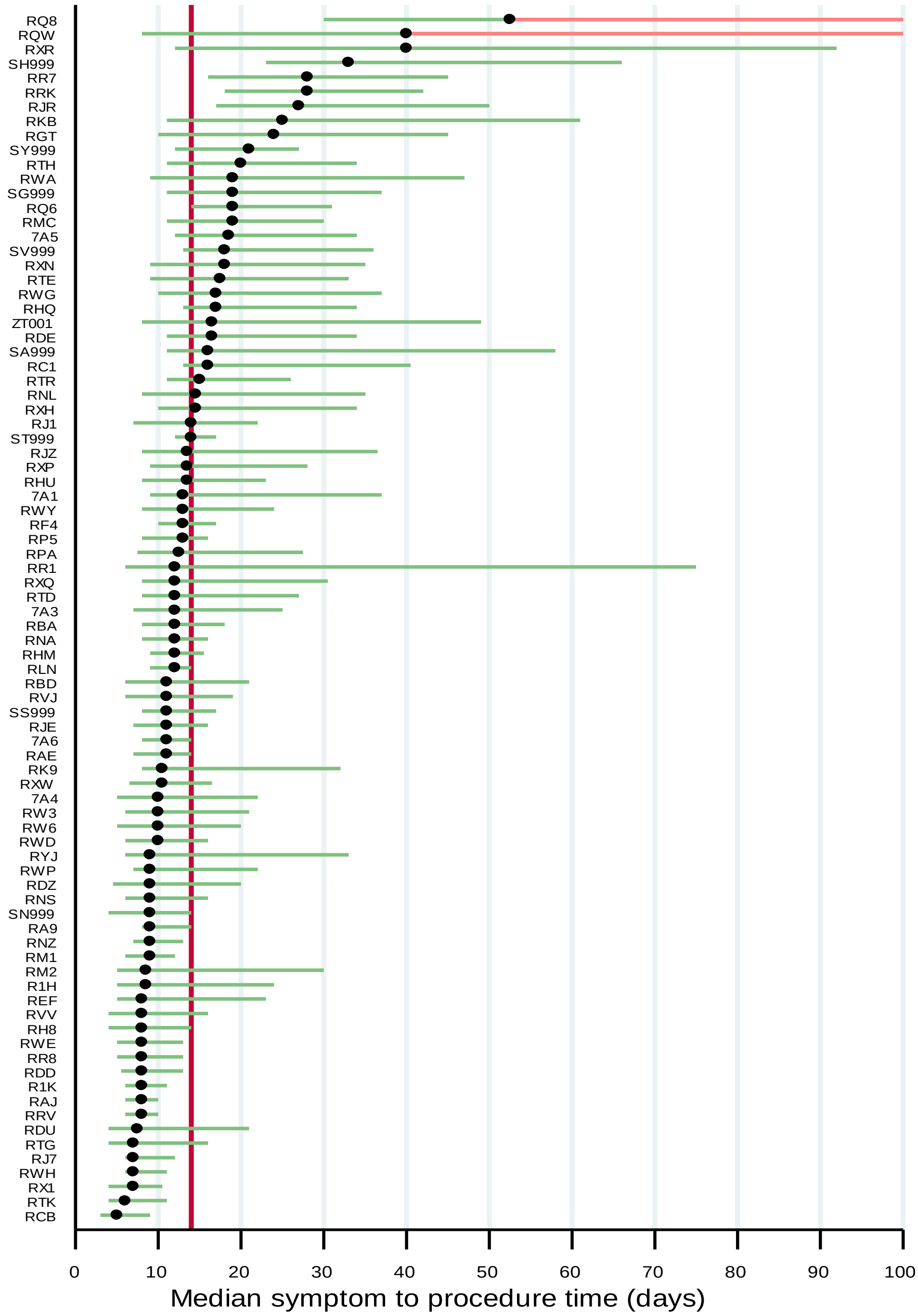
* Two highest values (179 and 207) in 2009 were winzorised to 150 days to reduce their effect on the scale of the vertical axis.

The distribution of symptom to operation times for all NHS trusts is summarised in Figure 2.2. 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 the NHS organisation is relatively small. The vertical red line in the graph represents the current NICE Guideline of 14 days from symptom to procedure.

Figure 2.2 shows that there was considerable variation among NHS trusts in the median time to surgery during 2015. The median was 14 days or less for 56 of the 84 organisations, but the median exceeded 20 days for ten vascular units. The values for the individual organisations can be found in Appendix 3.

In 2015, 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 acceptable, took comparatively longer to progress from symptom onset to surgery, with the median delay being 19 days (IQR 10 to 42).

Figure 2.2: Median time (and interquartile range) from symptom to procedure by NHS trust for procedures done between January and December 2015



2.3 Operative details and postoperative surgical outcomes

The majority of carotid interventions that are submitted to the NVR are unilateral endarterectomies. There were only four bilateral procedures. An endovascular carotid stent was used in 1.0% of procedures.

A carotid endarterectomy can be performed in various ways. The standard approach involves opening the artery to remove the plaque via an incision, after which it is repaired with stitches or a patch made with a vein or artificial material. There is some evidence that the use of patch reduces the risk of stroke or death during the perioperative period [Bond et al., 2004]. An alternative technique is the eversion carotid endarterectomy, which involves dividing the carotid artery, removing the plaque and turning the artery inside out, and then reattaching it. Shunts may be placed to ensure blood supply is maintained to the brain during the procedure, but the need for shunts is reduced when the operation is performed under local anaesthetic because this enables the patient to be assessed for signed of cerebral ischaemia.

Table 2.3 summarises the operative details of unilateral carotid endarterectomies performed during 2015. The most common type of endarterectomy involved using a carotid patch after the endarterectomy. Eversion endarterectomy was performed in less than 10% of patients. Overall, just over half of the procedures were performed under general anaesthetic and 53.3% involved the use of a shunt. Most patients were admitted as elective cases (63.0%), and 98% of patients had their operation start within the hours of 8am and 6pm.

Table 2.3: Details of unilateral carotid endarterectomies undertaken during 2015

Operation details		**Procedures (n=4,616)**	**(%)**
Anaesthetic	General only	2,531	54.8
	Local only	1,162	25.2
	Other	923	20.0
Type of Endarterectomy	Standard	688	14.9
	Standard + patch	3,559	77.1
	Eversion	369	8.0
Carotid shunt used		2,459	53.3
Ipsilateral Patency check		2,614	57.8

In 2015, just over half of the patients were admitted to the ward after their operation, with 44.0% of patients being admitted to either level 2 or level 3 critical care wards. The length of stay in critical care was typically short, with the median duration in level 2 and level 3 critical care wards being 1 day (IQR 0 to 1) and 2 days (IQR 1 to 2), respectively. Overall, the median length of stay in hospital was 3 days (IQR 2 to 5).

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 15,000 procedures performed in NHS hospitals between 2013 and 2015, the rates of the different complications tended to be around 2% (see Table 2.4). And, over this 3-year period:

- the rate of return to theatre was 2.8 (95% CI 2.6 to 3.1), and
- the rate of readmission within 30 days was 3.7% (95% CI 3.4 to 4.1).

Table 2.4: Postoperative outcomes following carotid endarterectomy

Complication	Procedures in 2013-2015	Complication rate (%)	95% Confidence interval
Bleeding within admission	14,766	2.6	2.3-2.8
Myocardial Infarct within admission	14,766	1.2	1.0-1.4
Stroke within 30 days	14,787	1.7	1.5-1.9
Death and/or stroke within 30 days	14,787	2.1	1.9-2.3
Cranial nerve injury within admission	14,696	1.7	1.5-1.9

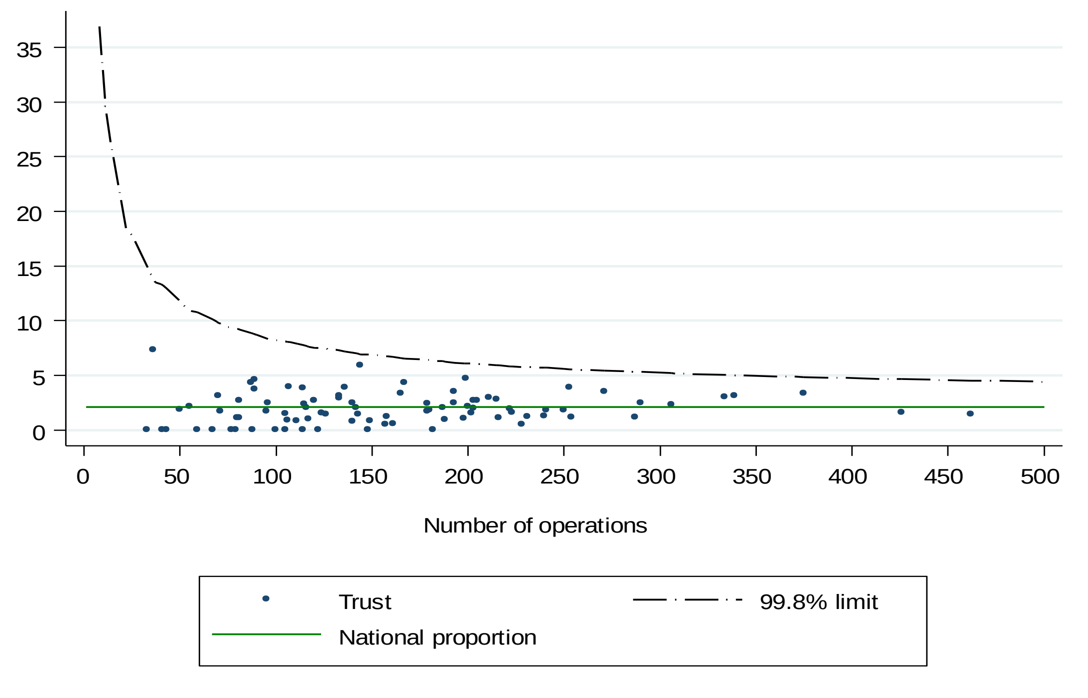
2.4 Rates of stroke/death within 30 days among NHS trusts

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, if a patient had diabetes, and the preoperative Rankin Scale.

The comparative, risk-adjusted 30 day death/stroke rates for individual NHS trusts are shown in the funnel plot in Figure 2.3 [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.

The funnel plot shows the risk adjusted rate of death/stroke within 30 days for all NHS organisations are all within the expected distance of the overall national average rate of 2.1% (ie, they were within the 99.8% control limits). Appendix 3 gives the figures for each organisation.

Figure 2.3: Funnel plot of risk-adjusted rates of stroke/death within 30 days for NHS trusts, for carotid endarterectomies between January 2013 and December 2015



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

2.5 Conclusion

An unexpected result for the data collected on carotid interventions in 2015 was the change in the number of procedures submitted to the NVR compared with the two previous years. As mentioned earlier, 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 fall in activity, there was little change in the median time from symptom to surgery. This seems to have stabilised around 14 days after the time fell between 2009 and 2012, with 57% of patients having their surgery within the recommended time. The results continue to show considerable variation in the time to intervention across NHS trusts, with around ten 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. High performing centres demonstrate that it is possible to achieve a pathway of care that meets the recommended standard of access for this treatment.

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.

3. Repair of abdominal aortic aneurysm

3.1 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

Between 1 January 2013 and 31 December 2015, the NVR received information on AAA repairs from 98 NHS organisations: 82 in England, 5 in Wales, 9 in Scotland, and 2 in Northern Ireland. These organisations submitted data on 12,996 elective infra-renal AAA procedures. The number of these procedures identified in the routine hospitals datasets over the same period was 15,066, which gives an overall case-ascertainment of 86%. There was a slight decrease in the number of AAA repairs performed in 2015 compared to 2013 (a fall of 5%), but this was not to the same degree as that observed for carotid interventions.

The estimated 2015 case-ascertainment figures for the four nations were: 89% for England, 96% for Wales, 84% for Northern Ireland and 72% for Scotland. The overall case-ascertainment has remained fairly stable over the last three years (Table 3.1).

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

	2013	2014	2015	Total
Audit procedures	4,328	4,470	4,198	12,996
Expected procedures	5,098	5,132	4,836	15,066
Estimated case-ascertainment	85%	87%	87%	86%

** 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, and in appendix 4, may be an underestimate for those NHS trusts that carry out complex EVAR procedures.

3.2 Overview of patient characteristics and surgical activity

The characteristics of patients who underwent an elective repair of an infra-renal AAA during 2015 are summarised in Table 3.2.

The percentage of patients with asymptomatic disease was 96.0%. About one quarter of patients were referred for vascular assessment after the aneurysm was detected by some form of screening. Most of these are likely to correspond to patients under local surveillance after an infra-renal AAA was detected incidentally rather than patients whose aneurysm was detected through the national screening programme.

The majority of procedures were performed for patients with an AAA diameter between 5.5 and 7.4 cms. Few 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; two-thirds had hypertension and about one-half suffered from some form of heart disease. A large proportion of patients were also on medication when assessed pre-operatively.

In recent years, there has been an increasing trend in the proportion of repairs performed as endovascular (EVAR) procedures, growing from 54% in 2009 to 66% in 2013. This trend has stabilised over the last few years, with EVAR procedures accounting for 69% of the elective infra-renal AAA repairs in 2015. There were small differences in the characteristics of patients who had EVAR and open procedures (Table 3.2), with those undergoing EVAR procedures being, on average, slightly older and having a greater burden of comorbid disease.

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

- The neck angle was less than 60 degrees for 90.7% of procedures
- The median proximal aortic neck diameter and length were 24 mm (IQR 22 to 26) and 23 mm (IQR 17 to 30), respectively
- There were 443 (15.8%) procedures that unilaterally extended into the iliac artery and 138 (4.9%) procedures required bilateral limb extensions

Among the open repairs, the most common type of repair was with a straight ‘tube’ graft (64.8%), followed by a bifurcated graft (35.1%).

Table 3.2: Characteristics of patients who had elective infra-renal AAA repair between January and December 2015. Column percentages

		Open AAA	%	EVAR	%	Total
Total procedures		1,316		2,882		4,198
Age group (years)	Under 66	321	24.4	248	8.6	569
	66 to 75	665	50.5	1,032	35.8	1,697
	76 to 85	316	24.0	1,366	47.4	1,682
	86 and over	14	1.1	236	8.2	250
Male		1,158	88.0	2,564	89.0	3,722
Female		158	12.0	318	11.0	476
Current smoker		383	29.1	558	19.4	941
Previous AAA surgery		90	6.8	293	10.2	383
Indication	Screen detected	440	33.5	665	23.1	1,105
	Non-screen	749	57.0	1,845	64.0	2,594
	Other	126	9.6	372	12.9	498
AAA diameter (cm)	Under 4.5	29	2.2	116	4.0	145
	4.5 to 5.4	58	4.4	157	5.5	215
	5.5 to 6.4	801	60.9	1,787	62.1	2,588
	6.5 to 7.4	244	18.5	509	17.7	753
	7.5 and over	184	14.0	308	10.7	492
ASA fitness grade	1,2	510	38.8	774	26.9	1,284
	3	769	58.5	1,958	68.0	2,727
	4,5	35	2.7	149	5.2	184
Comorbidities	Hypertension	875	66.5	2,029	70.4	2,904
	Ischemic heart disease	428	32.5	1,225	42.5	1,653
	Chronic heart failure	30	2.3	165	5.7	195
	Stroke	66	5.0	172	6.0	238
	Diabetes	160	12.2	457	15.9	617
	Chronic renal failure	120	9.1	383	13.3	503
	Chronic lung disease	264	20.1	809	28.1	1,073

3.3 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

These results for procedures performed in 2015 suggest that the majority of patients are receiving care that is consistent with the recommended pathway. In summary:

- 74.4% of elective patients were discussed at MDT meetings (3,125/4,198)
- 84.1% of patients with an AAA diameter ≥ 5.5cm deemed suitable for repair had a pre-operative CT/MR angiography assessment (3,223/3,833)
- 96.0% of patients underwent a formal anaesthetic review (4,029/4,198)
- 92.2% of patients who had an anaesthetic review had one by a consultant vascular anaesthetist (3,681/3,993; 36 missing)
- 82.2% of patients had their fitness measured (3,449/4,198), the most common assessment method being CPET (47.6% of measurements)

The overall proportion of patients having pre-operative CT/MR angiography and MDT assessment was lower than expected, but the figures might be conservative because patients for whom the dates were unknown were counted as equivalent to patients who did not receive these elements of care. The figures were reported in this way because, for audit purposes, hospitals should know the values.

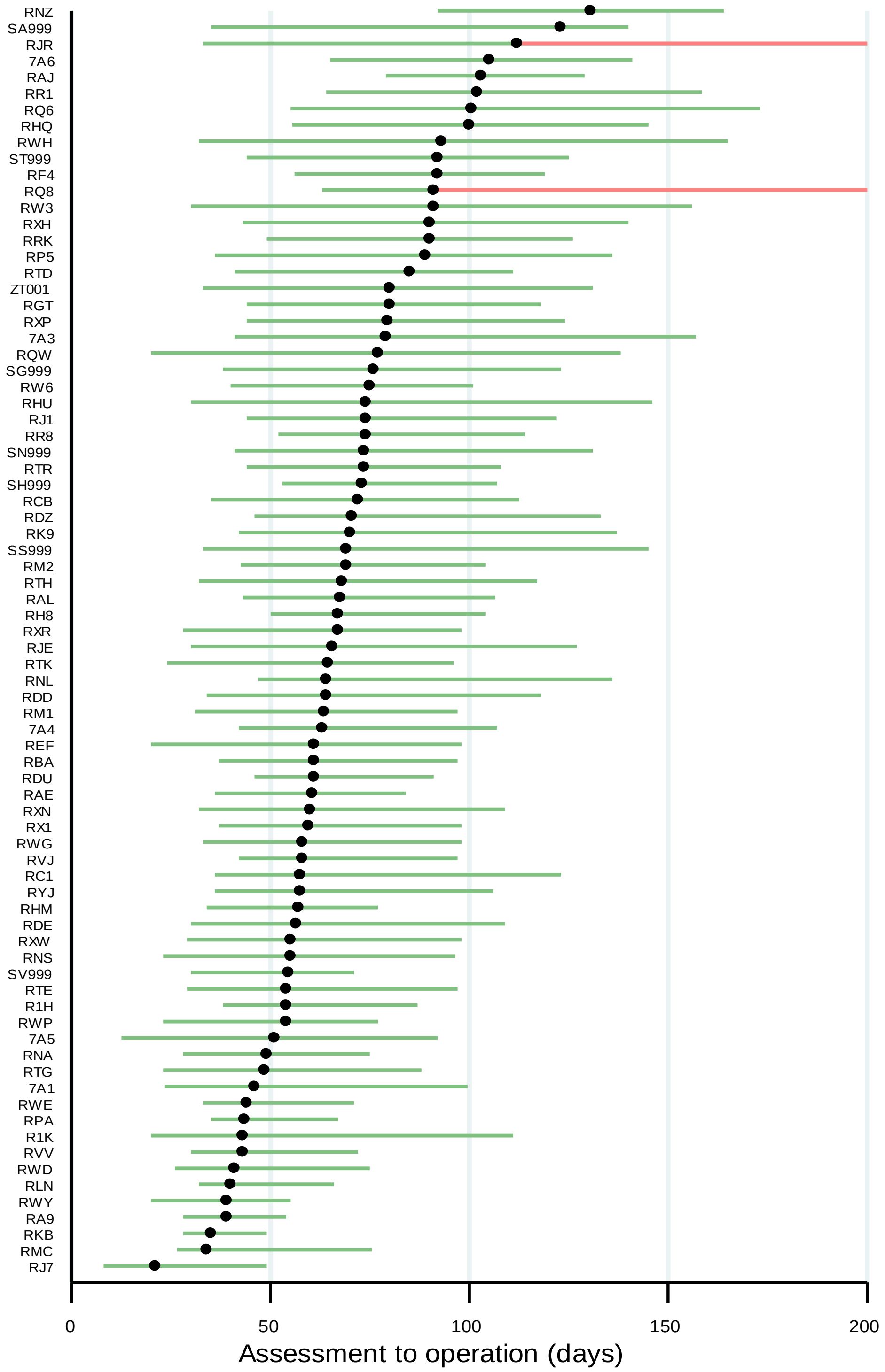
The National AAA Screening Programme has emphasised the importance of the timely scheduling of an elective repair to mitigate the risk of a patient's AAA rupturing while waiting for treatment. This is a small absolute risk of rupture, but the NAAASP recommends a target of 8 weeks from date of referral 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 3.1 (overleaf) summarises the variation among NHS trusts in the median (IQR) time from vascular assessment to surgery for procedures performed in 2015. The graph contains figures for all organisations that had 10 or more infra-renal AAA repairs cases 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 the 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 37% of the vascular units (29 of 78), 25% of patients operated on in 2015 waited more than 120 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 120 days is well over the National AAA Screening Programme target of 8 weeks from date of referral to surgery and the analysis also only covers the period from vascular assessment to surgery.

The values for the individual organisations can be found in Appendix 4.

Figure 3.1: Median (IQR) time from assessment to treatment (days) for patients who had elective infra-renal AAA repair between January and December 2015



3.4 Postoperative outcomes after elective infra-renal AAA repair

The overall patterns of postoperative care are summarised in Table 3.3. There were some notable differences between patients having open and EVAR procedures. For EVAR procedures, over half 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 3 days. For patients undergoing open repair, 97% of patients were admitted to a level 2 or level 3 critical care unit. They typically remained there for 2 days, and the median total postoperative stay was 8 days, and had a comparatively high in-hospital mortality rate. Patients having open repair were more susceptible to respiratory complications, and the rate of return to theatre was also slightly higher. The procedures had comparable 30-day readmission rates.

Table 3.3: Postoperative details of elective infra-renal AAA repairs undertaken between January and December 2015

		Open AAA (n=1,316)		EVAR (n=2,882)	
Admitted to	Ward	2.4%		57.1%	
	Level 2	56.4%		39.3%	
	Level 3	41.0%		3.6%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	2	1 to 4	1	0 to 1
	Level 3	2	2 to 4	1	1 to 2
Hospital length of stay (days)		8	7 to 11	3	2 to 5
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		3.0	2.2 to 4.1	0.4	0.2 to 0.7
Defined complications					
	Cardiac	6.5	5.3 to 8.0	1.8	1.3 to 2.3
	Respiratory	12.9	11.1 to 14.8	2.4	1.9 to 3.1
	Haemorrhage	1.8	1.1 to 2.6	0.9	0.6 to 1.3
	Limb ischaemia	2.8	2.0 to 3.9	0.7	0.4 to 1.1
	Renal failure	5.3	4.1 to 6.6	1.2	0.8 to 1.7
	Other	2.7	1.9 to 3.8	0.4	0.2 to 0.7
None of predefined		75.6	73.2 to 77.9	93.5	92.5 to 94.3
Return to theatre		7.0	5.7 to 8.5	2.1	1.6 to 2.7
Re-admission within 30 days		5.8	4.5 to 7.5	6.0	5.1 to 7.0

Patients undergoing EVAR procedures may experience an endoleak, in which blood still enters the aneurysm sac after the stent inserted during the repair. 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 more serious and generally require intervention. Among the 2015 EVAR procedures:

- 2,352 (83.3%) procedures experienced no endoleak while the patient was in hospital
- Type 1 endoleaks occurred in 117 (4.1%) procedures
- 121 endoleaks (either Type 1 or 2) required intervention at the time of the procedure

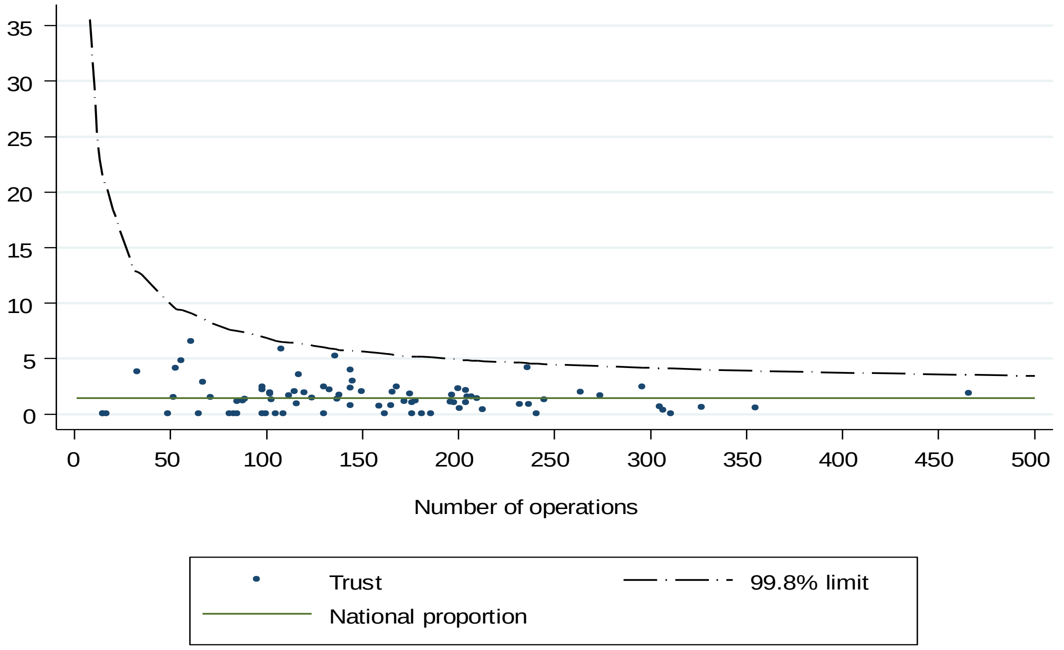
3.5 Postoperative in-hospital mortality for elective infra-renal AAA repair

The principal performance measure used by the NVR for elective infra-renal AAA repair is the postoperative in-hospital mortality rate. In this section, we report these outcomes for NHS organisations undertaking these AAA repairs during the period from 1 January 2013 to 31 December 2015. We used this 3-year period to give robust outcome estimates.

The comparative, risk-adjusted mortality rates for individual NHS trusts are shown in a funnel plot in Figure 3.2. 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 the mortality rates would be expected to fall if their outcomes only differed from the national rate because of random variation. The overall in-hospital mortality rate was 1.5%, 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 3.3A and 3.3B show the risk-adjusted rate of inpatient mortality among NHS trusts for open repair and EVAR procedures separately. Each funnel plot is centred on the national average mortality rate for these two procedures. The overall in-hospital mortality rates for open and EVAR procedures were 3.1% and 0.6%, respectively.

Figure 3.2: Risk-adjusted in-hospital mortality rates after elective infra-renal AAA repair among NHS vascular units for procedures performed between Jan 2013 and Dec 2015. The overall in-hospital mortality rate was 1.5%.



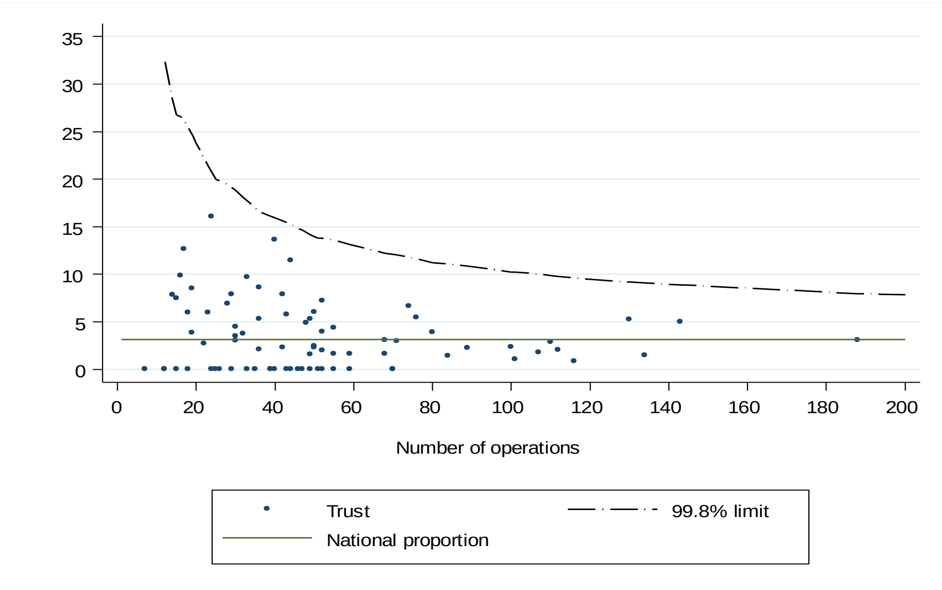
3.6 Conclusion

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 United Kingdom 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.

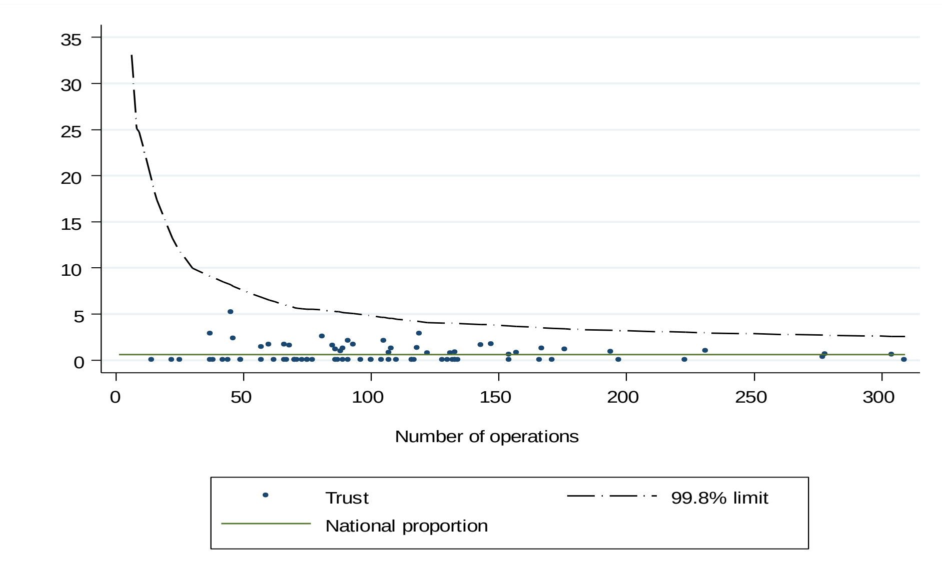
Nonetheless, postoperative mortality only reflects one part of the spectrum of outcomes that are important to patients, and the report highlights various issues for NHS trusts / Health Boards to examine along the care pathway. On the positive side, many patients received care that met the VSGBI standards of pre-operative assessment but there are several areas for improvement. First, around one quarter of patients were not discussed at MDT. 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 units did not meet this standard and are recommended to examine how the time to surgery can be shortened.

Figure 3.3: 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 were 3.1% and 0.6%, respectively.

A: Open repairs



B: EVAR procedures



4. Repair of ruptured and other abdominal aortic aneurysms

4.1 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.

This is the second Annual Report in which we provide information on the care received by patients with a ruptured AAA. Last year, we reported on 2,553 procedures performed in the 3-year period between 1 January 2012 and 31 December 2014. In this report, the analysis included procedures performed between 1 January 2013 and 31 December 2015. Details of 2,761 procedures were submitted to the NVR, giving an estimated case-ascertainment of 86% (compared to 73% in the previous report). The proportion of patients having an EVAR procedure over this 3-year period was 25.1% (n=694), slightly up from 22.6% between 2012 and 2014.

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 4.1). In comparison to patients undergoing an open repair, patients having EVAR had a smaller AAA diameter, on average, and a greater proportion had also undergone AAA surgery previously.

Table 4.1: Characteristics of patients who had a repair of a ruptured AAA between January 2013 and December 2015

		Open AAA	%	EVAR	%	Total
Total procedures		2,067		694		2,761
Age group (years)	Under 66	228	11.0	54	7.8	282
	66 to 75	772	37.3	194	28.0	966
	76 to 85	918	44.4	321	46.3	1,239
	86 and over	149	7.2	125	18.0	274
Male		1,701	82.3	594	85.6	2,295
Female		366	17.7	100	14.4	466
Previous AAA surgery		147	7.2	125	18.2	272
AAA diameter (cm)	<4.5	12	0.6	28	4.2	40
	4.5 to 5.4	73	3.7	36	5.4	109
	5.5 to 6.4	303	15.3	126	19.0	429
	6.5 to 7.4	410	20.7	143	21.5	553
	7.5 and over	1,183	59.7	331	49.8	1,514
ASA fitness grade	1 or 2	109	5.4	33	4.9	142
	3	199	9.9	131	19.5	330
	4	1,065	53.0	416	61.9	1,481
	5	636	31.7	92	13.7	728

Given the serious nature of a ruptured AAA, it is unusual for patients not to have an ASA grade of 4 or 5. We note that a greater proportion of patients had ASA grade 4/5 in this report compared to the previous report, and we again encourage NHS trusts to review the records of patients not given these ASA ratings for possible data entry errors.

Most (75.4%) of the open grafts performed in 2014 and 2015 were tubal. The next most common were bifurcated iliac (19.5%) and bifurcated groin (4.4%). Uni-iliac and crossover procedures made only 0.7%. For the patients undergoing EVAR, the basic characteristics of their anatomy were:

- 87.9% had a neck angle between 0-60 degrees; for 6.6%, it was 60-75 degrees.
- The mean neck diameter was 23.8mm and the mean neck length was 23.7mm
- The aneurysm was extended into either the left / right iliac artery for 17.9% of procedures and was extended bilaterally for 4.2% of procedures.

The outcomes of the surgical repair for patients with a ruptured AAA are summarised in Table 4.2. There were some noticeable differences in the postoperative care required by patients undergoing open and EVAR procedures. 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 renal failure. 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. These were 40.4% (95% CI 38.3 to 42.6) and 20.7% (95% CI 17.8 to 24.0), respectively.

Table 4.2: Postoperative details of emergency repairs for ruptured AAAs undertaken between January 2013 and December 2015 (unless otherwise stated)

		Open AAA (n=2,067)		**EVAR (n=694)**	
*Admitted to	Ward	0.3%		7.0%	
	Level 2	7.1%		41.6%	
	Level 3	85.4%		46.5%	
	Died in theatre	7.2%		4.9%	
		Median	***IQR***	***Median***	***IQR***
*Days in critical care:	Level 2	3	1 to 5	1	0 to 2
	Level 3	4	2 to 9	2	1 to 5
Hospital length of stay (days)		11	4 to 21	9	4 to 16
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		40.4	38.3 to 42.6	20.7	17.8 to 24.0
Defined complications					
	Cardiac	27.7	25.6 to 29.9	15.9	13.0 to 19.2
	Respiratory	35.3	33.0 to 37.6	20.8	17.5 to 24.4
	Haemorrhage	5.6	4.6 to 6.8	2.8	1.6 to 4.5
	Limb ischaemia	10.3	9.0 to 11.9	4.7	3.1 to 6.8
	Renal failure	31.8	29.7 to 34.1	14.2	11.4 to 17.3
	Other	7.3	6.1 to 8.6	4.2	2.7 to 6.2
None of predefined		33.0	30.8 to 35.3	62.4	58.3 to 66.4
*Return to theatre		21.6	18.4 to 25.0	8.2	5.0 to 12.5
*Re-admission within 30 days		6.4	3.9 to 9.7	13.8	8.9 to 19.9

*derived from 2014 and 2015 data only, due to changes in the dataset

In the previous report, the in-hospital postoperative mortality rates for open and EVAR procedures were 37.2% (95% CI 35.1 to 39.4) and 19.9% (95% CI 16.7 to 23.8), respectively. The slightly higher rates this year may reflect the increased case-ascertainment, with the NVR capturing more of the sickest patients. We note that 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.

In recognition of the relatively recent uptake of EVAR for emergency repair of ruptured AAA, we summarise the risk of an endoleak below (Table 4.3). In comparison to the elective EVAR repair of an intact infra-renal AAA, the risk of an endoleak was slightly higher, with 6.4% of patients experiencing a Type 1 complication (compared with 4.1%).

Table 4.3: Rates of endoleak for emergency repair of ruptured AAAs undertaken between January 2014 and December 2015**

Endoleak	%Patient with an endoleak	% endoleaks requiring intervention	Endoleak successfully repaired
Type 1	6.4%	84.4%	77.8%
Type 2	7.8%	12.8%	80.0%
Type 3	0.8%	75.0%	100.0%
Type 4	0.4%	100.0%	100.0%
Unclassified	0.6%	33.3%	100.0%

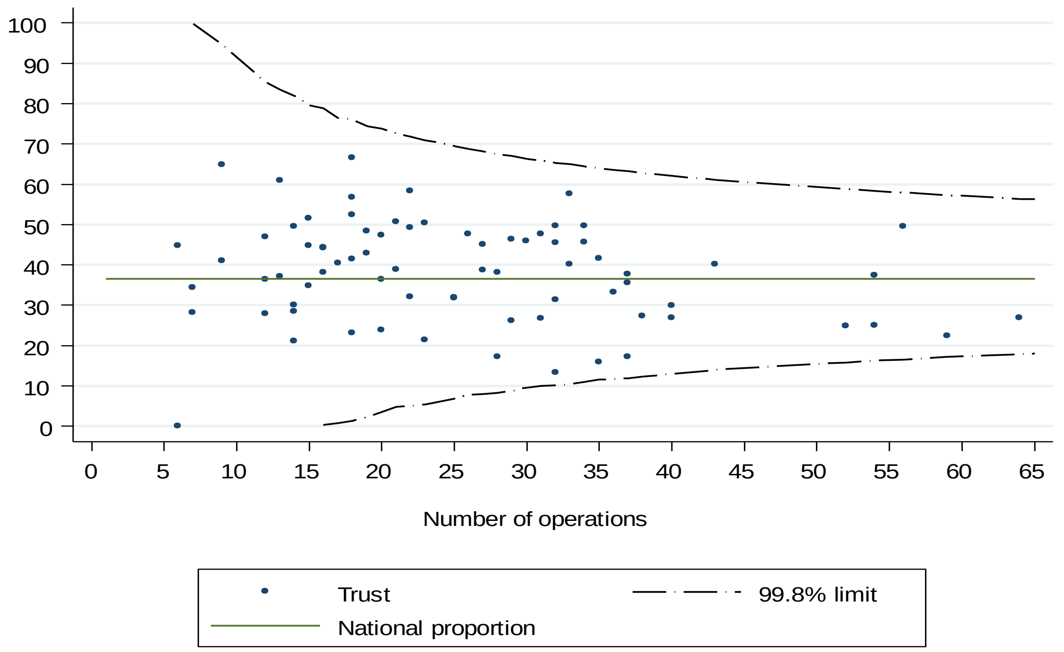
** data not available until January 2014

4.2 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 2014 to 31 December 2015. This is the first time such figures have been published for the UK, and reflects the increased number of these procedures within the NVR and the ability to undertake adequate risk-adjustment based on the changes to the NVR dataset introduced in January 2014.

The risk-adjusted mortality rates for individual NHS trusts are shown using a funnel plot in Figure 4.1. 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 mortality rates would be expected to fall if their outcomes only differed from the national rate because of random variation.

Figure 4.1: Risk-adjusted in-hospital mortality for emergency repairs of ruptured AAAs between January 2014 and December 2015 by NHS trust. Mean mortality was 36.6%.



All 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. We note that the rates among the hospitals tended to range from 20-60% but this reflects the relatively low volumes used to calculate these rates, and we would not recommend over-interpreting these figures for individual NHS trusts. The funnel plot gives no evidence that the underlying mortality rate for any organisation was different from the national average of 36.6% over this period. In coming years, we will have a larger sample sizes and be able to give more precise estimates of an organisations performance. Appendix 5 gives the figures for each NHS trust.

4.3 Conclusion: ruptured AAA

These results highlight a number of issues. First, a ruptured AAA remains a very serious condition, with high postoperative mortality and morbidity. This highlights the important role that the screening programme can play in preventing these events.

Second, only 25% of patients undergo an EVAR procedure for a ruptured AAA, in contrast to the two-thirds of elective infra-renal AAA repairs being performed this way. There are likely to be various clinical factors resulting in the selection of one technique over the other, including anatomical suitability and the physiological characteristics of patients. Indeed, the comparatively favourable results for EVAR procedures suggest that it is being introduced cautiously in patients for whom it is most clearly appropriate. We emphasise that the results here provide no evidence of the relative merits of the two techniques, and the initial results of the IMPROVE trial showed that the open and EVAR procedures produced equivalent results [Powell et al 2014].

Nonetheless, it is also possible that the use of EVAR in only 25% of patients reflects limitations in the availability of endovascular facilities and skills in some vascular units. Further work is required to establish whether pathway factors are a limitation on the use of EVAR for ruptured AAA patients.

4.4 Elective repair of complex aortic conditions

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)

Until recently, open surgery was the standard technique to repair complex aneurysms. However, EVAR procedures are increasingly being performed as endovascular grafts have developed to deal with these more complicated situations. Collectively these procedures are known as complex EVAR repairs, but cover a number of techniques. The most common are:

- fenestrated EVAR (FEVAR) which involves the use of a graft which 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 EVAR 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.

The 2015 Annual Report contained the first set of results on the outcomes of elective surgery for patients with complex abdominal aortic aneurysms, this being made possible by changes in the dataset introduced in 2014. In this section, we update those results for both open and complex EVAR procedures which cover the 2-year period between January 2014 and December 2015.

NHS hospitals have submitted 1,290 records related to complex AAA procedures to the NVR - 638 procedures for 2014 and 652 for 2015. These were submitted by 74 vascular units, and the volume of activity within these units ranged from 1 to 172 procedures (median=7). Of these procedures, 1,152 (89%) were endovascular (Table 4.4), with just over half being fenestrated EVARs.

Table 4.4: Characteristics of patients who had an elective repair of complex AAA between January 2014 and December 2015

		Open AAA	%	EVAR	%	Total
Total procedures		138		1,152		1,290
Age group (years)	Under 66	36	26.1	177	15.4	213
	66 to 75	59	42.8	456	39.6	515
	76 to 85	41	29.7	470	40.8	511
	86 and over	2	1.4	49	4.3	51
Male		115	83.3	974	84.5	1,089
Female		23	16.7	178	15.5	201
Type of procedure	FEVAR			593	51.5	
	BEVAR			97	8.4	
	TEVAR			205	17.8	
	Iliac branch graft			171	14.8	
	Composite graft			16	1.4	
	Other (eg, chimney / snorkel / periscope)			70	6.1	

The outcomes of elective repairs for patients with non infra-renal AAA are summarised in Table 4.5. The in-hospital postoperative mortality rates for open and EVAR procedures were around six times greater than the rates for infra-renal AAA for both open and EVAR repair, reflecting the complex nature of the disease and surgery. For EVAR procedures, three-quarters of patients were admitted to either level 2 or 3 critical care. For patients undergoing open repair, 97% of patients were admitted to a level 2 or level 3 critical care unit, where they typically remained there for 2-3 days. The median overall postoperative stay was 9 days. In addition, a greater proportion of patients having open repair were readmitted to critical care. Both types of procedure had a similar proportion of patients returned to theatre.

The median length of stay for EVAR was slightly shorter than for open repairs (6 v 9 days). However, patients having EVAR were more likely to be readmitted within 30 days than open repairs.

There was very little difference in the outcomes for the two most common complex EVAR procedures (Table 4.6).

Table 4.5: Postoperative details of complex AAA repairs undertaken between January 2014 and December 2015

		Open AAA (n=138)		EVAR (n=1,152)	
Admitted to	Ward	2.9%		20.6%	
	Level 2	48.6%		56.9%	
	Level 3	48.6%		22.4%	
	Died in theatre	0.0%		0.2%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	2	0 to 5	1	0 to 2
	Level 3	3	2 to 10	2	1 to 2
Hospital length of stay (days)		9	7 to 16	6	3 to 9
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		19.6	13.3 to 27.2	3.6	2.6 to 4.8
Re-admission to critical care		9.4	5.1 to 15.6	2.8	1.9 to 3.9
Return to theatre		13.0	7.9 to 19.8	7.4	6.0 to 9.1
30 day readmission rate		2.1	0.3 to 7.4	8.3	6.5 to 10.3

Table 4.6: Postoperative details of complex TEVARS and FEVARs undertaken between January 2014 and December 2015

		TEVAR (n=205)		FEVAR (n=593)	
Admitted to	Ward	11.2%		16.4%	
	Level 2	59.0%		60.2%	
	Level 3	29.3%		23.4%	
	Died in theatre	0.5%		0.0%	
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	1	0 to 2	1	0 to 2
	Level 3	2	1 to 2	2	1 to 3
Hospital length of stay (days)		6	3 to 11	6	4 to 9
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital postoperative mortality		2.9	1.1 to 6.3	4.0	2.6 to 6.0
Re-admission to critical care		2.9	1.1 to 6.3	2.9	1.7 to 4.6
Return to theatre		8.3	4.9 to 13.0	7.8	5.7 to 10.2
30 day readmission rate		9.2	5.1 to 15.0	9.2	6.7 to 12.4

4.5 Conclusion: complex AAA

Complex aortic aneurysm repairs comprise a relatively small part of the overall vascular surgical workload, but they consume a greater proportion of the health care resources than infra-renal AAA repair. Moreover, it is an area that is evolving due to the continuing development of new complex endovascular grafts. Consequently, we primarily provide these results to support the commissioning of vascular services in this area.

We are currently unsure of the level of case-ascertainment for these procedures. The coding of complex aortic procedures in Hospital Episode Statistics (HES) prevents these procedures from being clearly identified. Consequently, we do not know if 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 be focused on ensuring the care for these patients is delivered safely. We would recommend 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.

5 Lower limb revascularisation

5.1 Introduction

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 [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 arterial disease and its treatment can be found on the Circulation Foundation website at:

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

In this section, we give results on the processes and outcomes of lower limb revascularisation procedures. We focus on the data entered into the NVR since January 2014 because the Registry has only collected data on endovascular as well as bypass procedures from this time. Prior to this, information was only captured on lower limb bypass. This is the second time that national figures have been presented together for endovascular and bypass procedures and the results describe the differences in the selection of patients for the two interventions, differences in some of the risk factors and also similarities and differences in procedure outcomes.

The number of lower-limb endovascular procedures recorded in the NVR has increased over the past two years. The 2015 Annual Report described 3,403 cases performed in 2014. In this report, we report on 7,614 procedures. Based on lower limb endovascular procedures recorded in routinely collected hospital admissions data, we estimated that the NVR captured approximately 17.0% of the procedures performed in 2014 and 21.1% in 2015.

Over the same two year period, the NVR received information on 11,389 bypass procedures, representing an estimated 90% case-ascertainment for lower limb bypass.

5.2 Characteristics of patients

Tables 5.1 and 5.2 summarise the patient characteristics and risk factors of patients undergoing these two procedures. The distributions of age and sex are comparable among patients undergoing bypass and endovascular procedures. Both procedures were 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 5.2).

Table 5.1: Patient characteristics of patients undergoing lower limb revascularisation between January 2014 and December 2015

	Endovascular		Bypass	
	No. of procs	**%**	**No. of procs**	**%**
Total procedures	7,614		11,389	
Age group (years)				
Under 60	1,179	15.5	2,245	19.8
60 to 64	879	11.5	1,470	13.0
65 to 69	1,164	15.3	2,025	17.8
70 to 74	1,269	16.7	1,891	16.7
75 to 79	1,182	15.5	1,734	15.3
80 and over	1,941	25.5	1,980	17.5
Men	4,994	65.6	8,247	72.4
Women	2,620	34.4	3,142	27.6
Smoking				
Current smoker	1,921	25.2	3,906	34.3
Ex-smoker	4,315	56.7	6,198	54.5
Never smoked	1,374	18.1	1,278	11.2
Previous ipsilateral limb procedure	2,406	31.6	4,397	38.6
Fontaine score				
1 Asymptomatic	262	3.5	180	1.7
2 Intermittent claudication	3,115	41.5	3,159	29.8
3 Nocturnal &/or resting pain	1,564	20.8	3,924	37.0
4 Necrosis &/or gangrene	2,564	34.2	3,339	31.5

Table 5.2: Risk factors among patients undergoing lower limb revascularisation between January 2014 and December 2015

	Endovascular		Bypass	
	No. of procs	**%**	**No. of procs**	**%**
Total procedures	7,614		11,389	
Comorbidities				
None	1,121	14.7	1,573	13.8
Hypertension	4,677	61.4	7,683	67.5
Ischaemic heart disease	2,576	33.8	4,296	37.7
Diabetes	2,973	39.1	3,588	31.5
Stroke	599	7.9	909	8.0
Chronic lung disease	1,122	14.7	2,377	20.9
Chronic renal disease	1,034	13.6	1,102	9.7
Chronic heart failure	508	6.7	631	5.5
Medication				
None	623	8.2	525	4.6
Anti-platelet	5,920	77.8	9,676	85.0
Statin	5,744	75.4	9,348	82.1
Beta blocker	1,838	24.1	2,691	23.6
ACE inhibitor/ARB	2,761	36.3	4,301	37.8

The NVR dataset includes the facility for the collection of the ankle brachial pressure index (ABPI). The collection of this ABPI is recommended for patient assessment by NICE guidance for PAD [NICE 2012], but it is only entered for a minority of endovascular (6.6%) and bypass (7.4%) procedures. Assuming these samples are representative, we note that the average ABPI for endovascular procedures was 0.63, a value in the middle of the range associated with moderate PAD (0.5 to 0.7). The average ABPI for bypass procedures was 0.49, which is just within the range associated for severe disease (under 0.5).

Table 5.3 summarises characteristics of lower limb bypass procedures, the majority of which were performed under general anaesthetic. The most common anatomical location for the bypass procedure was a femoral to above knee (popliteal) procedure (22.2%), followed by femoral to below knee bypass (18.9%). Most graft types were autologous or prosthetic making over 80% of procedures.

The majority of endovascular procedures were performed under local anaesthetic (88.3%). Angioplasty in isolation was the dominant technique, with a stent being used in just 14.8% of procedures. When individual and combinations of angioplasties were categorised according to the highest anatomical level of procedure, just under a third were iliac procedures (30.2%), and about two thirds were femoro-popliteal procedures (59.9%). The remainder were tibial or pedal (8.1%) and aortic (1.8%) angioplasties. In terms of the immediate outcomes, 89.1% of all endovascular procedures were recorded as being successful. Residual stenosis was recorded in 5.3% of procedures, and 5.6% were noted as failures. These proportions did not vary between 2014 and 2015 (chi-square test, p=0.8).

Table 5.3: Characteristics of lower limb bypass procedures undertaken between January 2014 and December 2015

	Procedures (n=11,389)	**%**
Anaesthetic Type		
General	8,191	71.9
Regional	1,604	14.1
GA + regional	1,226	10.8
Other	368	3.2
Bypass location		
Femoral – femoral	818	7.2
Femoral – above knee	2,526	22.2
Femoral – below knee	2,153	18.9
Femoral – tibial	1,650	14.5
Other	4,346	38.2
Endarterectomy		
Alone	835	7.3
Adjunct to bypass	4,301	37.8
Graft type		
Autologous	5,170	45.4
Biological	918	8.1
Prosthetic	4,140	36.4
Vein and prosthetic	377	3.3

The outcomes of the revascularisation procedures are summarised in Table 5.4. Few patients required admission to critical care and 12% of endovascular procedures were performed in day care units. In-hospital postoperative mortality rates were 1.6% (95% CI 1.4 to 1.9) for endovascular procedures and 3.0% (95% CI 2.7 to 3.3) for lower limb bypass. Complications were relatively uncommon and over 90% of patients did not require further unplanned intervention. Indeed, a key outcome measure for both endovascular and bypass procedures is patient survival free of amputation. We note that national rates of unplanned amputation during the same admission were low (<5%).

Table 5.4: Postoperative outcomes for patients undergoing lower limb revascularisation between January 2014 and December 2015

		Endovascular		Bypass	
		No. of procs	%	No. of procs	%
Total procedures		7,614		11,389	
Admitted to	Ward	6,435	84.5	8,085	71.0
	Level 2	178	2.3	2,573	22.6
	Level 3	57	0.8	722	6.3
	Day case unit[1]	815	19.4	N/A	N/A
	Died in theatre	<5	0.0	<5	0.0
		Median	***IQR***	***Median***	***IQR***
Days in critical care:	Level 2	0	0 to 1	1	0 to 2
	Level 3	2	1 to 4	2	1 to 4
Hospital length of stay (days)		1	0 to 7	8	4 to 16
		Rate	***95% CI***	***Rate***	***95% CI***
In-hospital mortality rate		1.6	1.4 to 1.9	3.0	2.7 to 3.3
Defined complications					
Cardiac		2.0	1.7 to 2.4	3.5	3.2 to 3.9
Respiratory		1.6	1.3 to 1.9	4.5	4.1 to 4.9
Haemorrhage		0.6	0.4 to 0.8	2.1	1.9 to 2.4
Limb ischaemia		1.8	1.5 to 2.1	5.6	5.2 to 6.0
Renal failure		0.4	0.3 to 0.6	1.5	1.3 to 1.7
Other		0.1	0.04 to 0.2	0.5	0.4 to 0.6
None of predefined		94.2	93.6 to 94.7	85.4	84.7 to 86.0
Further unplanned lower limb procedure					
None		93.4	92.8 to 94.0	91.1	90.6 to 91.6
Angioplasty without stent		1.1	0.9 to 1.3	0.9	0.7 to 1.1
Angioplasty with stent		0.6	0.4 to 0.8	0.4	0.3 to 0.5
Lower limb bypass		1.5	1.3 to 1.8	2.8	2.5 to 3.1
Amputation at any level		3.0	2.6 to 3.4	3.8	3.5 to 4.2
Re-admission to higher level of care		1.1	0.9 to 1.4	2.7	2.4 to 3.0
Readmission within 30 days		8.8	8.0 to 9.5	10.5	9.8 to 11.1

1 These figures are based on procedures performed in 2015, when the data item became available within the NVR IT system.

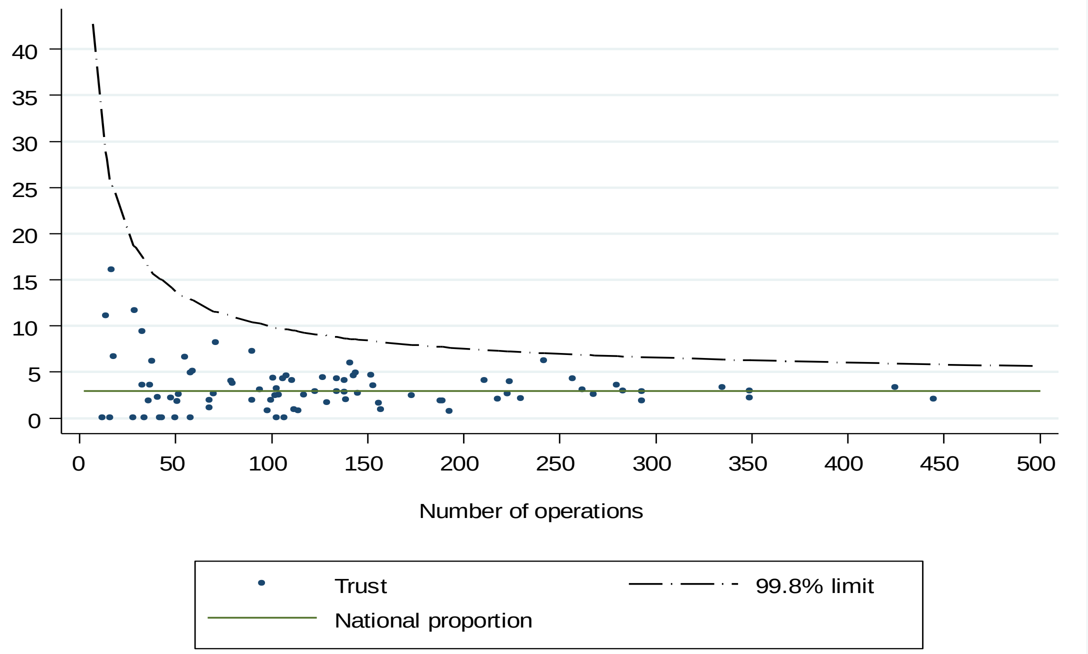
5.3 Rates of in-hospital death among NHS trusts

Risk-adjusted rates of in-hospital death for lower limb bypasses and 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. Risk adjustment model took into account the following characteristics: age, Fontaine score, anatomy of procedure, ASA grade, presence of renal disease and chronic lung disease.

Figure 5.1 shows the funnel plot of risk-adjusted mortality rates for the bypass procedures performed between January 2014 and December 2015. All the NHS trusts had a risk adjusted rate of in-hospital death that fell within the expected range given the number of procedures performed.

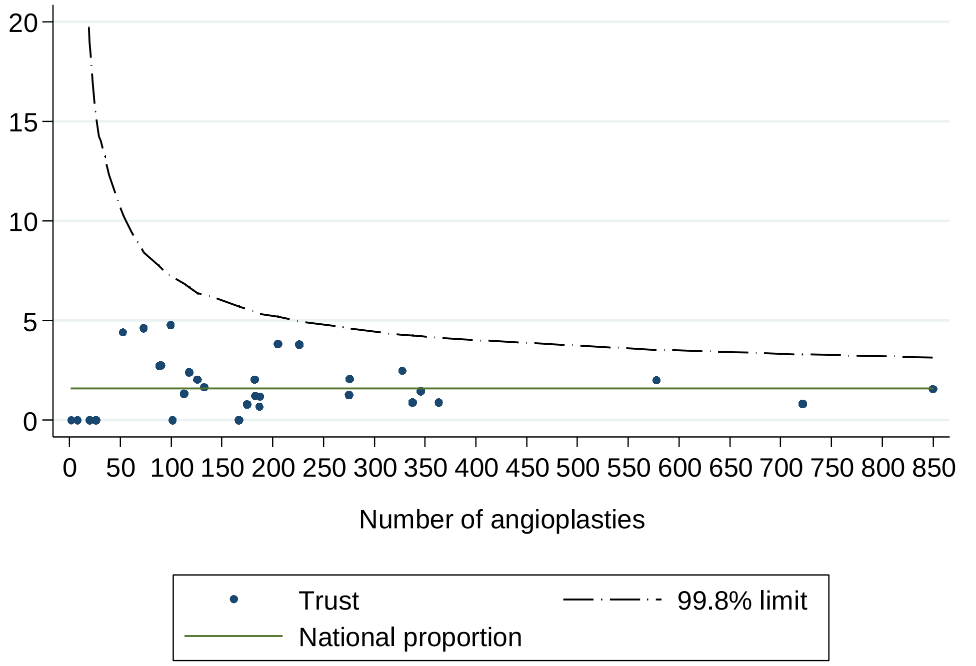
Risk-adjusted rates of in-hospital death for lower limb endovascular procedures were also calculated for vascular units. Given the low levels of case-ascertainment, the figures were limited to NHS trusts with an estimated case-ascertainment of 20% or more. The risk-adjustment model for these procedures took account of patient age, sex, Fontaine score, mode of admission, chronic lung disease and chronic heart disease.

Figure 5.1: Funnel plot of risk-adjusted in-hospital deaths of a lower limb bypass for NHS trusts, shown in comparison to the overall average of 3.0% for procedures performed between January 2014 and December 2015



The risk-adjusted mortality rates for NHS organisations performing lower limb endovascular procedures are displayed in Figure 5.2. All the NHS trusts had a risk adjusted rate of in-hospital death that fell within the expected range given the number of procedures performed. Appendix 7 gives the figures for both procedures by NHS trust.

Figure 5.2: Funnel plot of risk-adjusted in-hospital deaths of a lower limb angioplasty for NHS trusts, shown in comparison to the overall average of 1.6% for procedures performed between January 2014 and December 2015



The very low case-ascertainment for endovascular procedures are disappointing and it prevents the NVR from making any firm statements about the national picture. We are limited to commenting that, among the NHS trusts that have participated, care was being delivered safely. It is vital for hospital governance, medical revalidation and commissioning of vascular services that NHS trusts encourage a more active approach to submitting data on endovascular lower limb procedures to the NVR.

The outcomes for lower limb bypass are in line with recent literature, with a postoperative in-hospital mortality of 3.0%. However, for both bypass and endovascular procedures, the observed 10% 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 the cause of these readmissions.

6. Major Lower limb Amputation

6.1 Introduction

The analyses presented in this chapter describe the patterns of care and outcomes for patients who had a major lower limb amputation recorded in the NVR between 1 January 2014 and 31 December 2015. This report focuses on unilateral amputations related to vascular disease as these are the most common procedures. Records of bilateral amputations (n=132) and amputations due to trauma (n=44) were excluded from the analyses. Amputations that were performed after a lower leg bypass during the same admission are also not described in this report. It has been possible to enter details of joint bypass-amputation records in the NVR IT system only since January 2016, which is after the 2-year period described in this report.

Information on 5,318 major unilateral lower limb amputations was recorded in the NVR over the two-year data collection period, of which 2,542 were undertaken 2014 and 2,776 in 2015. Based on numbers of amputations recorded in routinely collected hospital admission data, we estimated that the case-ascertainment was approximately 53.0% in 2014 and 57.8% in 2015.

6.2 Characteristics of patients having lower limb amputations

Characteristics of the patients undergoing major unilateral lower limb amputations are summarised in Table 6.1, distinguishing between above knee amputations (AKAs) and below knee amputations (BKAs). The two types of procedure were distributed differently across the age groups, with BKAs being more common in patients under 60 years and AKAs more common in patients older than 80 years. Men made up 70% of the population group, and many patients were either current or ex-smokers.

The most common presenting problem was tissue loss (39.9% of BKAs and 35.4% of AKAs). For AKA patients, acute or chronic limb ischaemia were also common. Among the BKA patients, the second most common presenting problem was uncontrolled infection. Over a half of the patients had undergone a previous ipsilateral limb procedure.

Table 6.1: Characteristics of patients undergoing major unilateral lower limb amputation during 2014 and 2015

	Below knee	%	Above knee	%
Procedures	3,190		2,128	
Age group (years)				
Under 60	832	26.2	343	16.1
60 to 64	367	11.5	205	9.6
65 to 69	455	14.3	292	13.7
70 to 74	444	13.9	328	15.4
75 to 79	467	14.6	347	16.3
80 and over	622	19.5	613	28.8
Men	2,367	74.2	1,458	68.5
Women	823	25.8	670	31.5
Smoking				
Current	833	26.2	721	34.0
Ex-	1,548	48.6	1,056	49.8
Never	802	25.2	345	16.3
Presenting problem				
Acute limb ischaemia	313	9.8	481	22.6
Chronic limb ischaemia	596	18.7	481	22.6
Neuropathy	64	2.0	19	0.9
Tissue loss	1,271	39.9	754	35.5
Uncontrolled infection	933	29.3	368	17.3
Aneurysm	50	0.2	24	1.1
Previous ipsilateral limb procedure	2,001	62.8	1,311	61.7

The majority of patients had severe comorbid disease, indicated by ASA grades in Table 6.2. Approximately 60% of patients, regardless of the level of amputation, had hypertension. Diabetes and ischaemic heart disease were common comorbidities in both amputations groups. Just over 70% of patients in both groups were taking anti-platelet medication or statins and about a quarter to a third of the patients were on beta blockers, ACE inhibitors or ARBs.

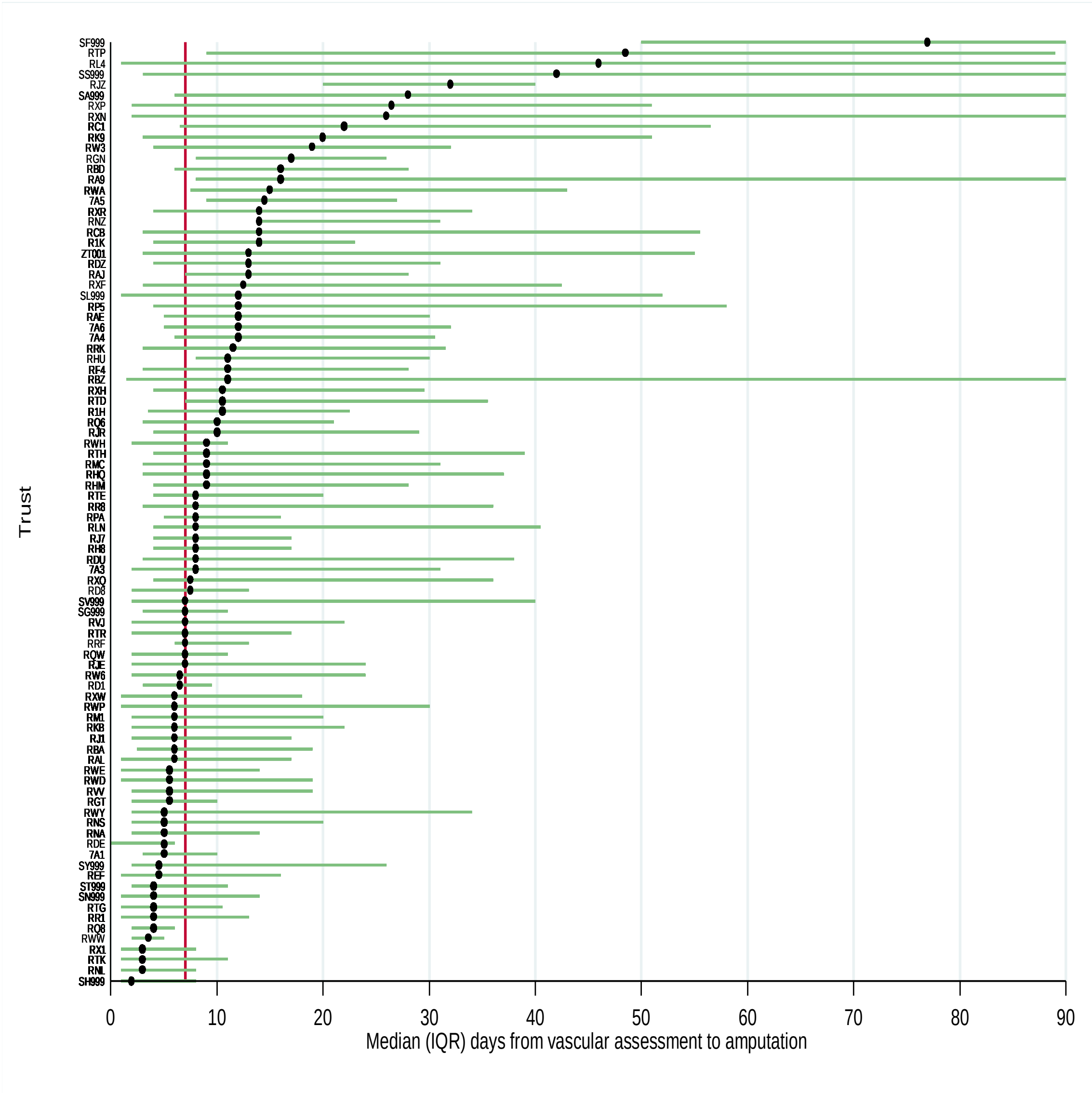
Table 6.2: Preoperative risk profile of patients undergoing lower limb amputation during 2014 and 2015

	Below knee	%	Above knee	%
Procedures	3,190		2,127	
ASA grade				
1 Normal	18	0.6	6	0.3
2 Mild disease	404	12.7	133	6.3
3 Severe, not life-threatening	2,222	69.7	1,293	60.8
4-5 Severe, life-threatening, or moribund patient	544	17.0	695	32.7
Comorbidities				
None	263	8.2	210	9.9
Hypertension	1,904	59.7	1,324	62.2
Ischaemic heart disease	1,201	37.7	908	42.7
Diabetes	2,157	67.6	873	41.0
Stroke	297	9.3	322	15.1
Chronic lung disease	444	13.9	551	25.9
Chronic renal disease	709	22.2	398	18.7
Chronic heart failure	268	8.4	230	10.8
Medication				
None	299	9.4	220	10.3
Anti-platelet	2,292	71.9	1,538	72.3
Statin	2,319	72.7	1,496	70.3
Beta blocker	836	26.2	564	26.5
ACE inhibitor/ARB	1,086	34.0	672	31.6

6.3 Timelines along the clinical pathway

In their 2014 report into lower limb amputation, the NCEPOD observed considerable variation between NHS trusts in the pre-operative process of care [NCEPOD 2014]. The data in the NVR supports this finding. Nationally, the median time from vascular assessment to amputation was seven days (interquartile range: 2 to 23 days), but there were considerable differences in this time across organisations. Figure 6.1 describes the variation among NHS trusts for those that had 10 or more major lower limb amputations with assessment and procedure dates. The median time is represented by a black dot. The interquartile ranges (IQRs) are shown by horizontal green lines.

Figure 6.1: Median (IQR) time from vascular assessment to amputation for procedures performed during 2014 and 2015, by NHS trust



There are various reasons for patients to wait different times for an amputation. In some circumstances, it is necessary to wait for adjunctive procedures which prevent a high level of amputation or which promote good healing/recovery. However, this is unlikely to explain the extent of the wide variation between NHS trusts shown in Figure 6.1 and vascular units should investigate the causes of this variation in delays before surgery

6.4 Perioperative care

Most lower limb amputations in the NVR were not planned: 74.9% of BKAs and 81.4% of AKAs were emergency procedures. Over 80% of all amputations were performed during the day, but a proportion of procedures were also undertaken during the evenings and nights (Table 6.3). In the 3 months during which data were available, a consultant surgeon was present in theatre in nearly 80% of amputations. General anaesthetic, alone or in combination with other methods, was used in 68% of BKAs and 69% of AKAs.

Primary wound closure was used in 70% of BKA and 86% of AKA. The wound was left open in approximately 17% of BKAs and only 3% of AKAs. Skin flaps were used in 14% of BKAs and 11% of AKAs.

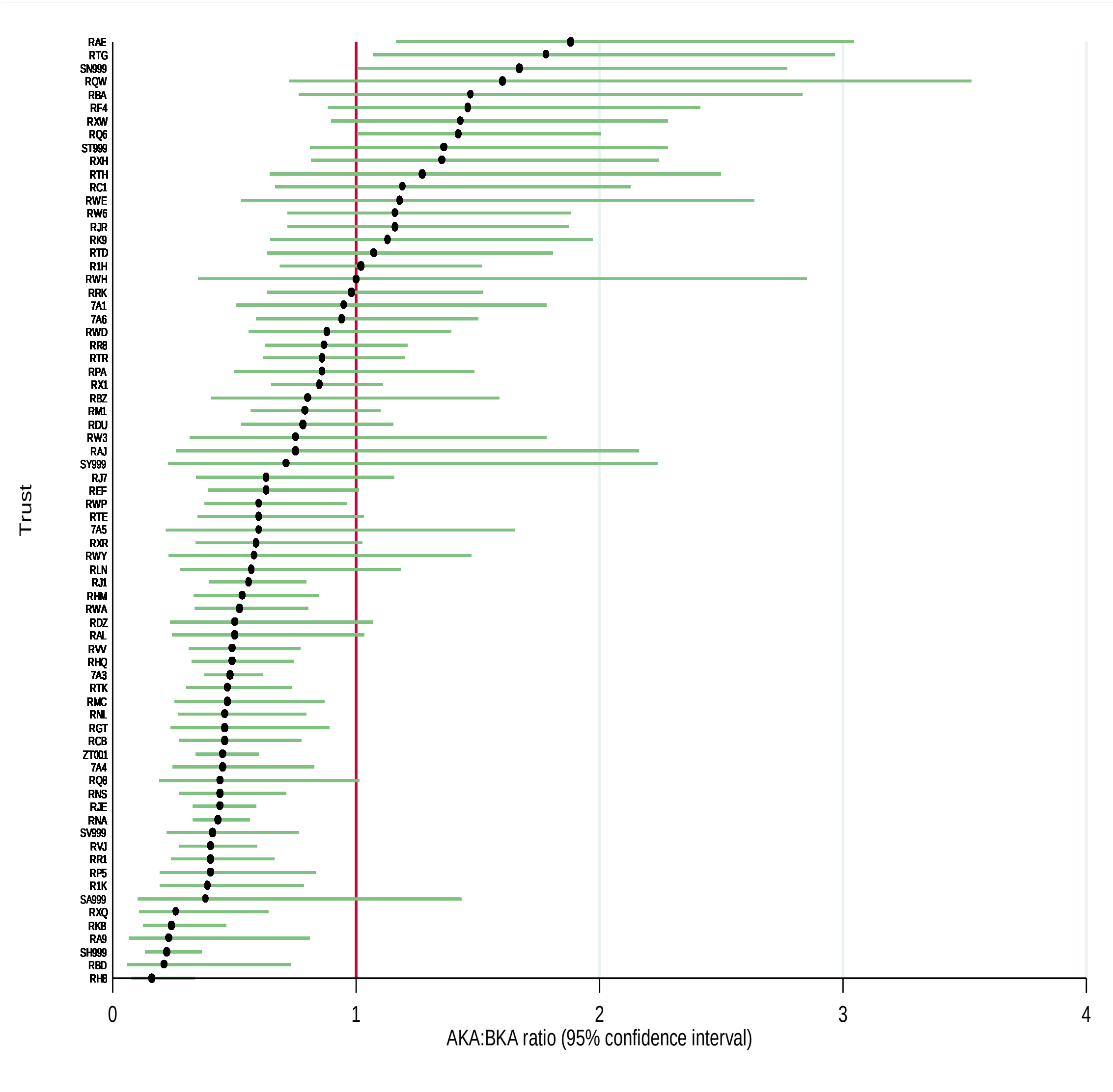
Table 6.3: Perioperative care of patients undergoing lower limb amputation during 2014 and 2015

	Below knee	**%**	**Above knee**	**%**
Procedures	3,190		2,128	
Admission				
Emergency	2,388	74.9	1,733	81.4
Elective	802	25.1	395	18.6
Time procedure started				
Day (8am-6pm)	2,687	84.2	1,711	80.4
Evening (6pm-midnight)	424	13.3	347	16.3
Night (midnight-8am)	79	2.5	70	3.3
Consultant present in theatre[1]	270	79.0	234	80.4
Prophylactic medication[1]				
Antibiotic prophylaxis	194	56.7	166	57.0
DVT prophylaxis	195	57.0	181	62.2

[1] These figures are based on amputations performed between 1 October and 31 December 2015, when the data items became available within the NVR IT system.

Approximately 60% of the major lower limb amputations recorded in the NVR were below knee amputations (n=3,190) and 40% were above knee amputations (n=2,128). Overall, the AKA:BKA ratio was 0.68, and the ratio was similar in both 2014 (=0.64) and 2015 (=0.69). Approximately two thirds of the NHS trusts had a ratio less than one and the remaining third had a ratio of one or above (Figure 6.2).

Figure 6.2: Ratio of above knee to below knee amputations during 2014 and 2015 by NHS trust[1]



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

6.5 Postoperative outcomes after major amputation

Overall, most patients (89.0% of BKA and 75.5% of AKA patients) were returned to the ward following amputation (Table 6.4). Of BKA patients, 8.1% went to a level 2 intensive care unit and 2.9% to a level 3 unit. These proportions were slightly higher for AKA patients, of whom 15.8 went on to receive to level 2 and 8.7% to level 3 intensive care. On average, amputation patients spent less than a day in intensive care. This is comparatively short given the typical duration of hospitalisation. The median length of hospital stay associated with lower limb amputations was 22 days (IQR: 12 to 39 days).

It is perhaps not surprising, therefore, that about 3% of amputation patients were returned to higher level of care at some point during their admission.

Table 6.4: Patient outcomes following lower limb amputation between 2014 and 2015

	Below knee (n=3,190)		**Above knee (n=2,128)**	
Destination after procedure				
Ward	89.0		75.5	
Level 2 unit	8.1		15.8	
Level 3 unit	2.9		8.7	
	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 9	4	2 to 9
Length of stay (days)	22	12 to 39	23	13 to 39
	Rate	**95% CI**	**Rate**	**95% CI**
In hospital mortality	5.6	4.8 to 6.4	12.4	11.0 to 13.8
Procedure complications				
Cardiac	4.5	3.8 to 5.3	8.5	7.3 to 9.7
Respiratory	6.9	6.1 to 7.9	13.0	11.6 to 14.5
Cerebral	0.8	0.5 to 1.2	1.0	0.6 to 1.5
Haemorrhage	0.7	0.4 to 1.0	0.8	0.4 to 1.2
Limb ischaemia	5.6	4.8 to 6.4	4.4	3.5 to 5.4
Renal failure	3.2	2.6 to 3.9	5.4	4.4 to 6.4
None of predefined	82.7	81.3 to 84.0	76.4	74.5 to 78.2
Return to theatre	12.5	11.4 to 13.7	8.0	6.8 to 9.2
Readmission to higher level of care	3.3	2.7 to 4.0	3.4	2.7 to 4.2

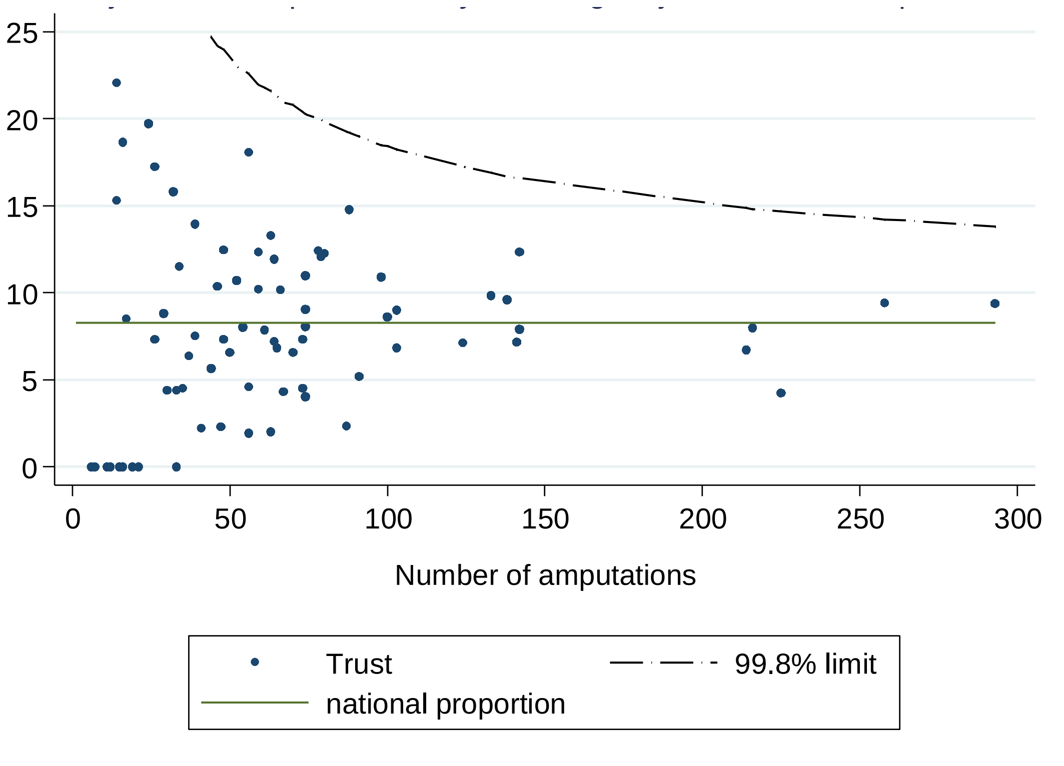
Most procedures did not have reported complications. The most common complications were respiratory problems, which occurred in 6.9% of BKAs and 13.0% of AKAs. Rates of return to theatre within the admission were 12.5% for BKA and 8.0% for AKA. Overall, a large proportion of patients were discharged from hospital alive, with in-hospital deaths reported to be 5.6% for BKA and 12.4% for AKA. About two thirds were referred to rehabilitation units or limb fitting centres (Table 6.5). Just over half of patients' wounds had healed by 30 days, but this increase slightly by the time the patient was discharged. Just under 1 in 10 patients were readmitted to hospital within 30 days of discharge.

Table 6.5: Discharge and follow-up of patients undergoing lower limb amputations occurring between 2014 and 2015, among patients discharged alive

	Below knee (n=3,012)	%	Above knee (n=1,865)	%
Wound healed at discharge	1,835	60.9	1,387	74.4
Wound healed at 30 days	1,508	50.1	1,107	59.4
Referred to rehabilitation or limb fitting	2,025	67.2	1,313	70.4
Readmission to hospital within 30 days	273	9.1	135	7.2

Adjusted in-hospital mortality following major unilateral lower limb amputation is shown, by NHS trust, in Figure 6.3. The rates were adjusted for patient age, sex, mode of admission, ASA grade, diabetes, chronic renal disease and level of amputation (above vs. below the knee). As shown in Figure 6.3, all NHS trusts had postoperative mortality rates that fell within the 99.8% control limits around the national average of 8.3%. However, the low case-ascertainment limits the generalisability of these observations. Appendix 8 gives the figures by NHS trust.

Figure 6.3: Inpatient mortality following lower limb amputation between 2014 and 2015, by NHS trust



6.6. Conclusion

In April 2016, The Vascular Society of Great Britain and Ireland (VSGBI) revised the 2010 Amputation Quality Improvement Framework (QIF), producing a recommendation titled *A Best Practice Clinical Care Pathway for Major Amputation Surgery*. The overarching aim of the best practice pathway is to reduce and maintain the reduction of the 90-day mortality following major lower limb amputation to 10% or less nationally. The VSGBI's best practice pathway includes recommendations for NHS Trusts, as well as detailed recommendations on all phases of the clinical care pathway.

The VSGBI Amputation QIF [2016] recommends that below the knee amputation should be undertaken where appropriate; vascular units should aim to have an above the knee to below the knee amputation ratio below one. We found that, in 2014 and 2015, the AKA:BKA ratio was 0.68 and about two thirds of the NHS trusts had ratios that met this recommendation. A number of NHS trusts, however, reported a ratio exceeding one, and these organisations need to examine whether this is a cause of concern.

Important recommendations in the Amputation QIF [VSGBI 2016] related to the perioperative phase of care include:

1. Amputations should be undertaken on a planned operating list during normal working hours
2. A Consultant Vascular Surgeon should operate, or be present in the theatre to supervise a senior trainee (ST4 or above) undertaking the amputation
3. Patient should have routine antibiotic and DVT prophylaxis according to local policy

The NVR data suggest that vascular services are on their way to meeting these standards. During 2014 and 2015, most amputations reported to the NVR were performed during normal working hours (84% of BKAs and 80% of AKAs were recorded as starting between 8am and 6pm). The NVR has been collecting information on the other standards for a shorter period of time, but in the latter period of 2015, a consultant was present in theatre in 78% of BKAs and 80% of AKAs. The routine use of antibiotic and DVT prophylaxis was comparatively low being around 60%. NHS trusts should aim to improve their pathways, and ensure accurate recording of information on these measures in the NVR.

In terms of monitoring performance, the VSGBI recommends that

1. All vascular amputations should be recorded in the National Vascular Registry
2. Information produced by the NVR should be reviewed to determine areas for improvement locally

At present, case-ascertainment for lower limb amputations is just over 50% and it is essential that this improves. NHS trusts should focus their attention on ensuring that all major amputations are recorded within the NVR: this will ensure that the Registry is able to provide accurate and precise information on amputation care in NHS hospitals, and the NHS trusts will be able to better monitor their own performance against the VSGBI's recommendations for best practice.

7. Tools for quality improvement

The National Vascular Registry aims to be the national source in the UK for comparative information on the five major vascular procedures. To achieve this depends upon high levels of case-ascertainment, something that has been achieved for elective infra-renal AAA repair, carotid endarterectomy and lower-limb bypass procedures. For lower-limb endovascular and major amputation procedures, there has been a steady increase in coverage but there needs to be considerable improvement in both areas.

The NVR has developed IT-based online reports as tools for hospitals to monitor data entry and the quality of care on a regular basis. Two reports are designed to provide an overall picture of practice, either in terms of activity over time (Figure 7.1) or in terms of the characteristics of patients having surgery (Figure 7.2). Both contain options that allow the results to be tailored to the user's requirements. We encourage local vascular units to use these two reports to monitor the degree to which all eligible patients are being entered in the NVR IT system.

Figure 7.1: Online report that describes levels of activity over time, by procedure

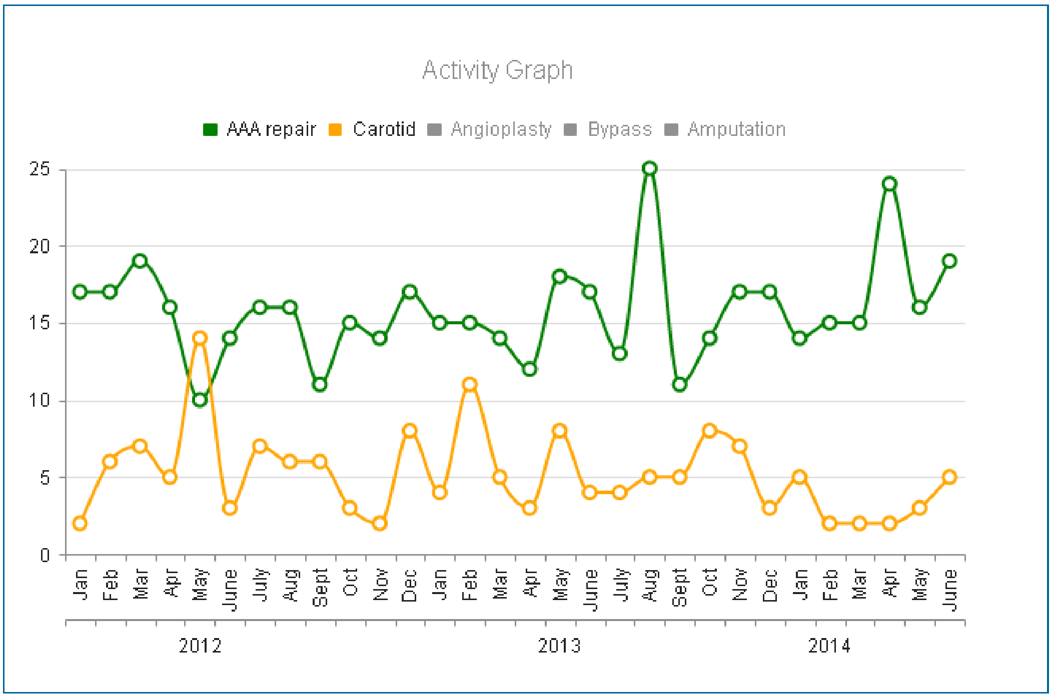
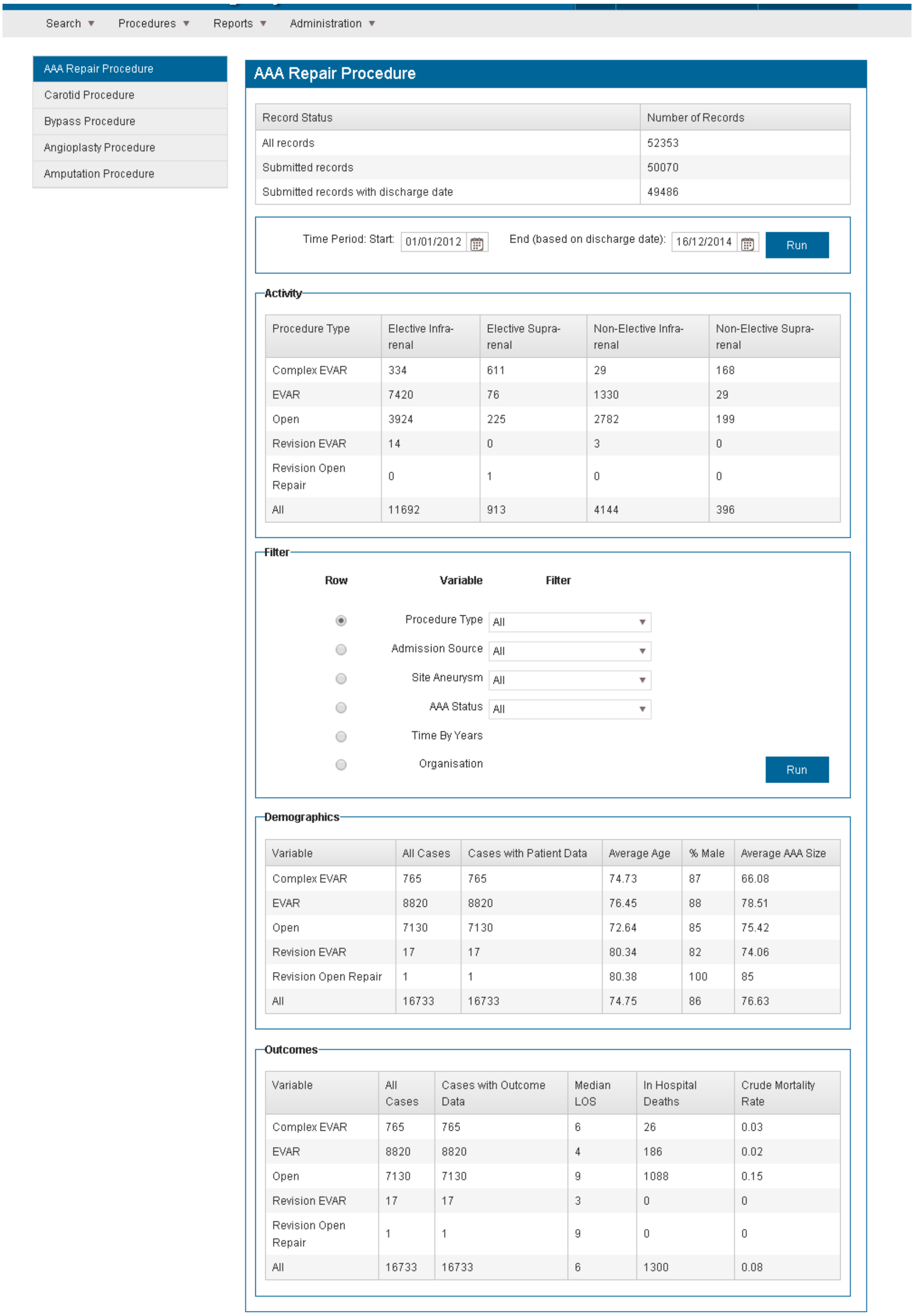


Figure 7.2: Online report that gives an overview of patient characteristics and outcomes



Search ▾ Procedures ▾ Reports ▾ Administration ▾

AAA Repair Procedure
Carotid Procedure
Bypass Procedure
Angioplasty Procedure
Amputation Procedure

AAA Repair Procedure

Record Status	Number of Records
All records	52353
Submitted records	50070
Submitted records with discharge date	49486

Time Period: Start: 01/01/2012 End (based on discharge date): 16/12/2014 Run

Activity

Procedure Type	Elective Infra-renal	Elective Supra-renal	Non-Elective Infra-renal	Non-Elective Supra-renal
Complex EVAR	334	611	29	168
EVAR	7420	76	1330	29
Open	3924	225	2782	199
Revision EVAR	14	0	3	0
Revision Open Repair	0	1	0	0
All	11692	913	4144	396

Filter

Row	Variable	Filter
◉	Procedure Type	All
○	Admission Source	All
○	Site Aneurysm	All
○	AAA Status	All
○	Time By Years	
○	Organisation	

Run

Demographics

Variable	All Cases	Cases with Patient Data	Average Age	% Male	Average AAA Size
Complex EVAR	765	765	74.73	87	66.08
EVAR	8820	8820	76.45	88	78.51
Open	7130	7130	72.64	85	75.42
Revision EVAR	17	17	80.34	82	74.06
Revision Open Repair	1	1	80.38	100	85
All	16733	16733	74.75	86	76.63

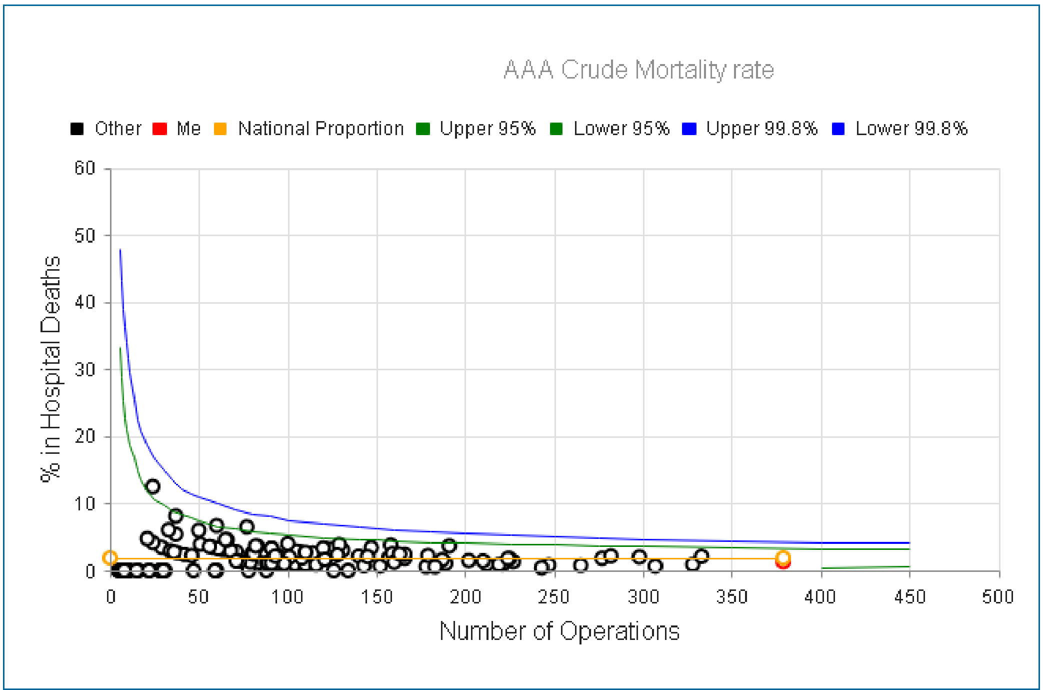
Outcomes

Variable	All Cases	Cases with Outcome Data	Median LOS	In Hospital Deaths	Crude Mortality Rate
Complex EVAR	765	765	6	26	0.03
EVAR	8820	8820	4	186	0.02
Open	7130	7130	9	1088	0.15
Revision EVAR	17	17	3	0	0
Revision Open Repair	1	1	9	0	0
All	16733	16733	6	1300	0.08

The other two online reports give vascular specialists and units the ability to view comparative information on the outcome of care. One of these produces a funnel plot of unadjusted postoperative in-hospital mortality rates for a user-defined cohort of patients and procedures, similar to the graphs in this report (Figure 7.3). This online version cannot be considered a definitive evaluation because the data do not undergo the extensive data checking and risk-adjustment process that occurs when we produce the Annual reports and consultant-outcome figures. Nonetheless, the report gives an indication of how the outcomes of a vascular unit / specialist compare to the results of others and so enable hospitals to monitor and benchmark performance in-between the publication of the annual reports.

We encourage vascular specialists and hospitals to use these online tools to support their local clinical audit and quality improvement activities.

Figure 7.3: Online report that enables an individual to examine unadjusted outcomes in comparison to the national rate



OrganisationName	All Cases	Cases with Outcome Data	In Hospital Deaths	Motality Rate
	379	379	5	1.32

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

Prof I Loftus	Chair	Vascular Society of GB&I
Miss R Bell		Vascular Society of GB&I
Mr J Boyle		Vascular Society of GB&I
Mr M Clarke		Vascular Society of GB&I
Mr D Harkin		Vascular Society of GB&I
Mr M Jenkins		Vascular Society of GB&I
Mr J J Earnshaw		National AAA Screening Programme
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 J van der Meulen, Chair	Royal College of Surgeons of England
Mr K Varty	Vascular Society of GB&I
Dr F Miller	British Society of Interventional Radiology
Mr C Clifford-Jones	Patient Representative
Ms S Hewitt	HQIP
Mr D McKinlay	HQIP
Ms Caroline Junor	Northgate Public Services (UK) Limited
Mr P Rottier	Northgate Public Services (UK) Limited

Plus members of the project / delivery team: Prof Ian Loftus (Lead Clinician), Prof David Cromwell, Dr Katriina Heikkila, Dr Amundeep Johal, and Mr Sam Waton

Appendix 2: NHS organisations that perform vascular surgery

Code	Organisation Name	AAA	CEA	Angio	Byp	Amp
7A1	Betsi Cadwaladr University Local Health Board	Yes	Yes	Yes	Yes	Yes
7A3	Abertawe Bro Morgannwg University Local Health Board	Yes	Yes	Yes	Yes	Yes
7A4	Cardiff and Vale University Local Health Board	Yes	Yes	Yes	Yes	Yes
7A5	Cwm Taf Local Health Board	Yes	Yes	Yes	Yes	Yes
7A6	Aneurin Bevan Local Health Board	Yes	Yes	Yes	Yes	Yes
R1H	Barts Health NHS Trust	Yes	Yes	Yes	Yes	Yes
R1K	London North West Healthcare NHS Trust	Yes	Yes	Yes	Yes	Yes
RA9	South Devon Healthcare NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RAE	Bradford Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RAJ	Southend University Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RAL	Royal Free London NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RBA	Taunton and Somerset NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RBD	Dorset County Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RBN	St Helens & Knowsley Teaching Hospitals NHS Trust	No	No	Yes	No	No
RBZ	Northern Devon Healthcare NHS Trust	No	No	Yes	Yes	Yes
RC1	Bedford Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RCB	York Teaching Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RDD	Basildon and Thurrock University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RDE	Colchester Hospital University NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RDU	Frimley Health NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RDZ	Royal Bournemouth and Christchurch Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
REF	Royal Cornwall Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
REM	Aintree University Hospital NHS Foundation Trust	No	No	Yes	No	No
RF4	Barking, Havering And Redbridge University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RGN	Peterborough and Stamford Hospitals NHS Foundation Trust	No	No	Yes	No	No
RGR	West Suffolk NHS Foundation Trust	No	No	Yes	No	No
RGT	Cambridge University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RH8	Royal Devon and Exeter NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RHM	University Hospital Southampton NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RHQ	Sheffield Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes

Code	Organisation Name	AAA	CEA	Angio	Byp	Amp
RHU	Portsmouth Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RHW	Royal Berkshire NHS Foundation Trust	No	No	Yes	No	No
RJ1	Guy's and St Thomas' NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RJ7	St George’s Healthcare NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RJE	University Hospital of North Midlands NHS Trust	Yes	Yes	Yes	Yes	Yes
RJR	Countess of Chester Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RJZ	King's College Hospital NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RK9	Plymouth Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RKB	University Hospitals Coventry and Warwickshire NHS Trust	Yes	Yes	Yes	Yes	Yes
RL4	Royal Wolverhampton Hospitals NHS Trust	No	No	Yes	No	No
RLN	City Hospitals Sunderland NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RM1	Norfolk and Norwich University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RM2	University Hospital of South Manchester NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RMC	Bolton NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RNA	The Dudley Group NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RNL	North Cumbria University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RNS	Northampton General Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RNZ	Salisbury NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RP5	Doncaster and Bassetlaw Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RPA	Medway NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RQ6	Royal Liverpool and Broadgreen University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RQ8	Mid Essex Hospital Services NHS Trust	Yes	Yes	Yes	Yes	Yes
RQQ	Hinchingbrooke Health Care NHS Trust	No	No	Yes	No	No
RQW	Princess Alexandra Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RR1	Heart of England NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RR7	Gateshead Health NHS Foundation Trust	No	Yes	Yes	Yes	Yes
RR8	Leeds Teaching Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RRK	University Hospitals Birmingham NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RRV	University College London Hospitals NHS Foundation Trust	No	Yes	Yes	Yes	No
RTD	Newcastle upon Tyne Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RTE	Gloucestershire Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RTG	Derby Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RTH	Oxford University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RTK	Ashford And St Peter's Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RTR	South Tees Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes

Code	Organisation Name	AAA	CEA	Angio	Byp	Amp
RVJ	North Bristol NHS Trust	Yes	Yes	Yes	Yes	Yes
RVV	East Kent Hospitals University NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RW3	Central Manchester University Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RW6	Pennine Acute Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWA	Hull and East Yorkshire Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWD	United Lincolnshire Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWE	University Hospitals of Leicester NHS Trust	Yes	Yes	Yes	Yes	Yes
RWG	West Hertfordshire Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWH	East and North Hertfordshire NHS Trust	Yes	Yes	Yes	Yes	Yes
RWP	Worcestershire Acute Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RWY	Calderdale and Huddersfield NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RX1	Nottingham University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RXF	Mid Yorkshire Hospitals NHS Trust	No	No	Yes	No	No
RXH	Brighton and Sussex University Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RXN	Lancashire Teaching Hospitals NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RXP	County Durham and Darlington NHS Foundation Trust	Yes	Yes	Yes	Yes	Yes
RXQ	Buckinghamshire Healthcare NHS Trust	No	Yes	Yes	Yes	Yes
RXR	East Lancashire Hospitals NHS Trust	Yes	Yes	Yes	Yes	Yes
RXW	Shrewsbury and Telford Hospital NHS Trust	Yes	Yes	Yes	Yes	Yes
RYJ	Imperial College Healthcare NHS Trust	Yes	Yes	Yes	Yes	Yes
SA999	NHS Ayrshire & Arran	Yes	Yes	Yes	Yes	Yes
SF999	NHS Fife	No	Yes	Yes	Yes	Yes
SG999	NHS Greater Glasgow and Clyde	Yes	Yes	Yes	Yes	Yes
SH999	NHS Highland	Yes	Yes	Yes	Yes	Yes
SL999	NHS Lanarkshire	Yes	Yes	Yes	Yes	Yes
SN999	NHS Grampian	Yes	Yes	Yes	Yes	Yes
SS999	NHS Lothian	Yes	Yes	Yes	Yes	Yes
ST999	NHS Tayside	Yes	Yes	Yes	Yes	Yes
SV999	NHS Forth Valley	Yes	Yes	Yes	Yes	Yes
SY999	NHS Dumfries and Galloway	No	Yes	Yes	Yes	Yes
ZT001	Belfast Health and Social Care Trust	Yes	Yes	Yes	Yes	Yes

Appendix 3: Carotid endarterectomy

Trust code	Estimated cases	NVR cases	Case-ascert.	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	Median delay and IQR from index symptom to surgery (days)	Median(IQR) length of stay (days)	% Adjusted Stroke and/or death rate
7A1	33	31	94%	29	75.0%	46.7%	55.2%	13 (9 - 37)	2 (1 - 5)	0.9%
7A3	109	116	106%	110	56.0%	72.4%	60.9%	12 (7 - 25)	4 (3 - 7)	3.0%
7A4	34	37	109%	32	81.3%	45.9%	62.5%	10 (5 - 22)	4 (3 - 11)	0.0%
7A5	23	24	104%	24	58.3%	37.5%	37.5%	19 (12 - 34)	3 (2 - 6)	2.7%
7A6	51	53	104%	51	72.0%	56.6%	76.5%	11 (8 - 14)	1 (1 - 6)	2.0%
R1H	40	40	100%	28	75.0%	52.5%	57.1%	9 (5 - 24)	5 (3 - 9)	2.3%
R1K	37	38	103%	36	88.6%	73.7%	88.9%	8 (6 - 11)	7 (4 - 12)	1.7%
RA9	25	27	108%	27	84.6%	48.1%	76.9%	9 (8 - 14)	2 (1 - 3)	0.0%
RAE	43	44	102%	41	78.0%	57.1%	80.5%	11 (7 - 14)	3 (3 - 4)	0.0%
RAJ	28	28	100%	26	92.3%	85.2%	96.2%	8 (6 - 10)	9 (7 - 13)	0.8%
RAL	19	6	32%	5	40.0%	33.3%	40.0%	20 (13 - 24)	4 (1 - 5)	0.0%
RBA	70	74	106%	74	72.6%	64.9%	60.8%	12 (8 - 18)	2 (1 - 3)	2.1%
RBD	16	14	88%	14	92.9%	57.1%	64.3%	11 (6 - 21)	4 (2 - 10)	0.0%
RC1	43	39	91%	32	65.6%	28.9%	40.6%	16 (13 - 41)	1 (1 - 2)	1.0%
RCB	153	154	101%	148	76.0%	91.6%	83.8%	5 (3 - 9)	3 (2 - 6)	3.4%
RDD	21	17	81%	16	100.0%	70.6%	93.8%	8 (6 - 13)	5 (2 - 11)	0.0%
RDE	57	55	96%	48	77.1%	29.1%	41.7%	17 (11 - 34)	3 (3 - 4)	2.4%
RDU	45	44	98%	42	76.2%	63.6%	66.7%	8 (4 - 21)	3 (2 - 5)	2.0%
RDZ	47	46	98%	44	70.7%	67.4%	68.2%	9 (5 - 20)	3 (2 - 4)	0.8%
REF	53	53	100%	50	81.6%	58.5%	66.0%	8 (5 - 23)	2 (1 - 4)	3.1%
RF4	33	29	88%	29	79.3%	39.3%	58.6%	13 (10 - 17)	3 (2 - 18)	3.9%
RGT	110	106	96%	95	63.4%	28.3%	36.8%	24 (10 - 45)	2 (1 - 3)	1.8%

Trust code	Estimated cases	NVR cases	Case-ascert.	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	Median delay and IQR from index symptom to surgery (days)	Median(IQR) length of stay (days)	% Adjusted Stroke and/or death rate
RH8	34	31	91%	31	80.6%	80.6%	80.6%	8 (4 - 14)	1 (1 - 3)	4.3%
RHM	57	57	100%	52	80.0%	33.3%	71.2%	12 (9 - 16)	2 (2 - 3)	2.0%
RHQ	73	61	84%	60	57.6%	32.8%	31.7%	17 (13 - 34)	3 (2 - 3)	2.7%
RHU	56	31	55%	31	70.0%	61.3%	53.3%	14 (8 - 23)	1 (1 - 1)	1.4%
RJ1	60	62	103%	51	49.0%	72.1%	52.9%	14 (7 - 22)	4 (3 - 8)	3.4%
RJ7	54	49	91%	49	73.5%	91.8%	83.7%	7 (6 - 12)	6 (4 - 10)	0.5%
RJE	76	77	101%	73	79.2%	51.9%	69.9%	11 (7 - 16)	2 (2 - 6)	1.2%
RJR	109	84	77%	80	57.1%	8.4%	17.9%	27 (17 - 50)	2 (2 - 3)	4.7%
RJZ	70	57	81%	48	66.7%	49.1%	54.2%	14 (8 - 37)	3 (2 - 6)	1.8%
RK9	52	45	87%	40	72.5%	53.3%	62.5%	11 (8 - 32)	1 (1 - 3)	0.0%
RKB	57	55	96%	53	67.3%	25.5%	30.2%	25 (11 - 61)	2 (1 - 3)	0.0%
RLN	40	37	93%	35	77.1%	55.6%	80.0%	12 (9 - 14)	2 (2 - 3)	0.0%
RM1	63	61	97%	53	73.6%	70.5%	79.2%	9 (6 - 12)	4 (3 - 7)	1.2%
RM2	95	43	45%	38	73.7%	57.1%	65.8%	9 (5 - 30)	3 (2 - 4)	1.0%
RMC	31	31	100%	29	67.9%	32.3%	37.9%	19 (11 - 30)	4 (3 - 4)	1.1%
RNA	90	91	101%	88	70.5%	60.0%	72.7%	12 (8 - 16)	2 (1 - 3)	2.3%
RNL	22	20	91%	18	55.6%	45.0%	50.0%	15 (8 - 35)	7 (3 - 9)	1.9%
RNS	47	48	102%	41	80.5%	52.1%	70.7%	9 (6 - 16)	2 (2 - 5)	3.9%
RNZ	22	21	95%	19	94.7%	52.4%	89.5%	9 (7 - 13)	1 (1 - 2)	1.7%
RP5	39	38	97%	38	73.7%	57.9%	65.8%	13 (8 - 16)	1 (1 - 7)	1.5%
RPA	46	41	89%	28	75.0%	43.9%	60.7%	13 (8 - 28)	1 (1 - 3)	2.4%
RQ6	149	126	85%	126	69.7%	15.9%	27.8%	19 (14 - 31)	2 (1 - 3)	3.1%
RQ8	34	34	100%	30	60.0%	6.1%	10.0%	53 (30 - 160)	2 (1 - 3)	0.0%
RQW	20	12	60%	11	72.7%	25.0%	36.4%	40 (8 - 176)	1 (1 - 3)	0.0%
RR1	46	43	93%	41	84.2%	53.5%	57.5%	12 (6 - 75)	3 (1 - 7)	2.9%

Trust code	Estimated cases	NVR cases	Case-ascert.	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	Median delay and IQR from index symptom to surgery (days)	Median(IQR) length of stay (days)	% Adjusted Stroke and/or death rate
RR7	23	22	96%	22	63.6%	4.5%	13.6%	28 (16 - 45)	3 (3 - 4)	1.1%
RR8	64	62	97%	57	70.2%	80.6%	80.7%	8 (5 - 13)	4 (2 - 6)	1.0%
RRK	80	78	98%	65	70.3%	6.4%	16.9%	28 (18 - 42)	2 (2 - 4)	2.7%
RRV	51	13	25%	13	76.9%	76.9%	84.6%	8 (6 - 10)	2 (1 - 5)	1.2%
RTD	90	80	89%	71	69.1%	46.3%	60.0%	12 (8 - 27)	3 (2 - 5)	1.9%
RTE	76	64	84%	54	66.0%	35.9%	40.7%	18 (9 - 33)	2 (1 - 3)	1.7%
RTG	55	54	98%	54	79.2%	83.3%	73.6%	7 (4 - 16)	5 (3 - 7)	5.9%
RTH	111	86	77%	65	50.8%	33.7%	41.5%	20 (11 - 34)	2 (1 - 2)	3.5%
RTK	38	38	100%	33	75.0%	68.4%	81.8%	6 (4 - 11)	5 (2 - 7)	0.6%
RTR	65	62	95%	62	76.7%	32.3%	46.8%	15 (11 - 26)	2 (2 - 3)	1.6%
RVJ	124	125	101%	119	74.6%	57.3%	66.4%	11 (6 - 19)	2 (1 - 3)	3.0%
RVV	79	78	99%	61	71.7%	64.1%	73.8%	8 (4 - 16)	4 (1 - 8)	0.5%
RW3	64	61	95%	48	71.1%	58.3%	66.0%	10 (6 - 21)	2 (1 - 4)	1.6%
RW6	108	113	105%	102	63.5%	64.6%	67.7%	10 (5 - 20)	3 (2 - 5)	1.6%
RWA	95	95	100%	91	51.7%	45.3%	38.5%	19 (9 - 47)	2 (2 - 4)	2.5%
RWD	40	40	100%	36	58.3%	84.6%	63.9%	10 (6 - 16)	2 (2 - 5)	1.4%
RWE	81	77	95%	71	84.5%	77.9%	83.1%	8 (5 - 13)	4 (3 - 6)	1.1%
RWG	72	66	92%	61	75.4%	28.8%	39.3%	17 (10 - 37)	4 (3 - 7)	2.5%
RWH	30	32	107%	27	88.9%	75.0%	88.9%	7 (6 - 11)	4 (2 - 9)	1.5%
RWP	70	70	100%	69	63.2%	72.5%	64.7%	9 (7 - 22)	2 (2 - 8)	1.2%
RWY	42	42	100%	39	66.7%	52.4%	64.1%	13 (8 - 24)	3 (2 - 4)	0.0%
RX1	80	74	93%	72	80.6%	86.5%	81.9%	7 (4 - 11)	1 (1 - 2)	1.1%
RXH	38	35	92%	34	69.7%	42.9%	50.0%	15 (10 - 34)	2 (1 - 3)	0.8%
RXN	48	43	90%	38	61.1%	35.7%	44.7%	18 (9 - 35)	1 (1 - 2)	2.0%
RXP	56	55	98%	50	68.0%	38.2%	54.0%	14 (9 - 28)	3 (3 - 6)	1.8%

Trust code	Estimated cases	NVR cases	Case-ascert.	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	Median delay and IQR from index symptom to surgery (days)	Median(IQR) length of stay (days)	% Adjusted Stroke and/or death rate
RXQ	63	61	97%	48	70.8%	36.7%	54.2%	12 (8 - 31)	1 (1 - 2)	3.9%
RXR	61	55	90%	54	79.2%	14.8%	30.2%	40 (12 - 92)	2 (1 - 5)	2.8%
RXW	36	36	100%	36	75.8%	63.9%	66.7%	11 (7 - 17)	1 (1 - 2)	2.7%
RYJ	80	57	71%	47	78.7%	44.6%	63.8%	9 (6 - 33)	3 (2 - 7)	3.5%
SA999	38	24	63%	23	54.5%	41.7%	43.5%	16 (11 - 58)	2 (2 - 3)	3.7%
SF999	10	9	90%	9	66.7%	11.1%	33.3%	21 (14 - 27)	2 (2 - 3)	7.3%
SG999	116	108	93%	104	46.1%	48.1%	38.5%	19 (11 - 37)	2 (2 - 4)	2.5%
SH999	35	36	103%	32	28.1%	2.9%	3.1%	33 (23 - 66)	3 (2 - 4)	0.0%
SL999	65	0	0%	No Data	No Data	No Data	No Data	No Data	No Data	No Data
SN999	30	29	97%	29	67.9%	72.4%	75.9%	9 (4 - 14)	5 (4 - 6)	4.6%
SS999	53	22	42%	22	81.8%	54.5%	63.6%	11 (8 - 17)	3 (2 - 3)	4.3%
ST999	27	25	93%	25	72.0%	56.0%	60.0%	14 (12 - 17)	3 (3 - 8)	3.1%
SV999	47	49	104%	38	44.4%	24.5%	31.6%	18 (13 - 36)	1 (1 - 3)	3.9%
SY999	30	20	67%	20	52.6%	31.6%	36.8%	21 (12 - 27)	2 (2 - 2)	0.0%
ZT001	164	157	96%	156	55.3%	49.7%	46.2%	17 (8 - 49)	3 (3 - 6)	1.4%

No data – no data available for indicators

Appendix 4: Elective infra renal AAA repairs

Trust code	Estimated cases	NVR Cases	Case-ascert.	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
7A1	50	50	100%	36	96%	98%	98%	86%	46 (24 - 100)	9 (6 - 12)	3 (2 - 6)	0.0%
7A3	67	75	112%	37	99%	100%	99%	88%	79 (41 - 157)	11 (9 - 21)	3 (2 - 4)	1.4%
7A4	38	27	71%	13	93%	100%	95%	100%	63 (42 - 107)	10 (8 - 14)	5 (4 - 7)	1.7%
7A5	14	12	86%	9	100%	100%	100%	100%	51 (13 - 92)	10 (9 - 21)	3 (3 - 4)	4.8%
7A6	45	39	87%	30	87%	100%	87%	90%	105 (65 - 141)	9 (8 - 14)	1 (1 - 3)	1.4%
R1H	40	44	110%	30	39%	100%	41%	32%	54 (38 - 87)	8 (6 - 13)	5 (3 - 8)	2.2%
R1K	50	45	90%	35	91%	98%	97%	93%	43 (20 - 111)	7 (1 - 10)	4 (3 - 8)	5.2%
RA9	34	36	106%	24	97%	97%	97%	97%	39 (28 - 54)	6 (5 - 8)	2 (2 - 4)	1.3%
RAE	41	44	107%	21	100%	95%	100%	100%	61 (36 - 84)	10 (8 - 13)	4 (4 - 7)	1.9%
RAJ	41	42	102%	31	71%	100%	74%	5%	103 (79 - 129)	9 (8 - 11)	4 (3 - 6)	1.3%
RAL	66	55	83%	44	95%	98%	96%	18%	68 (43 - 107)	8 (6 - 14)	3 (2 - 4)	2.0%
RBA	53	66	125%	42	95%	97%	95%	98%	61 (37 - 97)	8 (7 - 9)	2 (1 - 3)	2.1%
RBD	<5	<5	100%	0	xx	xx	xx	xx	xx	xx	N/A	0.0%
RC1	71	67	94%	55	96%	97%	95%	88%	58 (36 - 123)	7 (6 - 8)	2 (1 - 4)	1.2%
RCB	62	59	95%	24	88%	98%	88%	86%	72 (35 - 113)	8 (7 - 14)	3 (3 - 4)	1.5%
RDD	29	26	90%	17	88%	96%	86%	15%	64 (34 - 118)	8 (7 - 10)	1 (1 - 2)	0.0%
RDE	76	77	101%	52	65%	99%	68%	42%	57 (30 - 109)	8 (7 - 10)	3 (3 - 5)	0.5%
RDU	74	62	84%	49	98%	100%	98%	97%	61 (46 - 91)	9 (7 - 11)	2 (2 - 3)	0.0%
RDZ	92	74	80%	48	65%	97%	63%	66%	71 (46 - 133)	7 (6 - 9)	2 (1 - 5)	1.0%
REF	32	34	106%	22	91%	100%	93%	82%	61 (20 - 98)	10 (8 - 13)	3 (2 - 4)	0.0%
RF4	37	32	86%	28	97%	97%	97%	78%	92 (56 - 119)	xx	4 (2 - 6)	1.8%

Trust code	Estimated cases	NVR Cases	Case-ascert.	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
RGT	107	112	105%	92	91%	97%	91%	86%	80 (44 - 118)	9 (7 - 10)	2 (1 - 3)	0.6%
RH8	22	18	82%	13	100%	100%	100%	89%	67 (50 - 104)	7 (5 - 7)	2 (1 - 2)	0.0%
RHM	94	71	76%	51	97%	100%	97%	99%	57 (34 - 77)	8 (7 - 9)	3 (2 - 3)	0.9%
RHQ	60	60	100%	34	73%	97%	73%	63%	100 (56 - 145)	9 (6 - 11)	2 (1 - 3)	1.0%
RHU	44	45	102%	33	93%	100%	93%	33%	74 (30 - 146)	7 (6 - 9)	1 (1 - 1)	0.0%
RJ1	134	106	79%	87	89%	98%	89%	89%	74 (44 - 122)	9 (7 - 14)	3 (2 - 5)	0.5%
RJ7	126	92	73%	92	60%	100%	61%	61%	21 (8 - 49)	N/A	4 (3 - 6)	0.0%
RJE	112	116	104%	72	88%	99%	90%	80%	66 (30 - 127)	8 (7 - 12)	3 (2 - 4)	2.5%
RJR	71	51	72%	43	84%	96%	82%	65%	112 (33 - 202)	9 (6 - 20)	4 (2 - 6)	1.0%
RJZ	18	5	28%	3	80%	100%	100%	60%	115 (32 - 186)	xx	xx	0.0%
RK9	37	34	92%	17	94%	97%	93%	97%	70 (42 - 137)	7 (6 - 10)	2 (1 - 3)	2.4%
RKB	51	41	80%	25	51%	98%	51%	49%	35 (28 - 49)	8 (8 - 9)	1 (1 - 2)	2.3%
RLN	35	29	83%	23	24%	100%	21%	24%	40 (32 - 66)	9 (8 - 10)	3 (3 - 6)	0.0%
RM1	114	104	91%	57	75%	100%	73%	65%	64 (31 - 97)	9 (7 - 11)	3 (2 - 5)	0.6%
RM2	78	47	60%	30	60%	100%	70%	55%	69 (43 - 104)	8 (7 - 12)	3 (2 - 3)	0.0%
RMC	16	16	100%	11	100%	94%	100%	100%	34 (27 - 76)	10 (9 - 15)	6 (3 - 6)	1.5%
RNA	89	88	99%	62	88%	99%	86%	86%	49 (28 - 75)	7 (6 - 9)	2 (1 - 3)	0.4%
RNL	39	32	82%	18	66%	100%	69%	88%	64 (47 - 136)	8 (4 - 14)	5 (3 - 7)	2.9%
RNS	42	44	105%	29	100%	100%	100%	93%	55 (23 - 97)	8 (6 - 10)	2 (2 - 4)	2.4%
RNZ	10	12	120%	0	33%	100%	40%	42%	131 (92 - 164)	6 (4 - 9)	N/A	3.8%
RP5	72	72	100%	45	76%	89%	77%	64%	89 (36 - 136)	12 (7 - 15)	3 (2 - 5)	0.7%
RPA	42	47	112%	43	98%	100%	98%	98%	44 (35 - 67)	xx	1 (1 - 2)	4.0%
RQ6	116	86	74%	63	81%	94%	80%	53%	101 (55 - 173)	10 (7 - 14)	3 (2 - 5)	1.7%

Trust code	Estimated cases	NVR Cases	Case-ascert.	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
RQ8	36	30	83%	23	97%	93%	100%	67%	91 (63 - 209)	7 (6 - 9)	3 (3 - 4)	1.1%
RQW	20	15	75%	13	100%	100%	100%	93%	77 (20 - 138)	xx	5 (4 - 7)	6.5%
RR1	78	56	72%	45	93%	93%	93%	52%	102 (64 - 159)	6 (4 - 7)	3 (2 - 4)	0.8%
RR8	74	71	96%	55	89%	99%	88%	96%	74 (52 - 114)	7 (6 - 13)	2 (1 - 3)	0.0%
RRK	60	56	93%	45	98%	98%	98%	96%	90 (49 - 126)	8 (6 - 11)	3 (2 - 4)	2.4%
RTD	102	69	68%	37	72%	88%	71%	74%	85 (41 - 111)	8 (7 - 13)	4 (3 - 6)	1.8%
RTE	74	70	95%	39	84%	99%	88%	64%	54 (29 - 97)	7 (7 - 11)	3 (2 - 5)	1.7%
RTG	82	70	85%	53	97%	99%	100%	76%	49 (23 - 88)	8 (7 - 12)	6 (4 - 9)	0.4%
RTH	87	68	78%	37	84%	100%	83%	82%	68 (32 - 117)	6 (5 - 8)	2 (1 - 3)	0.9%
RTK	25	27	108%	23	44%	100%	40%	37%	65 (24 - 96)	xx	4 (2 - 7)	2.0%
RTR	50	48	96%	34	96%	94%	95%	92%	74 (44 - 108)	11 (8 - 15)	3 (2 - 4)	0.8%
RVJ	85	83	98%	49	89%	95%	90%	94%	58 (42 - 97)	7 (7 - 14)	2 (1 - 2)	2.0%
RVV	81	82	101%	71	89%	100%	88%	83%	43 (30 - 72)	6 (3 - 9)	1 (1 - 2)	1.6%
RW3	45	38	84%	28	100%	92%	100%	97%	91 (30 - 156)	8 (6 - 8)	3 (3 - 6)	1.7%
RW6	57	58	102%	53	93%	97%	92%	91%	75 (40 - 101)	11 (9 - 14)	4 (3 - 8)	2.3%
RWA	74	80	108%	26	No Data	No Data	No Data	No Data	No Data	9 (7 - 11)	4 (3 - 5)	4.1%
RWD	12	14	117%	1	93%	100%	92%	93%	41 (26 - 75)	7 (5 - 12)	xx	4.1%
RWE	73	66	90%	53	80%	100%	86%	65%	44 (33 - 71)	9 (7 - 10)	4 (3 - 7)	0.0%
RWG	56	42	75%	35	88%	98%	94%	88%	58 (33 - 98)	8 (4 - 13)	5 (3 - 6)	1.3%
RWH	32	32	100%	19	97%	97%	97%	91%	93 (32 - 165)	9 (8 - 12)	5 (2 - 7)	0.0%
RWP	77	77	100%	44	95%	99%	94%	83%	54 (23 - 77)	8 (7 - 10)	4 (3 - 5)	1.3%
RWY	32	36	113%	27	86%	94%	85%	89%	39 (20 - 55)	13 (10 - 16)	4 (3 - 7)	2.2%
RX1	91	92	101%	82	100%	99%	100%	99%	60 (37 - 98)	7 (6 - 10)	2 (1 - 2)	1.9%

Trust code	Estimated cases	NVR Cases	Case-ascert.	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
RXH	92	65	71%	48	97%	100%	98%	80%	90 (43 - 140)	8 (5 - 9)	2 (2 - 3)	1.0%
RXN	48	43	90%	34	91%	95%	93%	77%	60 (32 - 109)	7 (7 - 10)	2 (2 - 4)	3.5%
RXP	46	44	96%	28	86%	100%	85%	64%	80 (44 - 124)	7 (6 - 9)	5 (4 - 7)	3.0%
RXR	40	32	80%	27	97%	97%	100%	91%	67 (28 - 98)	9 (8 - 22)	2 (1 - 4)	0.0%
RXW	39	34	87%	21	97%	97%	97%	94%	55 (29 - 98)	8 (7 - 12)	2 (2 - 4)	0.0%
RYJ	53	46	87%	33	39%	96%	41%	0%	58 (36 - 106)	10 (8 - 12)	5 (3 - 6)	1.1%
SA999	11	10	91%	3	100%	100%	100%	100%	123 (35 - 140)	9 (9 - 24)	xx	0.0%
SG999	42	57	136%	31	93%	96%	93%	93%	76 (38 - 123)	11 (7 - 14)	4 (3 - 5)	5.9%
SH999	15	19	127%	5	100%	100%	100%	95%	73 (53 - 107)	10 (6 - 12)	4 (3 - 5)	1.5%
SL999	29	0	0%	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
SN999	24	18	75%	16	100%	94%	100%	83%	74 (41 - 131)	xx	4 (3 - 5)	1.2%
SS999	73	16	22%	8	94%	94%	93%	94%	69 (33 - 145)	10 (10 - 12)	3 (3 - 9)	0.9%
ST999	50	40	80%	22	65%	98%	63%	63%	92 (44 - 125)	14 (11 - 19)	5 (4 - 8)	1.9%
SV999	22	22	100%	10	100%	100%	100%	100%	55 (30 - 71)	7 (6 - 11)	4 (3 - 4)	0.0%
ZT001	175	145	83%	89	81%	99%	81%	73%	80 (33 - 131)	8 (7 - 11)	3 (3 - 5)	1.8%

xx – value not shown, due to small numbers

N/A – not applicable

No data – no data available for indicators

Appendix 5: Emergency repair of ruptured AAA

Trust code	NVR Cases	No. of EVAR	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
7A1	15	1	8 (4 - 16)	44.7%
7A3	54	1	10 (7 - 24)	37.3%
7A4	25	3	15 (7 - 20)	31.9%
7A5	7	2	11 (3 - 22)	28.2%
7A6	19	4	1 (0 - 15)	48.4%
R1H	18	7	7 (2 - 14)	52.4%
R1K	18	12	15 (2 - 32)	66.5%
RA9	14	6	12 (6 - 15)	21.0%
RAE	20	0	11 (3 - 16)	36.3%
RAJ	16	7	9 (5 - 23)	38.1%
RAL	33	14	10 (3 - 19)	57.6%
RBA	22	6	6 (2 - 13)	32.0%
RC1	26	5	10 (2 - 17)	47.5%
RCB	27	7	10 (3 - 21)	38.7%
RDD	2	0	xx	xx
RDE	32	10	7 (3 - 12)	45.4%
RDU	33	10	8 (3 - 24)	40.1%
RDZ	35	10	9 (5 - 17)	15.9%
REF	12	1	8 (1 - 14)	46.9%
RF4	15	0	10 (1 - 22)	51.5%
RGT	37	24	9 (5 - 14)	17.2%
RH8	15	0	13 (8 - 23)	34.8%
RHM	36	5	14 (5 - 24)	33.2%
RHQ	28	5	18 (7 - 37)	17.2%
RHU	13	5	10 (7 - 23)	37.1%
RJ1	64	41	11 (5 - 18)	26.8%
RJ7	40	29	10 (6 - 17)	29.9%
RJE	56	26	9 (2 - 15)	49.6%
RJR	25	9	23 (13 - 36)	31.7%
RJZ	6	5	9 (5 - 10)	44.7%
RK9	20	0	10 (3 - 18)	23.8%
RKB	17	2	9 (7 - 12)	40.4%
RLN	16	3	9 (4 - 47)	44.3%
RM1	59	13	11 (5 - 22)	22.4%
RM2	6	3	11 (8 - 14)	0.0%
RMC	4	0	xx	xx
RNA	54	11	9 (4 - 18)	25.0%
RNL	27	0	14 (5 - 34)	45.0%

Trust code	NVR Cases	No. of EVAR	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
RNS	31	2	14 (7 - 30)	26.7%
RP5	21	6	13 (5 - 31)	50.7%
RPA	20	9	6 (2 - 16)	47.2%
RQ6	37	9	12 (4 - 19)	35.5%
RQ8	5	0	13 (9 - 14)	20.6%
RQW	13	3	9 (2 - 13)	60.9%
RR1	23	7	8 (4 - 12)	21.3%
RR8	40	16	11 (6 - 20)	26.8%
RRK	16	2	10 (0 - 21)	44.1%
RTD	32	5	16 (5 - 22)	31.3%
RTE	29	0	12 (6 - 18)	46.3%
RTG	32	10	10 (1 - 18)	49.6%
RTH	29	1	10 (4 - 14)	26.1%
RTK	14	9	9 (3 - 20)	30.0%
RTR	34	14	10 (3 - 26)	45.6%
RVJ	37	4	13 (5 - 25)	37.6%
RVV	23	14	8 (1 - 15)	50.4%
RW3	14	6	13 (10 - 16)	28.4%
RW6	28	10	15 (9 - 27)	38.1%
RWA	34	4	9 (4 - 15)	49.6%
RWD	22	0	13 (10 - 32)	58.2%
RWE	38	7	15 (4 - 27)	27.2%
RWG	18	4	4 (1 - 10)	56.6%
RWH	18	2	15 (11 - 32)	41.3%
RWP	30	4	9 (2 - 20)	45.9%
RWY	21	2	13 (8 - 24)	38.8%
RX1	35	20	10 (4 - 16)	41.6%
RXH	43	11	10 (2 - 20)	40.0%
RXN	12	5	6 (4 - 18)	27.8%
RXP	31	1	11 (3 - 20)	47.6%
RXR	14	3	11 (3 - 18)	49.5%
RXW	12	1	24 (4 - 36)	36.3%
RYJ	9	8	7 (3 - 10)	64.8%
SA999	4	0	xx	xx
SG999	22	1	10 (2 - 17)	49.2%
SH999	9	0	12 (2 - 13)	41.0%
SL999	2	0	xx	xx
SN999	19	4	9 (1 - 15)	42.8%
SS999	18	2	13 (2 - 16)	23.1%
ST999	32	12	13 (7 - 27)	13.3%
SV999	7	0	9 (2 - 21)	34.3%
ZT001	52	6	10 (7 - 18)	24.8%

xx – value not shown, due to small numbers

Appendix 6: Repair of complex AAAs

Trust code	NVR Cases	No. of EVAR	Median (IQR) length of stay (days)
7A3	2	0	xx
7A4	8	4	8 (5 - 11)
7A5	2	0	xx
7A6	1	0	xx
R1H	18	17	10 (6 - 16)
R1K	8	8	7 (3 - 9)
RAJ	2	1	xx
RAL	71	71	6 (5 - 10)
RBA	3	1	xx
RC1	13	13	7 (5 - 11)
RCB	9	8	3 (3 - 5)
RDD	5	3	2 (1 - 4)
RDE	6	5	8 (6 - 20)
RDU	28	27	3 (2 - 7)
RDZ	7	5	4 (3 - 7)
REF	2	0	xx
RF4	1	1	xx
RGT	25	23	5 (2 - 8)
RH8	3	2	xx
RHM	26	23	4 (3 - 6)
RHQ	12	12	3 (2 - 7)
RJ1	172	152	6 (3 - 9)
RJ7	90	89	7 (6 - 11)
RJE	12	9	5 (3 - 11)
RJR	6	4	5 (2 - 18)
RJZ	3	3	xx
RKB	8	8	4 (2 - 5)
RLN	6	5	9 (4 - 33)
RM1	25	25	8 (5 - 10)
RM2	4	2	xx
RNA	14	13	5 (2 - 7)
RNL	2	2	xx
RNS	1	0	xx
RP5	5	1	21 (8 - 21)
RQ6	79	60	8 (4 - 14)
RQ8	3	3	xx
RQW	7	7	6 (4 - 13)
RR1	102	95	6 (4 - 11)
RR8	18	18	5 (3 - 6)
RRK	12	11	3 (2 - 10)

Trust code	NVR Cases	No. of EVAR	Median (IQR) length of stay (days)
RTD	51	51	6 (4 - 10)
RTE	4	3	xx
RTG	44	43	7 (4 - 10)
RTH	13	13	4 (3 - 7)
RTK	15	14	8 (7 - 15)
RTR	10	10	7 (5 - 10)
RVJ	20	20	3 (2 - 5)
RVV	9	7	3 (2 - 5)
RW3	30	26	6 (3 - 10)
RW6	2	0	xx
RWA	28	28	6 (4 - 7)
RWD	1	0	xx
RWE	41	41	7 (5 - 10)
RWG	1	0	xx
RWH	6	1	8 (2 - 37)
RWP	5	2	11 (8 - 16)
RX1	19	18	2 (2 - 3)
RXH	25	19	3 (2 - 7)
RXN	3	3	xx
RXR	3	1	xx
RXW	1	1	xx
RYJ	67	56	9 (6 - 15)
SG999	4	4	xx
SH999	1	0	xx
SN999	10	10	7 (4 - 10)
SS999	4	3	xx
ST999	15	15	7 (5 - 9)
SV999	1	1	xx
ZT001	24	22	4 (3 - 7)

xx – value not shown, due to small numbers

Appendix 7: Lower limb revascularisation

Trust code	Endovascular NVR cases	Median (IQR) length of stay (days)	Adjusted in-hospital mortality	Bypass NVR cases	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
7A1	No Data	No Data	No Data	43	5 (4 - 10)	0.0%
7A3	275	10 (2 - 20)	1.3%	257	16 (8 - 31)	4.2%
7A4	26	4 (1 - 9)	0.0%	90	9 (6 - 25)	7.2%
7A5	2	**	**	41	15 (9 - 27)	2.2%
7A6	90	0 (0 - 2)	2.8%	123	7 (2 - 20)	2.9%
R1H	13	**	**	127	10 (6 - 20)	4.4%
R1K	53	6 (2 - 23)	4.4%	153	10 (5 - 27)	3.5%
RA9	6	**	**	70	6 (4 - 13)	2.6%
RAE	No Data	No Data	No Data	144	9 (6 - 17)	4.9%
RAJ	113	8 (0 - 25)	1.3%	80	16 (7 - 26)	3.8%
RAL	35	**	**	37	11 (7 - 17)	3.5%
RBA	328	0 (0 - 1)	2.5%	268	6 (3 - 12)	2.5%
RBD	No Data	No Data	No Data	50	5 (3 - 9)	0.0%
RBZ	18	**	**	98	4 (1 - 9)	0.8%
RC1	39	**	**	104	6 (4 - 12)	2.5%
RCB	850	0 (0 - 4)	1.5%	293	8 (4 - 14)	2.9%
RDD	2	**	**	12	7 (5 - 16)	0.0%
RDE	5	**	**	117	7 (4 - 12)	2.5%
RDU	29	**	**	242	6 (3 - 13)	6.2%
RDZ	No Data	No Data	No Data	94	9 (5 - 19)	3.0%
REF	1	**	**	103	9 (5 - 14)	3.2%
RF4	5	**	**	71	7 (4 - 20)	8.1%
RGT	10	**	**	173	8 (4 - 14)	2.4%
RH8	175	1 (0 - 8)	0.8%	138	6 (3 - 13)	4.1%
RHM	No Data	No Data	No Data	145	7 (4 - 14)	2.7%
RHQ	62	**	**	157	8 (4 - 15)	0.9%
RHU	No Data	No Data	No Data	36	5 (2 - 10)	1.8%
RJ1	276	3 (1 - 10)	2.1%	349	8 (4 - 22)	2.9%
RJ7	338	2 (1 - 8)	0.9%	218	11 (5 - 18)	2.0%
RJE	226	2 (0 - 13)	3.8%	223	7 (3 - 20)	2.6%
RJR	1	**	**	111	8 (5 - 16)	4.0%
RJZ	2	**	**	55	15 (8 - 30)	6.6%
RK9	3	**	**	114	8 (5 - 16)	0.8%
RKB	188	1 (0 - 14)	1.2%	68	10 (3 - 24)	1.1%
RLN	3	**	**	58	14 (6 - 29)	4.9%
RM1	No Data	No Data	No Data	107	10 (5 - 23)	0.0%

	Endovascular			Bypass		
Trust code	NVR cases	Median (IQR) length of stay (days)	Adjusted in-hospital mortality	NVR cases	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
RM2	346	1 (0 - 7)	1.5%	2	**	**
RMC	205	0 (0 - 10)	3.8%	28	9 (5 - 21)	0.0%
RNA	578	1 (0 - 10)	2.0%	425	7 (3 - 14)	3.3%
RNL	167	0 (0 - 4)	0.0%	112	7 (4 - 11)	0.9%
RNS	1	**	**	101	11 (6 - 19)	4.3%
RNZ	No Data	No Data	No Data	29	6 (3 - 9)	11.6%
RP5	11	**	**	103	5 (2 - 8)	0.0%
RPA	89	0 (0 - 4)	2.7%	102	6 (4 - 15)	2.4%
RQ6	9	**	**	349	8 (4 - 17)	2.1%
RQ8	183	1 (0 - 4)	1.2%	59	6 (4 - 14)	5.0%
RQW	1	**	**	38	6 (4 - 20)	6.2%
RR1	2	**	**	134	6 (3 - 12)	2.9%
RR7	182	1 (0 - 1)	2.0%	Procedure not performed at this trust		
RR8	26	**	**	193	5 (3 - 13)	0.7%
RRK	88	**	**	262	7 (4 - 14)	3.1%
RRV	21	**	**	16	6 (3 - 9)	0.0%
RTD	No Data	No Data	No Data	79	12 (7 - 25)	4.0%
RTE	10	**	**	152	8 (5 - 18)	4.6%
RTG	722	2 (1 - 9)	0.8%	280	9 (5 - 18)	3.6%
RTH	16	**	**	68	6 (3 - 19)	1.9%
RTK	73	4 (2 - 11)	4.6%	141	8 (5 - 17)	6.0%
RTR	5	**	**	156	10 (6 - 21)	1.6%
RVJ	22	**	**	335	7 (4 - 16)	3.3%
RVV	118	2 (1 - 14)	2.4%	100	6 (3 - 12)	1.9%
RW3	187	1 (0 - 6)	0.6%	108	16 (9 - 36)	4.6%
RW6	55	**	**	293	7 (4 - 14)	1.9%
RWA	1	**	**	143	12 (7 - 28)	4.6%
RWD	1	**	**	134	9 (4 - 17)	4.2%
RWE	3	**	**	189	8 (5 - 16)	1.9%
RWG	19	**	**	51	7 (5 - 15)	1.8%
RWH	15	**	**	33	11 (8 - 38)	9.4%
RWP	100	3 (2 - 11)	4.8%	129	6 (4 - 16)	1.7%
RWY	2	**	**	138	10 (6 - 19)	2.8%
RX1	13	**	**	211	5 (2 - 10)	4.0%
RXH	No Data	No Data	No Data	230	12 (6 - 22)	2.1%
RXN	17	**	**	42	4 (4 - 11)	0.0%
RXP	1	**	**	48	8 (5 - 20)	2.1%
RXQ	No Data	No Data	No Data	58	4 (2 - 7)	0.0%
RXR	23	**	**	52	5 (3 - 14)	2.5%
RXW	No Data	No Data	No Data	224	4 (2 - 7)	3.9%
RYJ	31	**	**	17	8 (6 - 12)	16.0%

	Endovascular			Bypass		
Trust code	NVR cases	Median (IQR) length of stay (days)	Adjusted in-hospital mortality	NVR cases	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
SA999	No Data	No Data	No Data	18	24 (13 - 40)	6.6%
SF999	No Data	No Data	No Data	34	7 (4 - 8)	0.0%
SG999	8	1 (1 - 2)	0.0%	33	13 (8 - 26)	3.6%
SH999	364	2 (0 - 8)	0.9%	106	9 (5 - 15)	4.3%
SL999	No Data	No Data	No Data	5	16 (7 - 18)	0.0%
SN999	20	0 (0 - 1)	0.0%	188	9 (7 - 16)	1.9%
SS999	No Data	No Data	No Data	14	12 (6 - 22)	11.1%
ST999	133	4 (1 - 19)	1.6%	139	13 (8 - 28)	2.0%
SV999	No Data	No Data	No Data	283	5 (3 - 12)	3.0%
SY999	102	1 (0 - 4)	0.0%	90	9 (5 - 17)	1.9%
ZT001	126	3 (0 - 6)	2.0%	445	6 (4 - 11)	2.0%

xx – value not shown, due to small numbers

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

No data – no data available for indicators

Appendix 8: Major lower limb amputation

Trust code	NVR Cases	Median (IQR) delay from vascular assessment to surgery (days)	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
7A1	39	5 (3 - 10)	19 (15 - 41)	7.5%
7A3	293	8 (2 - 31)	22 (12 - 37)	9.4%
7A4	48	12 (6 - 31)	56 (30 - 112)	12.5%
7A5	16	15 (9 - 27)	36 (23 - 51)	18.7%
7A6	70	12 (5 - 32)	33 (21 - 44)	6.5%
R1H	98	11 (4 - 23)	35 (21 - 55)	10.9%
R1K	39	14 (4 - 23)	36 (22 - 47)	13.9%
RA9	16	16 (8 - 101)	13 (9 - 23)	0.0%
RAE	74	12 (5 - 30)	27 (16 - 50)	4.0%
RAJ	14	13 (7 - 28)	29 (21 - 48)	15.3%
RAL	33	6 (1 - 17)	22 (13 - 34)	0.0%
RBA	37	6 (3 - 19)	19 (13 - 21)	6.3%
RBD	17	16 (6 - 28)	20 (10 - 39)	8.5%
RBZ	33	11 (2 - 93)	19 (13 - 30)	4.4%
RC1	46	22 (7 - 57)	23 (15 - 32)	10.4%
RCB	65	14 (3 - 56)	23 (14 - 36)	6.9%
RDE	6	5 (0 - 6)	27 (15 - 32)	0.0%
RDU	103	8 (3 - 38)	22 (12 - 42)	6.8%
RDZ	30	13 (4 - 31)	26 (17 - 33)	4.4%
REF	73	5 (1 - 16)	20 (13 - 28)	4.5%
RF4	63	11 (3 - 28)	37 (24 - 61)	13.3%
RGT	41	6 (2 - 10)	20 (14 - 30)	2.2%
RH8	63	8 (4 - 17)	21 (15 - 29)	2.0%
RHM	78	9 (4 - 28)	29 (15 - 51)	12.4%
RHQ	100	9 (3 - 37)	24 (14 - 38)	8.6%
RHU	5	11 (8 - 30)	29 (25 - 42)	0.0%
RJ1	138	6 (2 - 17)	33 (18 - 55)	9.6%
RJ7	44	8 (4 - 17)	24 (12 - 43)	5.6%
RJE	214	7 (2 - 24)	22 (10 - 38)	6.7%
RJR	67	10 (4 - 29)	25 (15 - 42)	4.3%
RJZ	3	xx	xx	xx
RK9	50	20 (3 - 51)	15 (7 - 26)	6.5%
RKB	56	6 (2 - 22)	18 (8 - 34)	18.1%
RLN	32	8 (4 - 41)	29 (14 - 59)	15.8%
RM1	142	6 (2 - 20)	17 (11 - 28)	12.3%
RMC	47	9 (3 - 31)	31 (19 - 50)	2.3%
RNA	258	5 (2 - 14)	18 (9 - 32)	9.4%
RNL	59	3 (1 - 8)	17 (9 - 31)	12.3%

Trust code	NVR Cases	Median (IQR) delay from vascular assessment to surgery (days)	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
RNS	79	5 (2 - 20)	29 (17 - 45)	12.0%
RNZ	5	14 (14 - 31)	28 (14 - 29)	0.0%
RP5	35	12 (4 - 58)	24 (10 - 42)	4.5%
RPA	52	8 (5 - 16)	41 (31 - 64)	10.7%
RQ6	133	10 (3 - 21)	29 (17 - 51)	9.8%
RQ8	26	4 (2 - 6)	25 (17 - 46)	7.3%
RQW	26	7 (2 - 11)	29 (22 - 46)	17.2%
RR1	74	4 (1 - 13)	16 (8 - 28)	11.0%
RR8	142	8 (3 - 36)	21 (12 - 42)	7.9%
RRK	80	12 (3 - 32)	27 (17 - 49)	12.3%
RTD	56	11 (7 - 36)	29 (16 - 51)	1.9%
RTE	56	8 (4 - 20)	18 (13 - 32)	4.6%
RTG	64	4 (1 - 11)	22 (15 - 40)	7.2%
RTH	34	9 (4 - 39)	17 (11 - 27)	11.5%
RTK	88	3 (1 - 11)	13 (7 - 25)	14.8%
RTR	141	7 (2 - 17)	21 (15 - 35)	7.1%
RVJ	124	7 (2 - 22)	25 (12 - 40)	7.1%
RVV	87	6 (2 - 19)	21 (12 - 33)	2.3%
RW3	21	19 (4 - 32)	19 (8 - 38)	0.0%
RW6	66	7 (2 - 24)	21 (13 - 35)	10.2%
RWA	91	15 (8 - 43)	23 (15 - 35)	5.2%
RWD	74	6 (1 - 19)	23 (14 - 38)	9.0%
RWE	24	6 (1 - 14)	21 (14 - 42)	19.7%
RWH	14	9 (2 - 11)	28 (18 - 40)	22.1%
RWP	74	6 (1 - 30)	22 (13 - 41)	8.1%
RWY	19	5 (2 - 34)	31 (15 - 51)	0.0%
RX1	216	3 (1 - 8)	14 (8 - 25)	8.0%
RXH	61	11 (4 - 30)	22 (15 - 33)	7.9%
RXN	7	26 (2 - 166)	15 (8 - 38)	0.0%
RXP	2	xx	xx	xx
RXQ	29	8 (4 - 36)	30 (18 - 55)	8.8%
RXR	54	14 (4 - 34)	16 (8 - 34)	8.0%
RXW	73	6 (1 - 18)	19 (10 - 30)	7.3%
RYJ	1	xx	xx	xx
SA999	11	28 (6 - 91)	34 (9 - 65)	0.0%
SF999	4	xx	xx	xx
SG999	15	7 (3 - 11)	37 (27 - 50)	0.0%
SH999	103	2 (1 - 8)	28 (10 - 49)	9.0%
SL999	4	xx	xx	xx
SN999	64	4 (1 - 14)	43 (26 - 75)	11.9%
SS999	4	xx	xx	xx
ST999	59	4 (2 - 11)	25 (16 - 44)	10.2%

Trust code	NVR Cases	Median (IQR) delay from vascular assessment to surgery (days)	Median (IQR) length of stay (days)	Adjusted in-hospital mortality
SV999	48	7 (2 - 40)	26 (15 - 47)	7.3%
SY999	12	5 (2 - 26)	33 (15 - 49)	0.0%
ZT001	225	13 (3 - 55)	12 (6 - 20)	4.2%

xx – value not shown, due to small numbers

Appendix 9: 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 on 1 August 2016. 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 tailor 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
National Vascular Database (NVD)	An on-line database funded by The Vascular Society to collect data on major vascular procedures performed in the National Health Service. This was the predecessor of the National Vascular Registry.
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.

Registered charity number: 212808