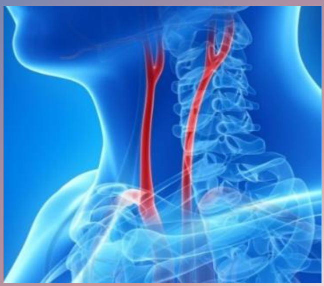

# NATIONAL VASCULAR REGISTRY

## 2020 Annual Report

**November 2020**


Royal College of Surgeons of England
ADVANCING SURGICAL CARE

VASCULAR SOCIETY
OF GREAT BRITAIN AND IRELAND

British Society of Interventional Radiology
Registered Charity No: 1084852

HQIP
Healthcare Quality Improvement Partnership

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Royal College of Surgeons of England
ADVANCING SURGICAL CARE

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

The RCS managed the publication of the 2020 Annual report.

VASCULAR SOCIETY
OF GREAT BRITAIN AND IRELAND

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

British Society of Interventional Radiology
Registered Charity No: 1084852

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

# Commissioned by

HQIP
Healthcare Quality Improvement Partnership

The Healthcare Quality Improvement Partnership (HQIP) is led by a consortium of the Academy of Medical Royal Colleges, the Royal College of Nursing and National Voices. Its aim is to promote quality improvement in patient outcomes, and in particular, to increase the impact that clinical audit, outcome review programmes and registries have on healthcare quality in England and Wales. HQIP holds the contract to commission, manage and develop the National Clinical Audit and Patient Outcomes Programme (NCAPOP), comprising around 40 projects covering care provided to people with a wide range of medical, surgical and mental health conditions. The programme is funded by NHS England, the Welsh Government and, with some individual projects, other devolved administrations and crown dependencies. www.hqip.org.uk/national-programmes. Registered charity no: 1127049

# Contents

# Acknowledgements

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

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

We would also like to thank:

- VSGBI Audit and Quality Improvement Committee
- Bristol Vascular Patient and Public Involvement (PPI) Group
- Patrick Palmer, Richard Armstrong and Edd Caton from Northgate Public Services (UK) Limited

Finally, we would like to thank Dr Fiona Miller for her contribution to the development of the NVR as clinical lead for interventional radiology.

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# Foreword

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

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

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

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

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

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

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

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

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

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

# Executive Summary

## Abdominal aortic aneurysms (AAA)

***1) Elective infra-renal AAA***

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

***VSGBI AAA Quality Improvement Framework***

| |
|---|
| All elective procedures should be reviewed preoperatively in an MDT that includes surgeon(s) and radiologist(s) as a minimum. |
| All patients should undergo standard preoperative assessment and risk scoring, as well as CT angiography to determine their suitability for EVAR. |
| All patients should be seen in pre-assessment by an anaesthetist with experience in elective vascular anaesthesia. |
| Ideally, a vascular anaesthetist should also be involved to consider fitness issues that may affect whether open repair or EVAR is offered. |

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

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

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

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

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

# Repair of abdominal aortic aneurysm (AAA) to prevent rupture

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

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

Of these

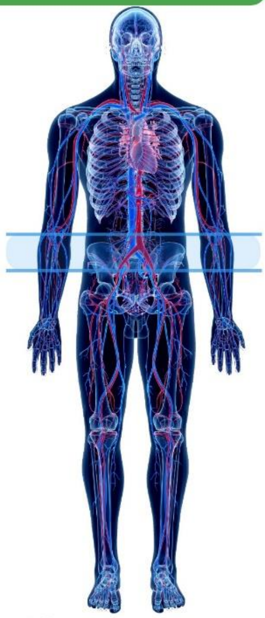
3,445

1,355 (39%) were open repair

- 90% were male
- 78% were older than 65 years
- 67% had hypertension
- 86% were a current or ex-smoker

2,090 (61%) were endovascular repair (EVAR)

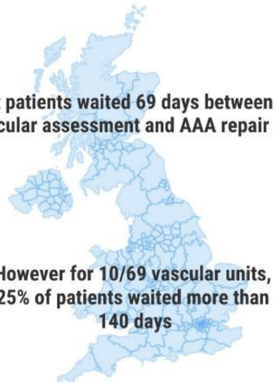
- 90% were male
- 92% were older than 65 years
- 70% had hypertension
- 85% were a current or ex-smoker



## Glossary

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

## Waiting Times



**Most patients waited 69 days between vascular assessment and AAA repair**

**However for 10/69 vascular units, 25% of patients waited more than 140 days**

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

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

## How were patients assessed?

- 85% discussed at multi-disciplinary team meeting
- 83% had fitness measured
- 91% had pre-operative angiography assessment
- 95% had formal anaesthetic review
  - 91% of these had review by consultant vascular anaesthetist

## Patient outcomes after surgery

**Open**

- 2.3% died in hospital
- 4.7% were readmitted within 30 days
- 7 days (6-10 days) average length of stay (typical range)

**EVAR**

- 0.4% died in hospital
- 5.7% were readmitted within 30 days
- 2 days (1-3 days) average length of stay (typical range)

### *2) Complex aneurysm repair*

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

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

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

### *3) Repair of ruptured AAA*

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

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

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

# Repair of elective complex aortic aneurysms to prevent rupture

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

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

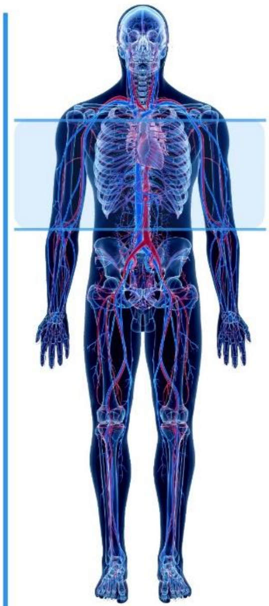
Of these

2,577

- 271 (11%) were open repair
- 2,306 (89%) were endovascular repair

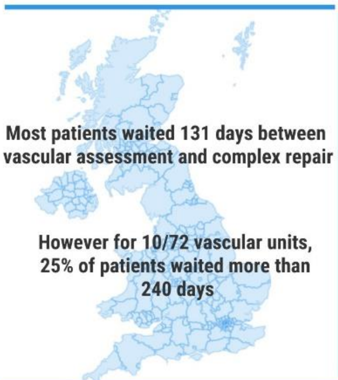
## Which people had surgery?

| | Open repair | Endovascular repair |
|---|---|---|
| were male | 88% | 82% |
| were older than 65 years | 79% | 86% |
| had hypertension | 74% | 77% |
| were a current or ex-smoker | 86% | 84% |



## Glossary

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



**Most patients waited 131 days between vascular assessment and complex repair**

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

The most common complex endovascular procedures were:

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

## Patient outcomes after surgery

**Open**

- 14.0% died in hospital
- 7.8% were readmitted within 30 days
- 9 days (6-15 days) average length of stay (typical range)

**Endovascular**

- 2.7% died in hospital
- 9.1% were readmitted within 30 days
- 4 days (2-7 days) average length of stay (typical range)

## Lower Limb Interventions for Peripheral Arterial Disease

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

**1) Lower limb bypass surgery**

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

**VSGBI: PAD QIF**

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

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

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

**2) Lower limb endovascular procedures**

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

**VSGBI: PAD QIF**

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

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

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

# Lower limb bypass for peripheral arterial disease to prevent limb loss

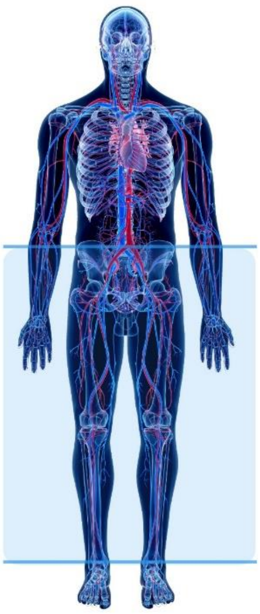
**Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower limb arteries that can severely affect a patient's quality of life, and risk their limb.**

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

**18,090** lower limb bypass procedures carried out in 2017-2019

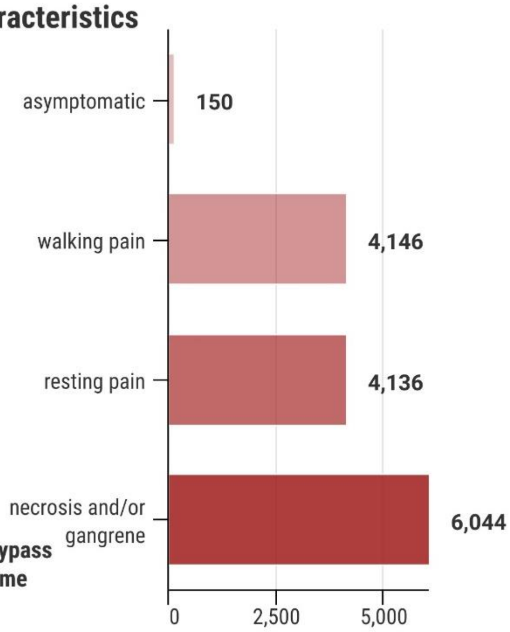
**11,283** were admitted electively

**6,807** were admitted in an emergency

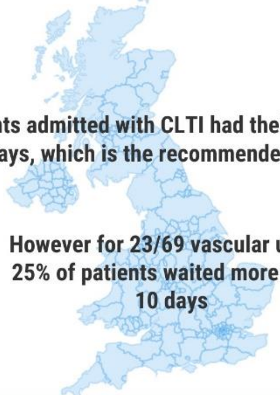


## Patient characteristics

- **74%** were male
- **66%** were older than 65 years
- **35%** were diabetic
- **89%** were current or ex-smokers




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



**50% of patients admitted with CLTI had their bypass within 5 days, which is the recommended time**

**However for 23/69 vascular units, 25% of patients waited more than 10 days**

## Glossary

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

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

## Patient outcomes post bypass

**Elective**

- **1.0%** died in hospital
- **10.2%** were readmitted within 30 days
- **5 days (3-8 days)** average length of stay (typical range)

**Emergency**

- **4.8%** died in hospital
- **15.1%** were readmitted within 30 days
- **14 days (9-25 days)** average length of stay (typical range)

# Lower limb angioplasty/stenting for peripheral arterial disease

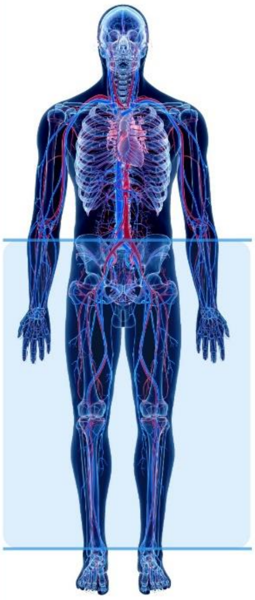
**Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower limb arteries that can severely affect a patient's quality of life, and risk their limb.**

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

**23,881** lower limb angioplasty/stent procedures carried out in 2017-2019

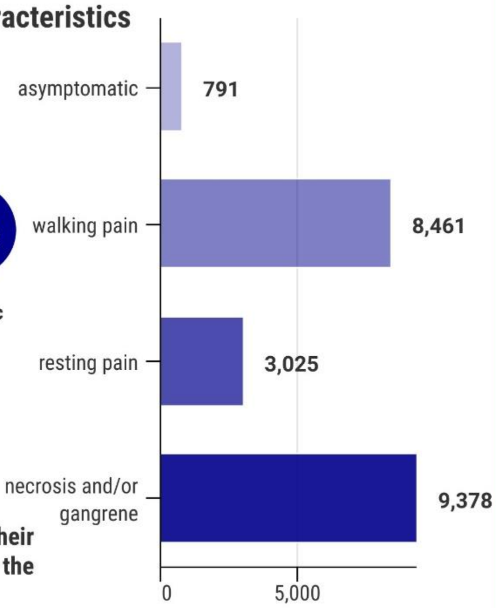
**17,276** were admitted electively

**6,605** were admitted in an emergency



## Patient characteristics

- **67%** were male
- **70%** were older than 65 years
- **47%** were diabetic
- **80%** were current or ex-smokers




**52% of patients admitted with CLTI had their angioplasty/stent within 5 days, which is the recommended time**

**However for 30/58 vascular units, 25% of patients waited more than 10 days**

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

## Glossary

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

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

## Patient outcomes post procedure

**Elective**

- 0.4% died in hospital
- 7.5% readmitted within 30 days
- 0 days (0-1 days) average length of stay (typical range)

**Emergency**

- 4.6% died in hospital
- 17.9% readmitted within 30 days
- 12 days (6-26 days) average length of stay (typical range)

### 3) Major lower limb amputation

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

***VSGBI: Amputation QIF***

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

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

***VSGBI: Amputation QIF***

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

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

***VSGBI Amputation QIF and NCEPOD Report***

| |
|---|
| Major amputations should be undertaken on a planned operating list during normal working hours. |
| A consultant surgeon should operate or at least be present in the theatre to supervise a senior trainee (ST4 or above) undertaking the amputation. |
| The patient should have routine antibiotic and DVT prophylaxis according to local policy. |

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

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

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

# Lower limb major amputation for peripheral arterial disease

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

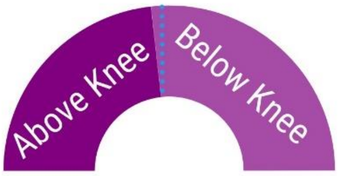
PAD can gradually progress in some patients and an operation to improve blood flow may no longer be possible. In these situations, people will require amputation of the lower limb.

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

10,022 amputations

- 4,818 above Knee
- 5,204 below Knee

Hospitals should aim to have an above knee amputation to below knee amputation ratio below 1. In 2017-2019, the national ratio was 0.93, but it varied greatly across the country. 27 hospitals had a ratio above 1, and of these, 10 were above 1.5.




## Glossary

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

## Which people had surgery?

**Above knee:**

- 68% were male
- 71% were older than 65 years
- 43% were diabetic
- 84% were current or ex-smokers

**Below knee:**

- 75% were male
- 57% were older than 65 years
- 69% were diabetic
- 78% were current or ex-smokers

## Patient outcomes after surgery

**Above Knee**

- 7.2% died in hospital within 30 days
- 8.9% were readmitted within 30 days
- 22 days (13-39 days) average length of stay (typical range)

**Below Knee**

- 2.4% died in hospital within 30 days
- 10.6% were readmitted within 30 days
- 23 days (14-38 days) average length of stay (typical range)

## Carotid endarterectomy

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

***VSGBI Provision of services***

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

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

***NICE guideline NG128***

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

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

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

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

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

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

# Carotid artery surgery to prevent stroke

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

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

### Which people had surgery?

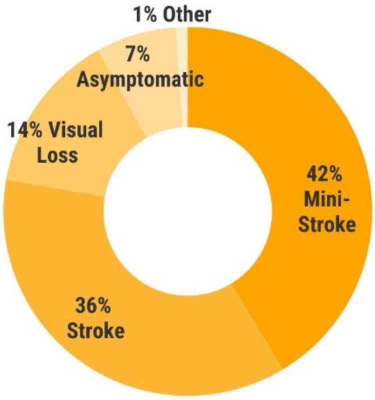
69% were male

73% were older than 65 years

24% were diabetic

29% had heart disease

### Reasons for surgery




## Glossary

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

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

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

A patient showing symptoms is known to be symptomatic.

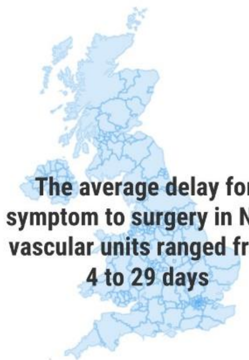
### Treatment times for symptomatic patients

Recommended time from symptom to surgery is within 14 days

average 12 days (8-22 days typical range)

Symptom → Referral → Seen by surgeon → Operation

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



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

### Outcomes of surgery

CEA

1.9% died and/or had a stroke within 30 days of the procedure

4.4% were readmitted within 30 days

2 days (2-5 days) average length of stay (typical range)

# Recommendations

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

# 1. Introduction

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

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

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

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

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

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

## 1.1 The 2020 Annual Report

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

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

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

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

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

The NVR process measures are linked to standards of care that are drawn from various national guidelines. These focus on (i) specific aspects of care before and after the vascular intervention, and (ii) the time taken by patients to move along the care pathway. An overall framework for vascular services is described by the "Provision of Services for Patients with Vascular Disease" published by the Vascular Society [VSGBI 2018].

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

*For elective AAA repair*

- The Vascular Society. "Quality Improvement Framework for AAA" [VSGBI 2012]
- Standards and outcome measures for the National AAA Screening Programme (NAAASP) [NAAASP 2009].

*For peripheral arterial disease*

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

*For carotid endarterectomy*

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

## 1.2 Publication of information on the VSQIP website

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

The website also provides access to:

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

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

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

## 1.3 How to read this report

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

The data used in this report was extracted from the NVR IT system in July 2020. This was to allow sufficient time for NHS hospitals to enter follow-up information about the patients having these vascular interventions, and to provide a period in which NHS consultants could check the completeness and accuracy of their data. Only records that were locked by NHS staff (i.e., the mechanism used in the IT system for a hospital to indicate that data entry is complete) were included in the analysis of the 2017-19 audit period. The data submission deadline was later in 2020 than in previous years due to impact of the COVID-19 pandemic on hospital services.

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

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

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

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

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

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

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

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

The results in this section should be regarded as preliminary. Information in the submitted records was not always complete, and a portion of the records had not been locked when the data extract was taken from the NVR data collection system (September 2020). Thus, the results are restricted to the data from 84 NHS vascular units whose activity in the NVR between January and March 2020 was similar to that during the same period in 2019.

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

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

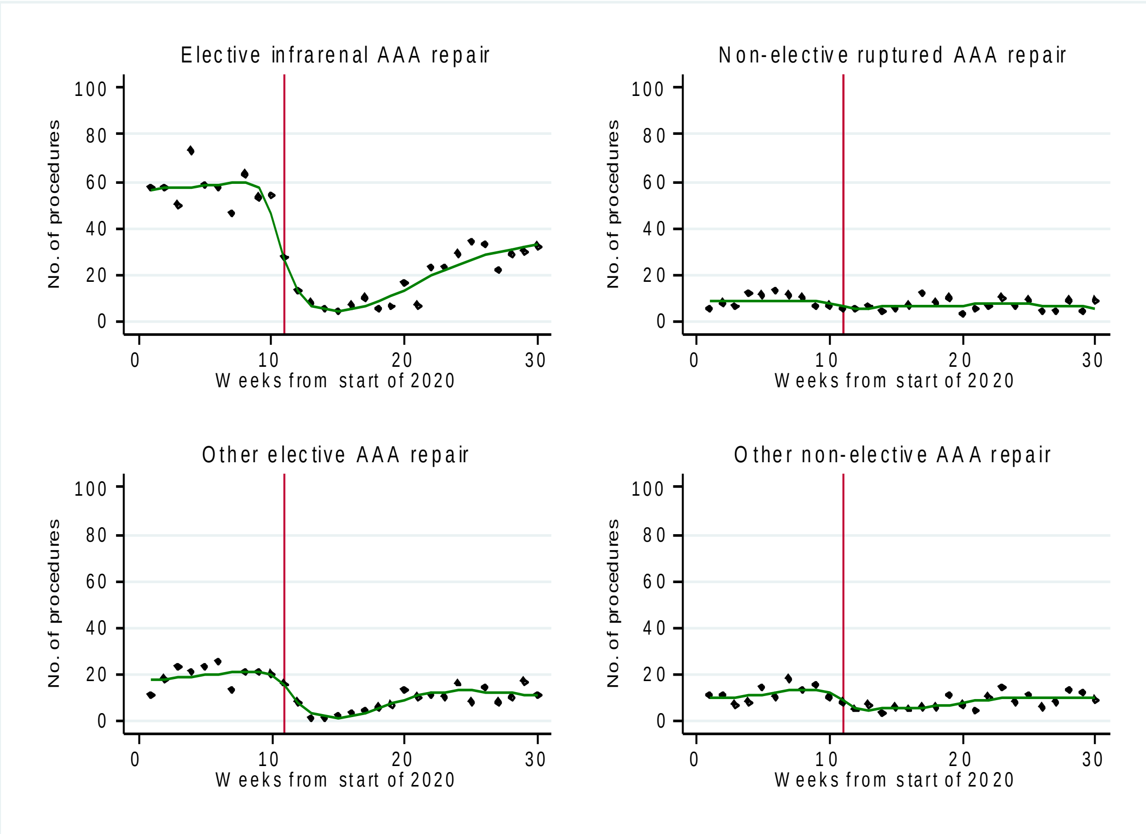
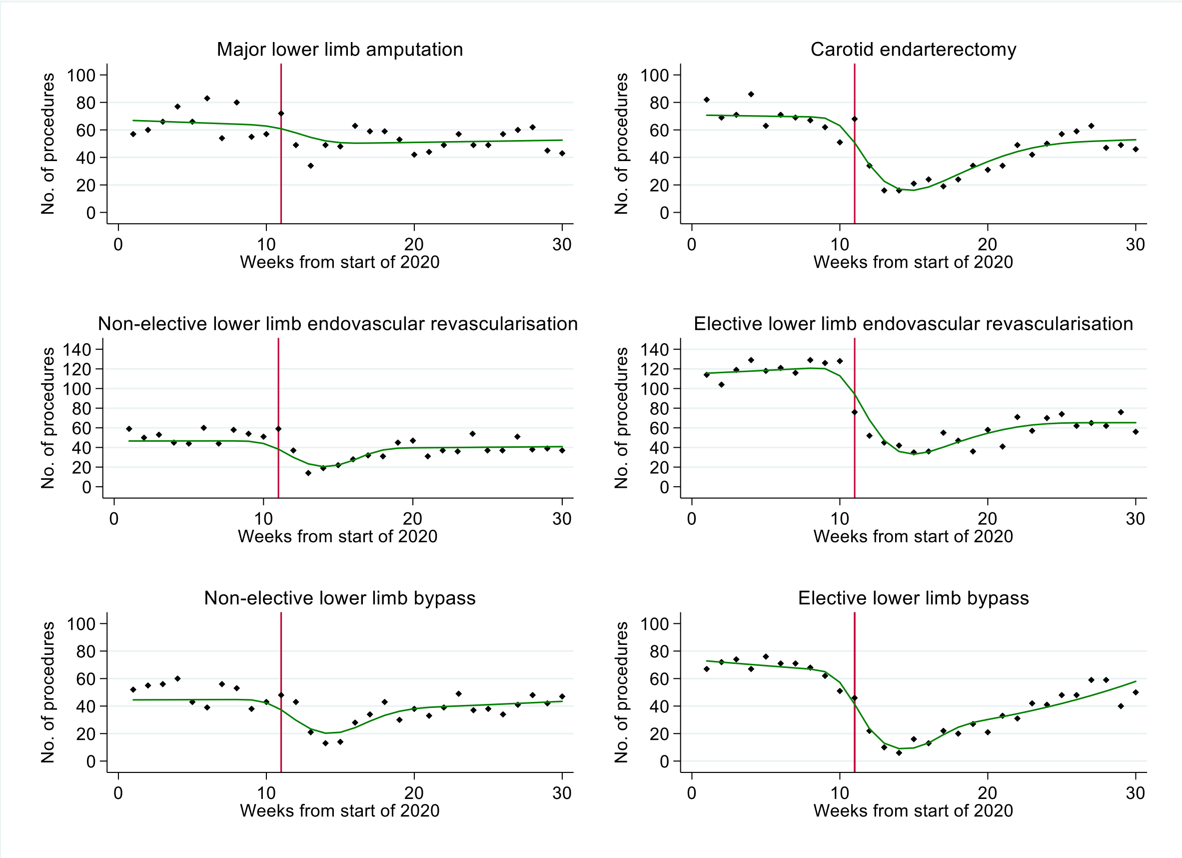


Figure 1.2: Weekly number of lower limb procedures and carotid endarterectomies in 84 NHS vascular units between 5 January and 1 August 2020.




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

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

# 2. Repair of elective infra-renal abdominal aortic aneurysm

## 2.1 Background

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

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

The audit period from 1 January 2017 to 31 December 2019 covered in the 2020 Annual report saw a number of changes in the organisation of vascular services undertaking AAA repair. The number of NHS vascular units performing AAA repairs decreased from 78 in 2017 to 75 in 2019. Furthermore, the number of elective infra-renal AAA repairs being performed continued to fall, with 3,445 procedures recorded in 2019 compared with 4,286 in 2017 (Table 2.1).

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

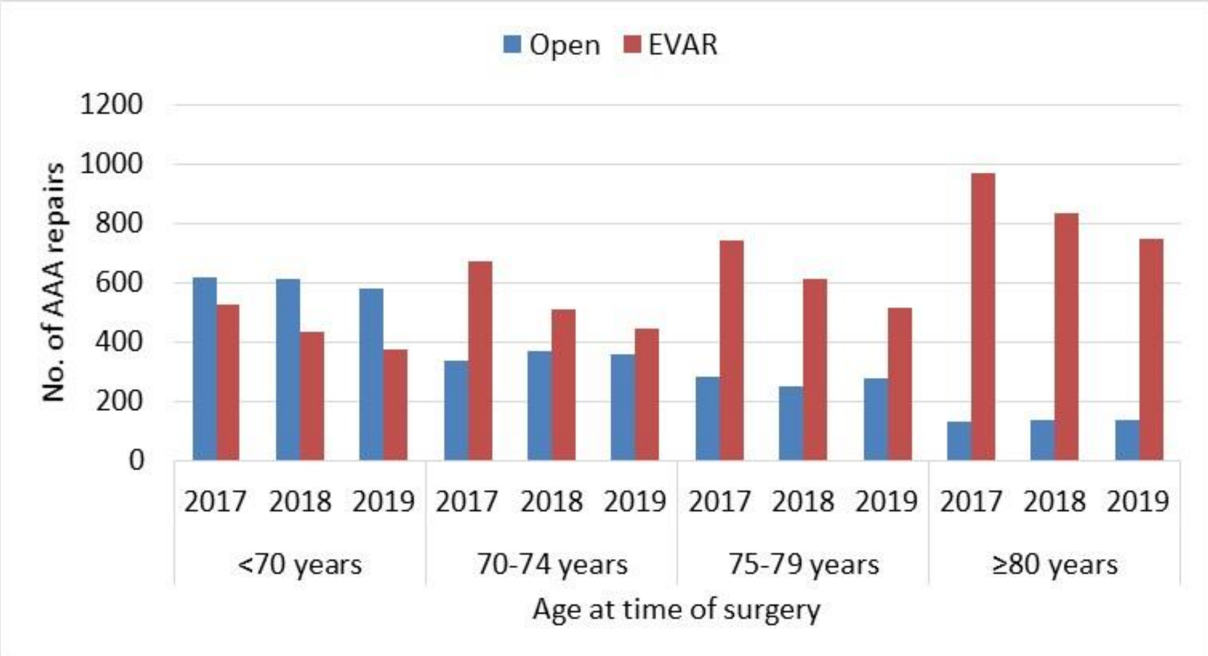
The fall in the volume of AAA repairs coincided with a decrease in the number of endovascular (EVAR) procedures, so that they accounted for 61% of the elective infra-renal AAA repairs in 2019 compared with 68% in 2017. The reduction has occurred over all age ranges (Figure 2.1). The numbers of open procedures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

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

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

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

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




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

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

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

- the neck angle was less than 60 degrees for 90.8% of procedures
- the median proximal aortic neck diameter and length were 23 mm (IQR 21 to 25) and 24 mm (IQR 18 to 31), respectively
- there were 346 (17.4%) procedures that unilaterally extended into the iliac artery and 102 (5.1%) that required bilateral limb extensions.

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

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

## 2.2 Preoperative care pathway for elective infra-renal AAA

**VSGBI AAA QIF**

| |
|---|
| All elective procedures should be reviewed preoperatively in an MDT that includes surgeon(s) and radiologist(s) as a minimum. |
| All patients should undergo standard preoperative assessment and risk scoring, as well as CT angiography to determine their suitability for EVAR. |
| All patients should be seen in pre-assessment by an anaesthetist with experience in elective vascular anaesthesia. |
| Ideally, a vascular anaesthetist should also be involved to consider fitness issues that may affect whether open repair or EVAR is offered. |

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

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

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

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

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

### ***National AAA Screening Programme***

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

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

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

In the right panel, the black diamonds show that the median delay at the majority of vascular units tended to fall within the range of 50 to 90 days (median 69: IQR 36 - 114). At 14% of the vascular units (10 of 69), a quarter of patients who had operations in 2019 waited more than 140 days; nevertheless, this is an improvement from the 22% of units where a quarter of patients waited as long in 2018.

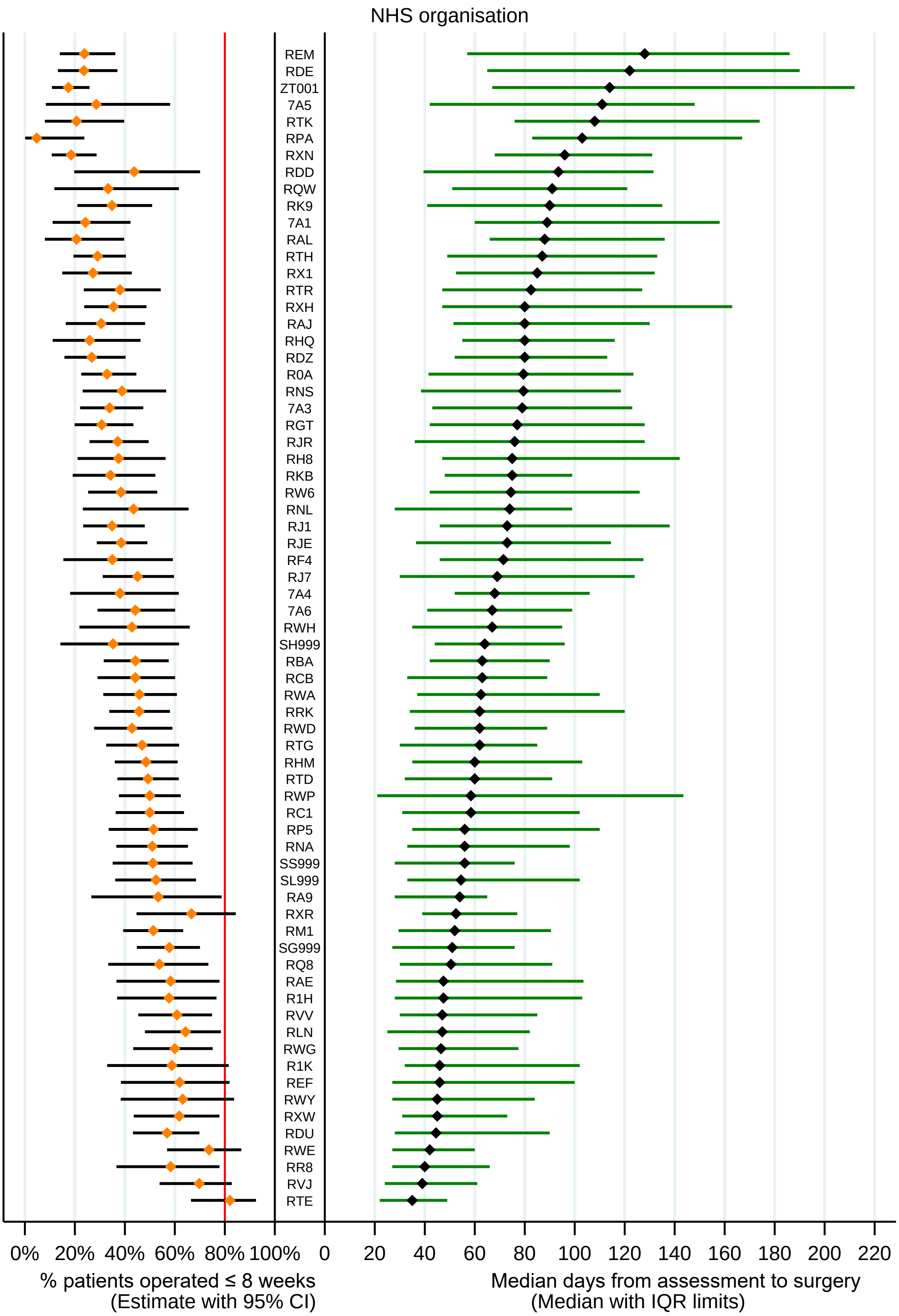
In the left panel of Figure 2.2, the orange diamonds show the proportion of patients that were seen within the recommended 8 weeks after their CT/MR angiography assessment. The grey horizontal bars depict their 95% confidence intervals. The red line shows the 80% target indicated by NAAASP.

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

There are legitimate reasons for why patients wait for surgery, such as the optimisation of comorbid medical conditions. However, 140 days is 2.5 times greater than the National AAA Screening Programme target of 8 weeks from date of referral to surgery (and this analysis also under-estimates this by being restricted to the time from vascular assessment to surgery).

The values for the individual organisations can be found in the online appendices spreadsheet.

Figure 2.2: Median (IQR) time from assessment to treatment (days) for patients who had elective infra-renal AAA repair between January and December 2019 (black diamonds) and proportion seen within 8 weeks of assessment (orange diamonds)



## 2.3 Postoperative outcomes after elective infra-renal AAA repair

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

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

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

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

Patients undergoing EVAR procedures may experience various types of endoleak. Of these, type I endoleaks (in which blood leaks around the points of graft attachment) are the most serious and generally require intervention. Among the EVAR procedures performed in 2019:

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

Patient frailty was one of the new quantities to be collected in the NVR from January 2019. Frailty is a syndrome defined as increased vulnerability due to a decline in reserve and function, and covers both cognitive and physical domains. The importance of frailty assessment has already been established in patient selection and postoperative care among older surgical patients, and there is evidence for its use in preoperative optimization with an elderly care physician review prior to vascular surgery.

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

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

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

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

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

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

The comparative, risk-adjusted mortality rates for individual NHS Trusts are shown in a funnel plot in Figure 2.3. The overall in-hospital mortality rate was 1.4%, and all NHS Trusts had a risk-adjusted rate of inpatient mortality that fell within the expected range given the number of procedures they each performed.

Figures 2.4A and 2.4B show the risk-adjusted rate of inpatient mortality among NHS Trusts for open repair and EVAR procedures separately. The funnel plots are centred on the national mortality rate for these two procedures. The overall in-hospital mortality rates for open and EVAR procedures for the 3-year period between 2017 and 2019 were 2.9% and 0.6%, respectively.

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

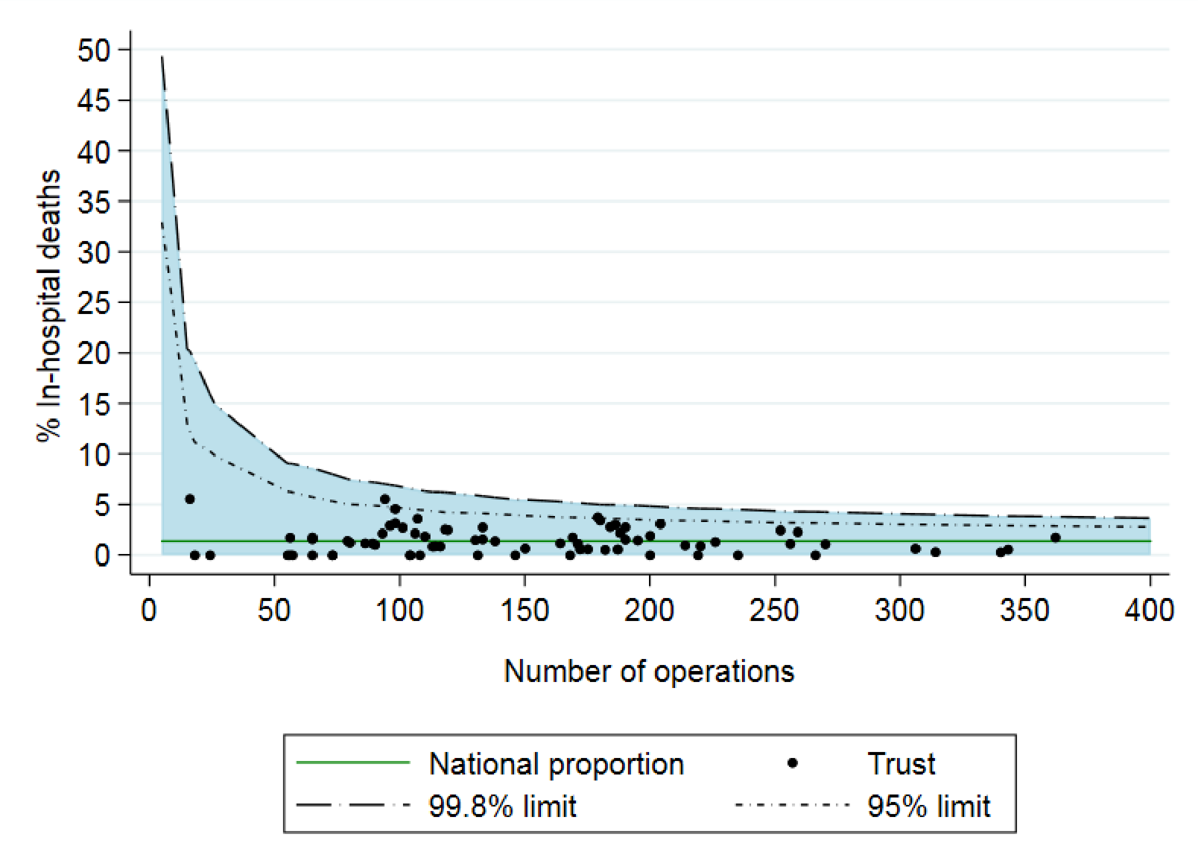
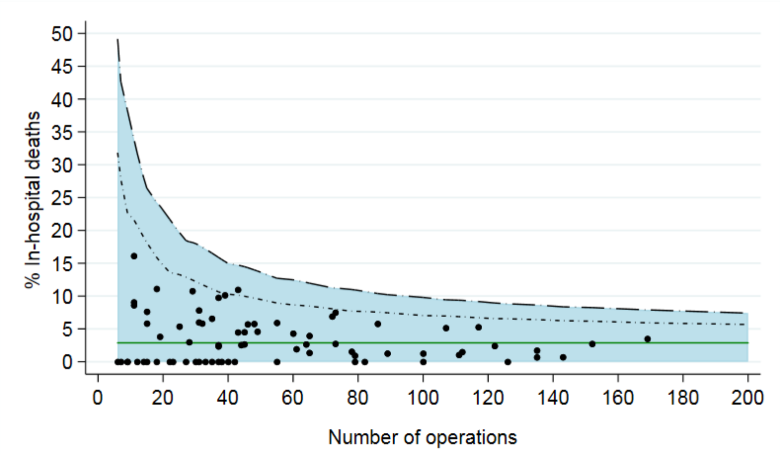
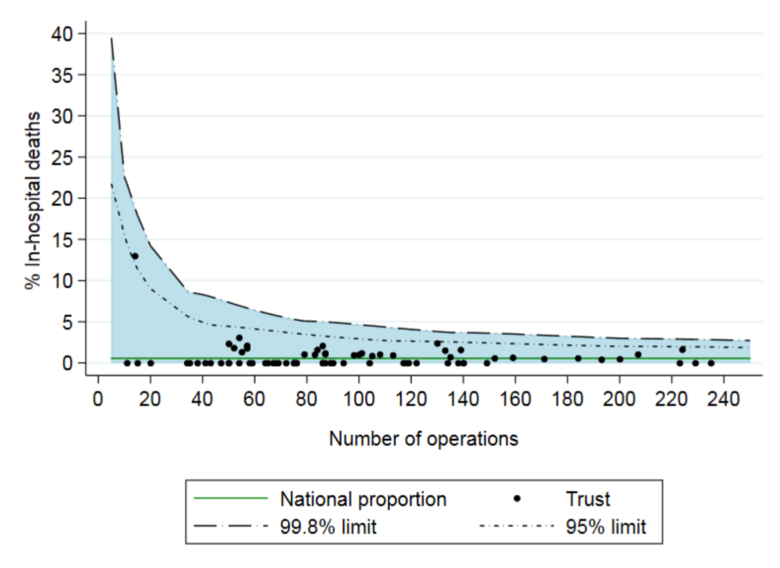


Figure 2.4: Funnel plot of risk-adjusted in-hospital mortality after elective AAA repair for open and EVAR procedures performed between 2017 and 2019.




*A: Open repairs*

The postoperative in-hospital mortality rate for open repair procedures was 2.9%




B: EVAR procedures

The postoperative in-hospital mortality rate for EVAR procedures was 0.6%

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

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

# 3. Elective repair of complex aortic conditions

## 3.1 Patterns of complex aortic surgery

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

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

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

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

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

This chapter provides results for the 3-year period between January 2017 and December 2019. The NVR received 2,577 records related to complex AAA procedures from 73 vascular units. The numbers have fluctuated over these three years, with 872 procedures in 2017, 917 in 2018 and 788 in 2019. Of these procedures, 2,306 (89%) were endovascular (Table 3.1), with just over half being fenestrated repairs.

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

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

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

Figure 3.1: Number of trusts performing elective complex AAA repair

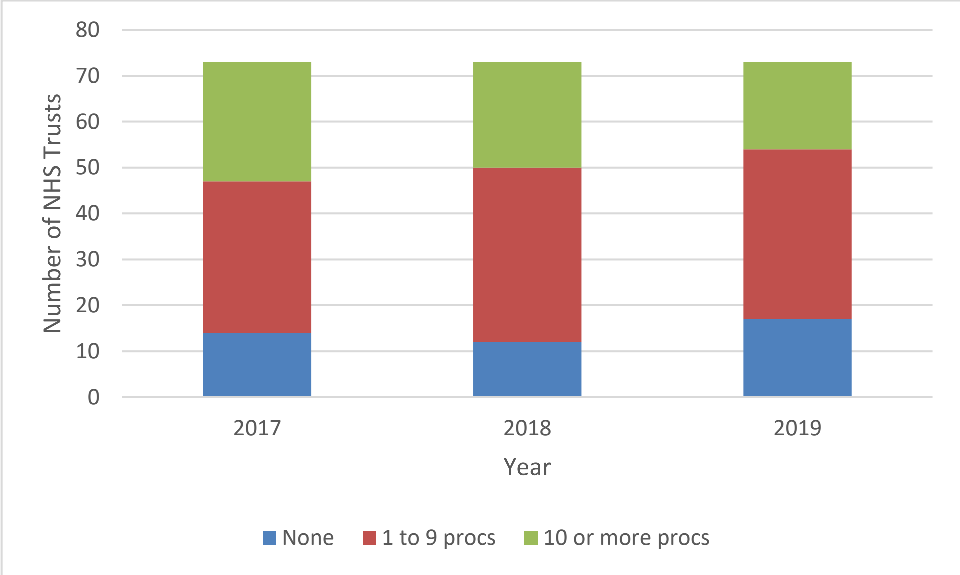



Table 3.1: Characteristics of patients who had an elective repair of complex AAA between January 2017 and December 2019

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

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

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

The 2016 NVR snapshot audit identified a number of reasons why patients having complex repairs typically had a longer delay between vascular assessment and surgery than patients having infra-renal endovascular repair. These included:

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

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

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

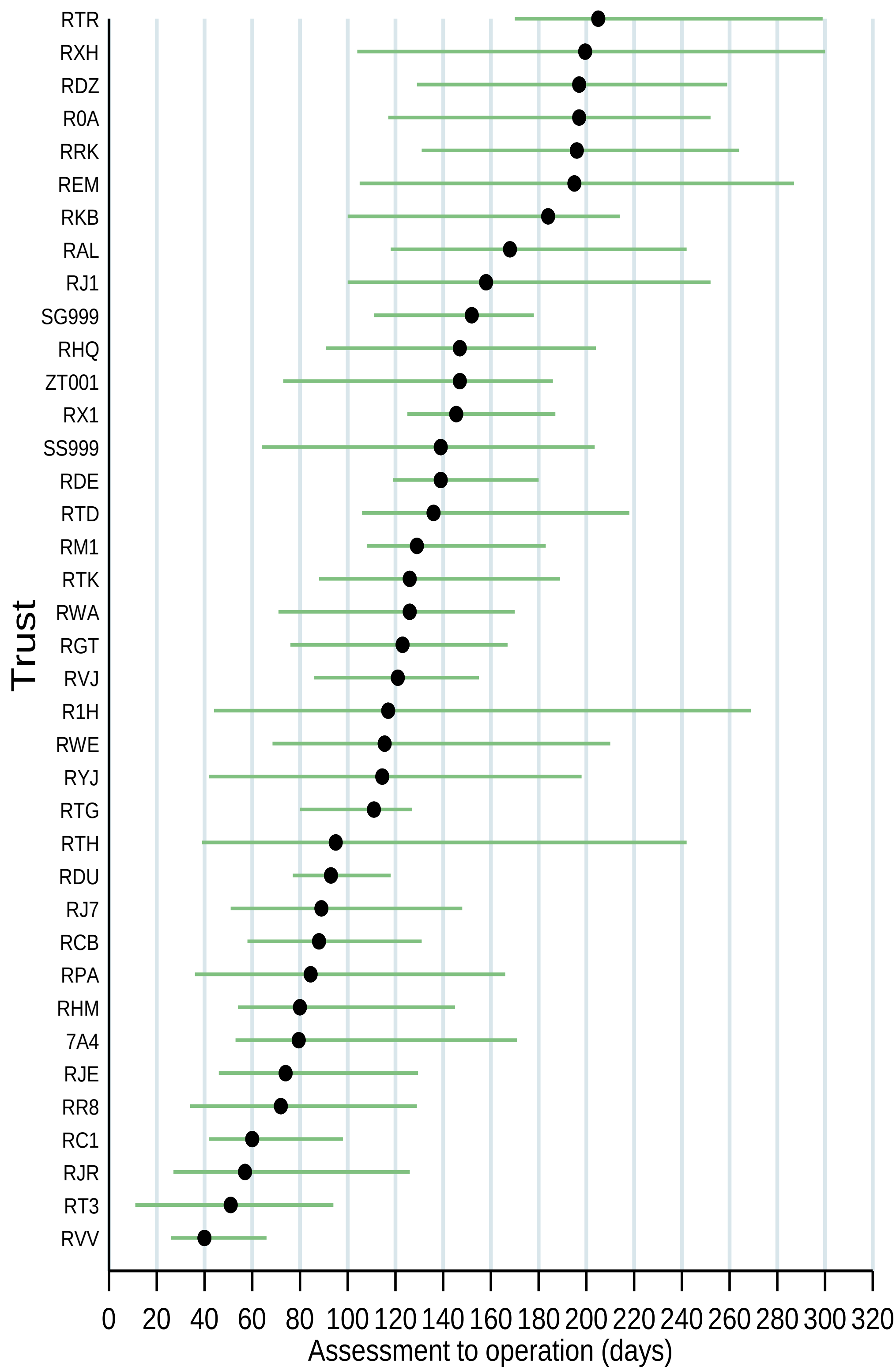


Table 3.2 describes the outcomes of elective complex AAA repairs. As with elective infra-renal AAA repairs, clear differences can be seen between open and EVAR procedures:

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

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

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

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

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

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

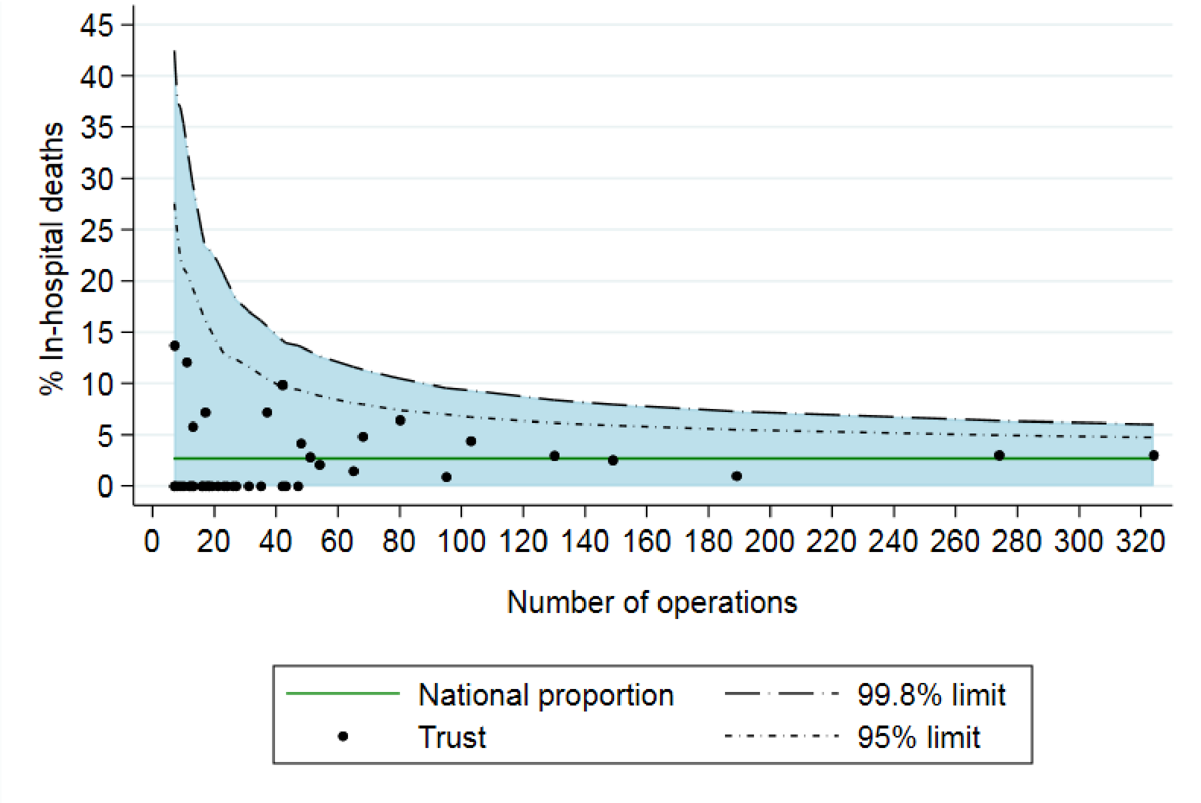
| | | TEVAR (n=469) | | FEVAR (n=1,303) | |
|---|---|---|---|---|---|
| Admitted to | Ward | 18.3% | | 15.8% | |
| | Level 2 | 60.1% | | 65.3% | |
| | Level 3 | 21.3% | | 18.8% | |
| | Died in theatre | 0.2% | | 0.1% | |
| | | ***Median*** | ***IQR*** | ***Median*** | ***IQR*** |
| Days in critical care: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

## 3.2 Postoperative in-hospital mortality for complex endovascular procedures

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

The adjusted mortality rates for individual NHS Trusts are shown using a funnel plot in Figure 3.3. All 44 NHS Trusts had an in-hospital mortality that fell within the expected range around the national average of 2.7%, given the number of procedures performed. The rates among the NHS Trusts ranged from 0 to 15% but this reflected the relatively low volumes used to calculate these rates.

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




## 3.3 Comment

Complex aortic aneurysm repairs account for a relatively small part of the overall vascular surgical workload, but they consume a relatively greater proportion of the health care resources than infra-renal AAA repairs. The relatively high postoperative mortality rate, particularly for open repairs, highlights the need for NHS Trusts and Commissioners to focus on ensuring the care for these patients is delivered safely. It is recommended that complex aortic surgery should only be commissioned from vascular units that submit complete and accurate data on caseload and outcomes of these procedures to the NVR. Furthermore, commissioning of complex AAA intervention should be reviewed if units perform less than 10 procedures annually.

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

# 4. Repair of ruptured abdominal aortic aneurysms

## 4.1 Surgical activity for ruptured AAA

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

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

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

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

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

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

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

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

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

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

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

## 4.2 Postoperative in-hospital mortality for ruptured AAA repair

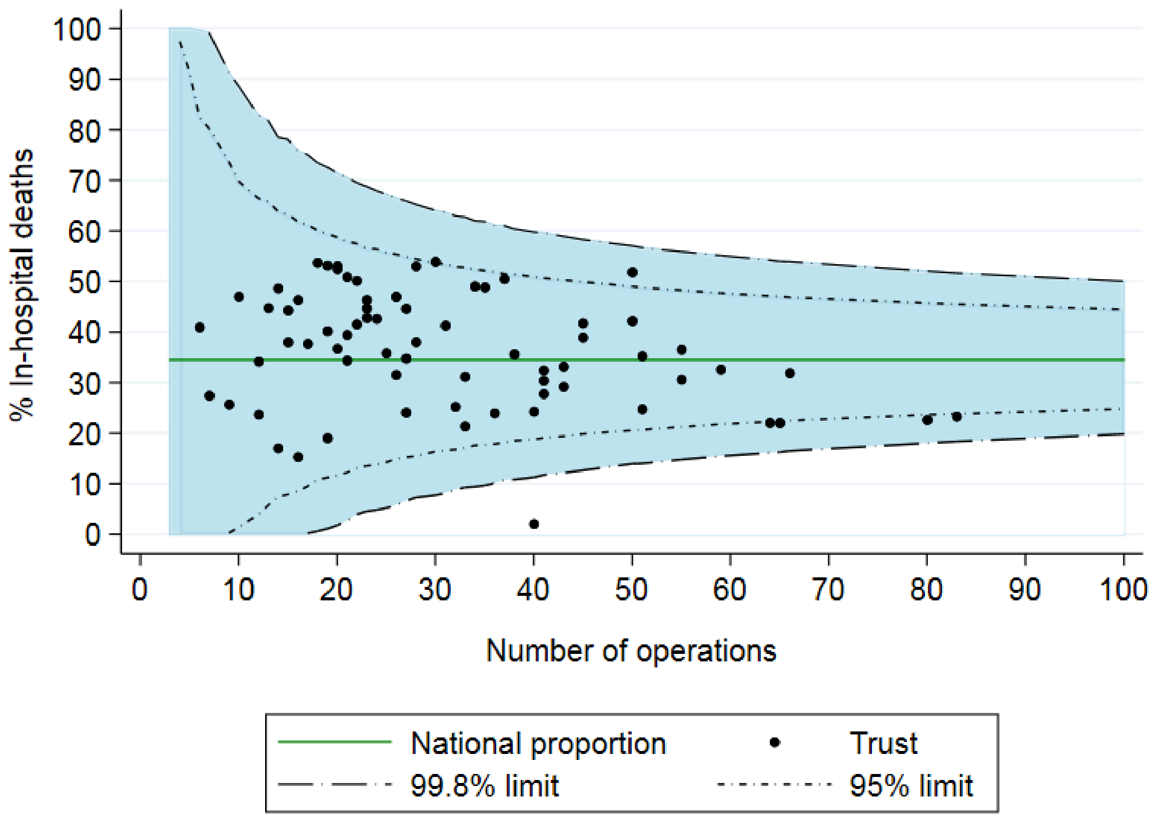
For NHS organisations undertaking repair of a ruptured AAA between 1 January 2017 and 31 December 2019, the risk-adjusted postoperative mortality rates are shown using a funnel plot in Figure 4.1.

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

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

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

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




* The online appendices spreadsheet can be found at [https://www.vsqip.org.uk/reports/2020-annual-report/](https://www.vsqip.org.uk/reports/2020-annual-report/)

# 5. Lower limb bypass for PAD

## 5.1 Introduction

Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower limb arteries [Peach et al 2012]. The disease can affect various sites in the legs, and produces symptoms that vary in their severity, from pain in the legs during exercise to persistent ulcers, or gangrene.

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

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

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

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

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

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

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

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

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

## 5.2 Time to revascularisation for patients with CLTI

***VSGBI: PAD QIF***

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

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

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

Figure 5.1 (overleaf) summarises the median (IQR) time from admission to surgery (right panel) across 69 NHS Trusts that performed 10 or more bypasses for non-elective admissions between 2017 and 2019. The left panel shows the proportion of patients waiting inside 5 days (with 95% confidence intervals shown as grey lines). The red line indicates a recommended 80% target. In the right panel, the red vertical line indicates the 5-day standard defined by the VSGBI. In summary:

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

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

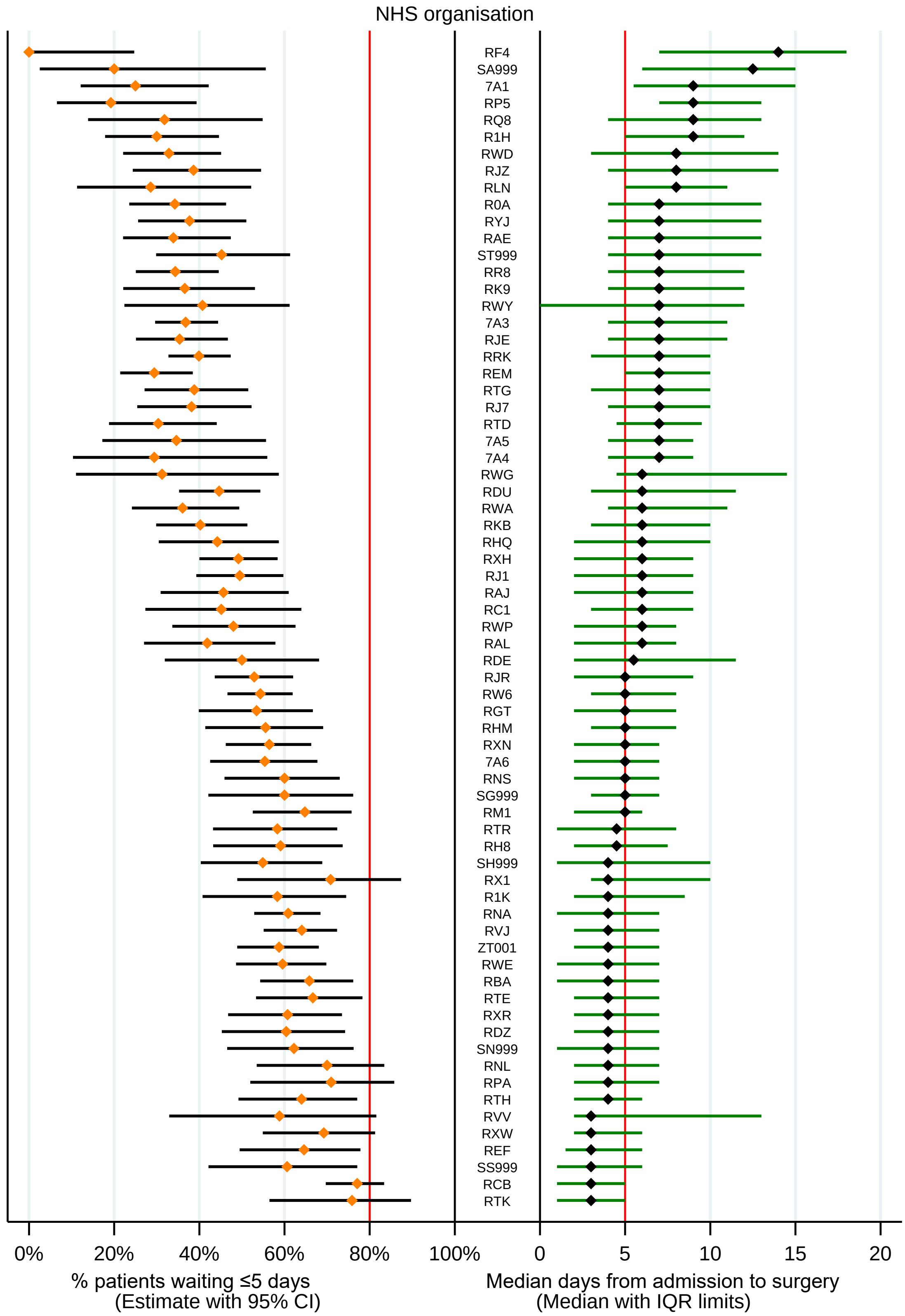


Table 5.2: Postoperative outcomes for patients undergoing elective and non-elective lower limb bypasses between January 2017 and December 2019

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

## 5.3 Postoperative outcomes for lower limb bypasses

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

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

However, the figures show that 10% of elective and 15% of non-elective patients have an unplanned readmission within 30 days. The NVR does not have data on the reasons for readmission but local services should review their local rates to determine their cause.

The outcomes of the revascularisation procedures for patients with CLTI admitted non-electively are summarised in Table 5.3. There are some differences in outcomes according to whether patients met the 5-day target for the delay between assessment and surgery, although we caution against the over-interpretation of these figures. Further work is required to identify the degree to which these differences arise from the time to surgery or from the patients having more severe disease, for which outcomes would be expected to be worse.

Table 5.3: Postoperative outcomes following lower limb bypass, for patients undergoing non-elective revascularisation for CLTI, stratified by the preoperative length of stay (LOS) in hospital

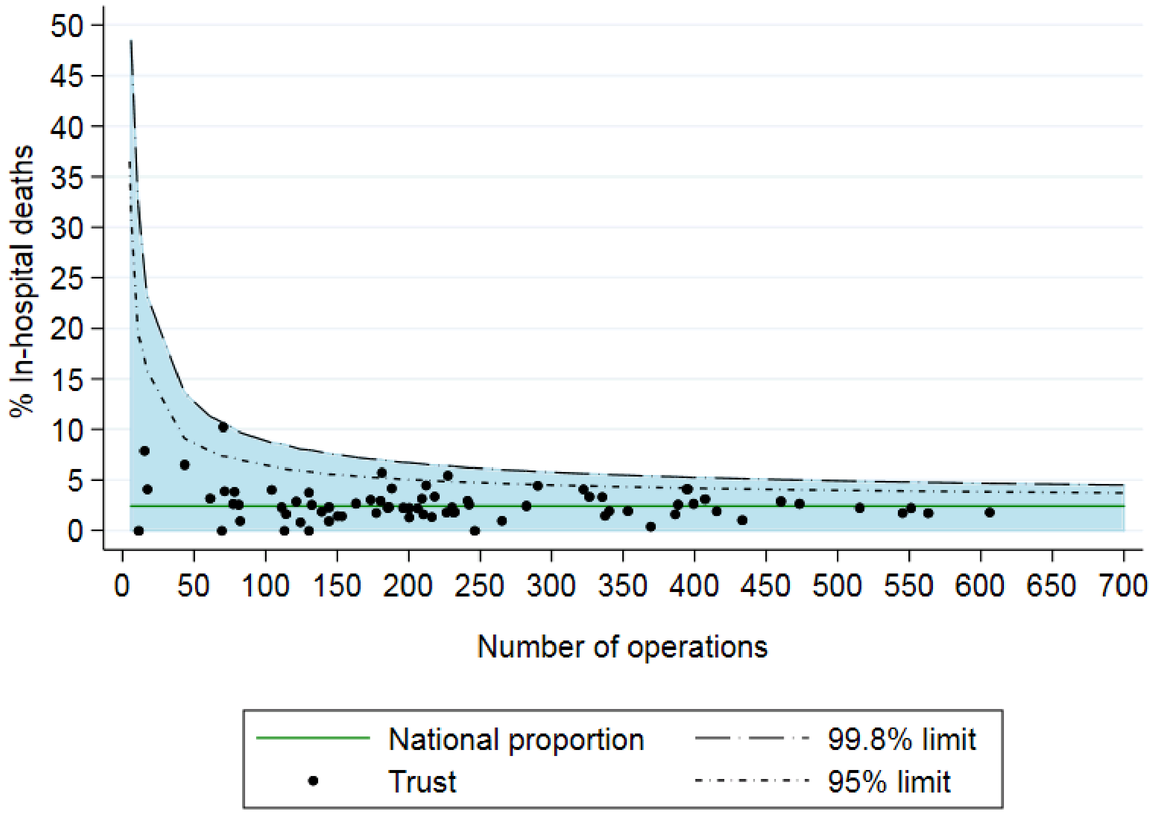
| | **Patients with preoperative LOS ≤5 days** | | **Patients with preoperative LOS >5 days** | |
|---|---|---|---|---|
| | **No.** | | **No.** | |
| Procedures | 2,243 | 49.9% | 2,255 | 50.1% |
| | **Median** | **IQR** | **Median** | **IQR** |
| Days in critical care | | | | |
| Level 2 | 1 | 0 to 2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

## 5.4 Rates of in-hospital death after lower limb bypass

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

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

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



## Patients who undergo a hybrid lower limb revascularisation procedures

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

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

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

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

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

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

# 6. Lower limb angioplasty/stent for peripheral arterial disease

## 6.1 Introduction

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

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

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

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

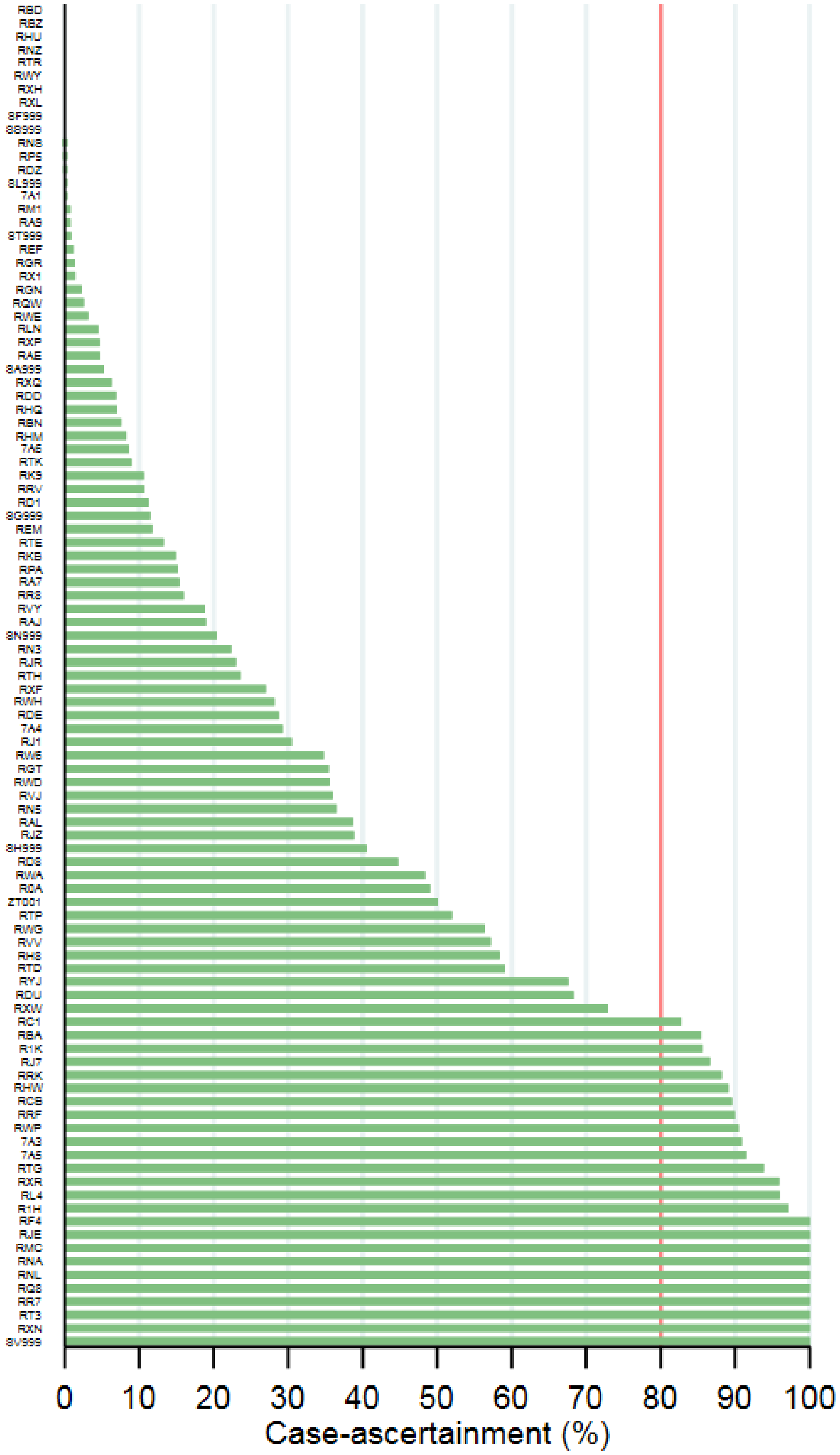
- 35 Trusts failed to submit 10% of the expected number of procedures
- 14 Trusts submitted less than 10 cases and were excluded from the Trust-level analysis
- 10 Trusts did not submit any cases.

The 2018 GIRFT report on vascular services recommended that case-ascertainment rates for lower limb endovascular procedures should exceed 85% [Horrocks 2018]. NHS hospitals should ensure there are sufficient resources (including administrative support) for vascular services to meet this target level of participation in the NVR.

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

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

Figure 6.1: Case-ascertainment by NHS Trust



## 6.2 Procedure characteristics

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

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

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

Half of the endovascular procedures involved treatment of a single vessel (55%), with 32% treating two, 10% treating 3 and 3% treating 4 or more vessels. The most common site was the superficial femoral artery, followed by the popliteal (18% of vessels, 28% of cases), common iliac (17% of vessels, 22% of cases) and tibial/pedal arteries (15% of vessels, 23% of cases). Plain balloon angioplasty alone was the most common type of intervention (29,035 vessels, 75%); a stent alone was used in 3,476 (9%) vessels and 6,108 (16%) were a combination of angioplasty and stenting. The success rate of the procedures (defined as successful by the operator) was high overall, although the rate decreased slightly for anatomical locations further down the leg.

Table 6.2: Characteristics of lower limb endovascular procedures by anatomical location

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

[1] The other indication for intervention was occlusion. 215 vessels and aorta missing lesion codes.
[2] The other outcomes were residual stenosis and failure. 229 vessels and aorta missing outcome codes.

***VSGBI: PAD QIF***

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

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

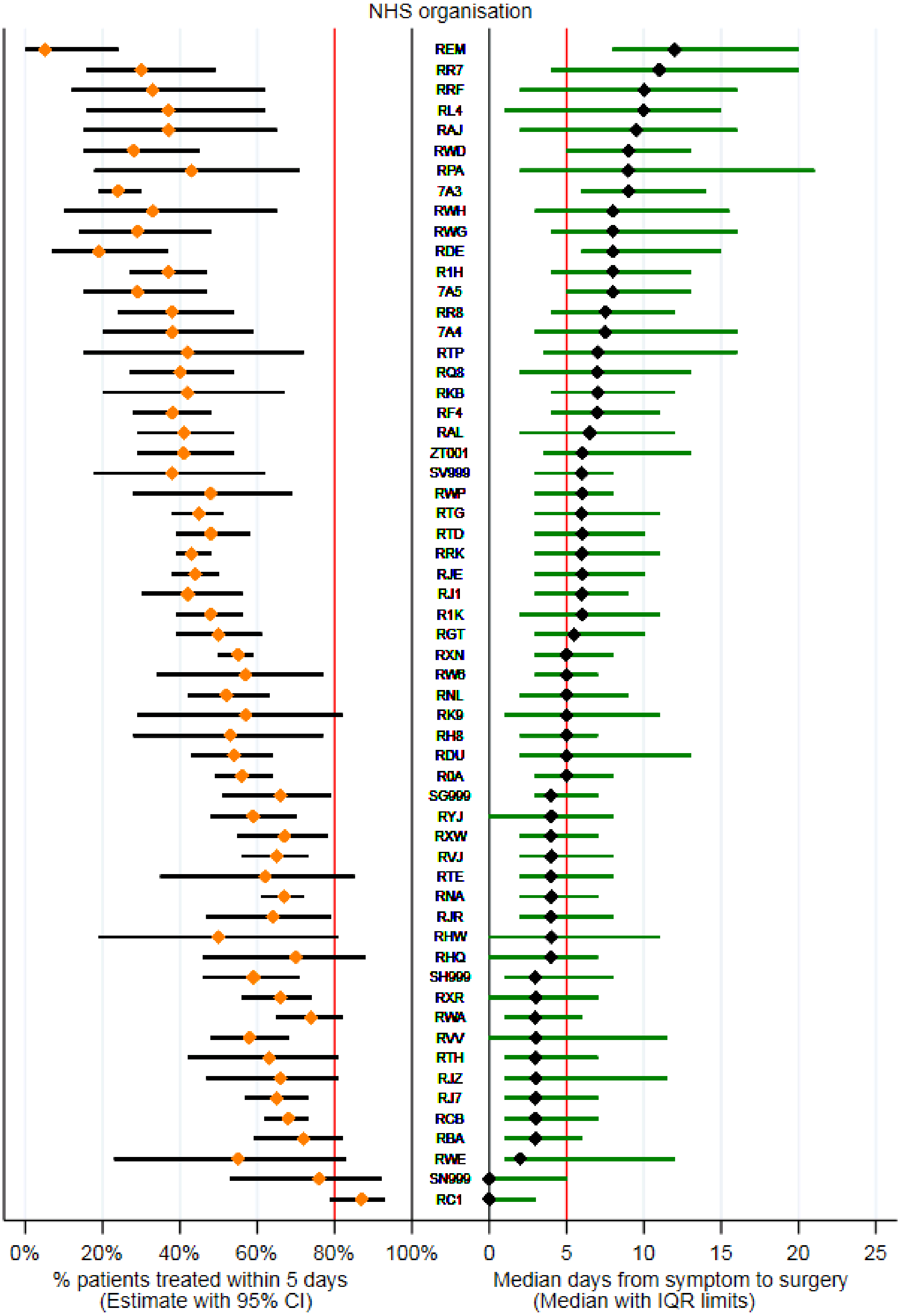
***VSGBI: PAD QIF***

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

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

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

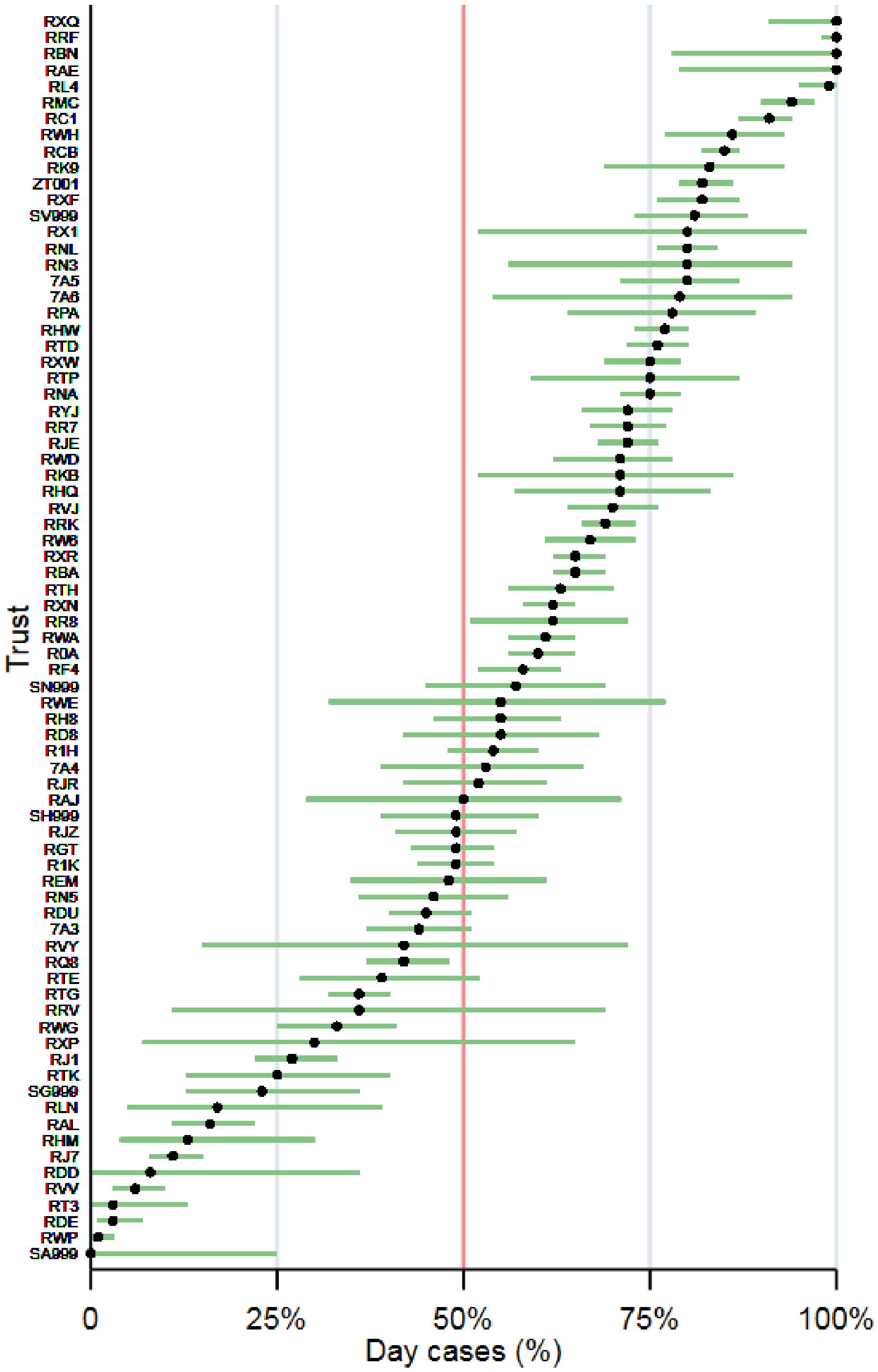
Figure 6.2 Proportion of non-elective CLTI patients who were revascularised within 5 days and time from admission to procedure by active NHS Trust with a volume of ≥10 non-elective CLTI cases



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

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

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



## 6.3 Outcomes of lower limb angioplasty/stents

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

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

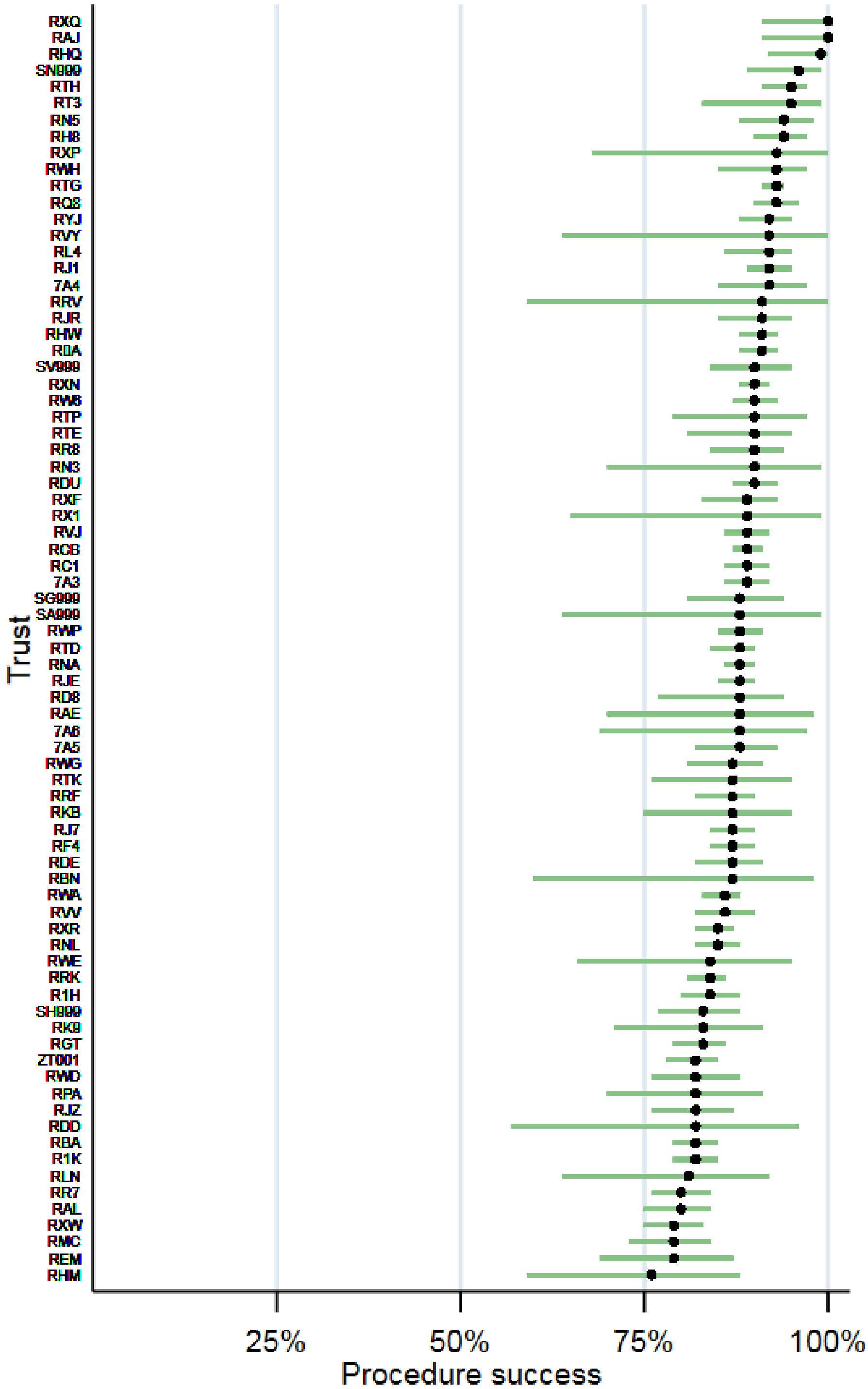


Table 6.3 describes specific outcomes for lower limb endovascular procedures, by mode of admission. As expected, patients undergoing endovascular revascularisation as non-elective admissions generally had worse outcomes than those undergoing elective procedures. Patients undergoing endovascular procedures for acute limb ischaemia also had worse outcomes than CLTI, with in-hospital mortality rate of 1.2 (95%CI 0.6-2.2) for elective and 5.5 (95%CI 4.0-7.2) for non-elective admissions.

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

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

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

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

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

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

Table 6.4: Postoperative outcomes following endovascular lower limb revascularisation, for patients with CLTI undergoing non-elective revascularisation[1], by preoperative length of hospital stay

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

[1] Fontaine score 3 or 4

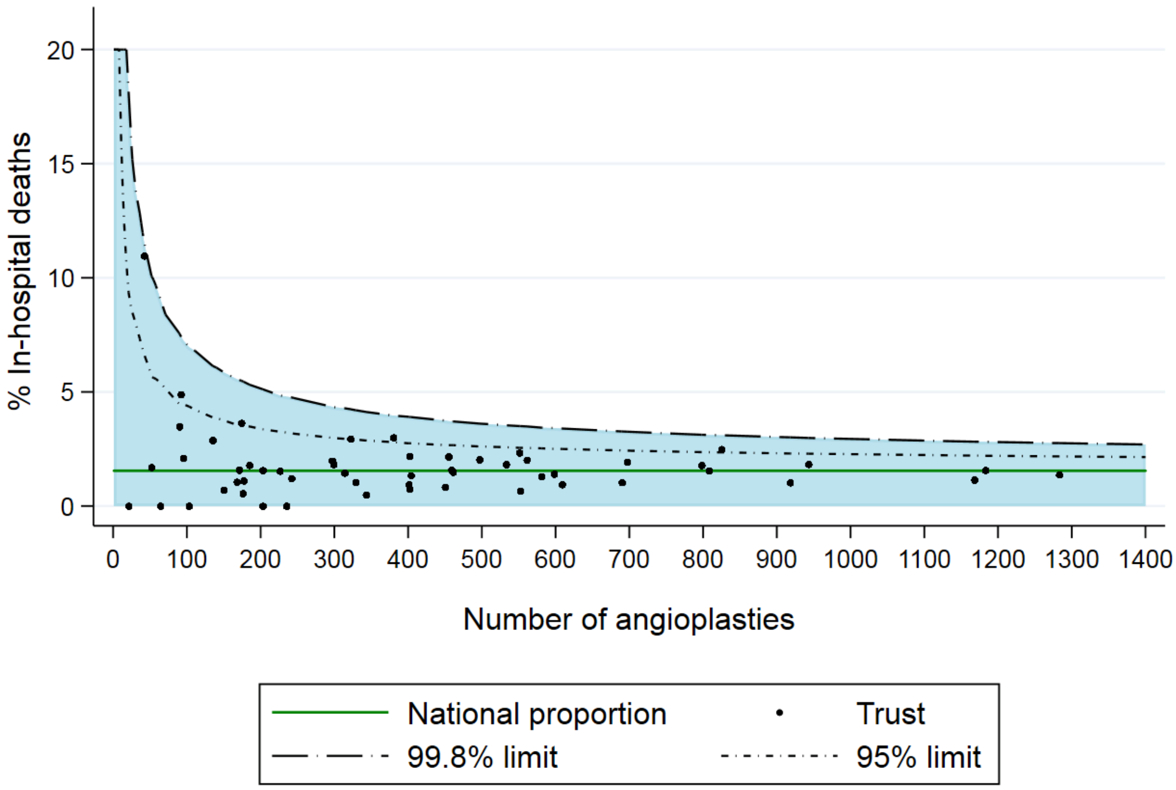
## 6.4 Risk-adjusted in-hospital deaths

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

All NHS trusts had a risk-adjusted rate of postoperative in-hospital mortality that fell within the expected range of the overall national average of 1.6% (95% CI: 1.4 to 1.7).

The rates of in-hospital mortality after endovascular revascularisation were adjusted to take account of the differences in patient populations within each organisation. The model included admission mode, presenting problem, Fontaine score, patient age, gender, chronic lung disease, chronic renal disease, chronic heart failure and smoking status.

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




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

# 7. Major lower limb amputation

## 7.1 Introduction

This chapter describes the patterns of care and outcomes for patients undergoing unilateral major lower limb amputations due to vascular disease during the audit period from January 2017 to December 2019.

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

In addition, NHS hospitals submitted information on 3,335 (23.5%) minor amputations, 256 (1.8%) bilateral amputations, 137 (1.0%) amputations due to trauma and 527 (3.7%) associated with a bypass. As the chapter focuses on major unilateral lower limb amputations, these records were not included in the analysis.

Table 7.1 gives the estimates of case-ascertainment for major unilateral lower limb amputations. The overall level of case-ascertainment is close to the target of 85% recommended within the 2018 GIRFT vascular surgery report [Horrocks 2018]. Nonetheless, many NHS Trusts are still failing to record a large proportion of their major lower limb amputations in the NVR.

Table 7.1: Estimated case-ascertainment for major lower limb vascular amputations by year

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

## 7.2 Care pathways

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

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

***VSGBI: Amputation QIF***

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

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

Figure 7.1 describes the times from vascular assessment to amputation by NHS Trust for patients admitted non-electively, together with percentage of patients that had a wait exceeding 30 days. The graph shows some variation across the NHS Trusts in the median wait, but among the 25% of patients who have the longest waits, there was considerably greater variation in the delay across NHS trusts. At 11 NHS Trusts, more than 25% of patients had a wait that exceeded 30 days, which is similar to the 2019 annual report. Several NHS Trusts had a wide range of time from vascular assessment to amputation.

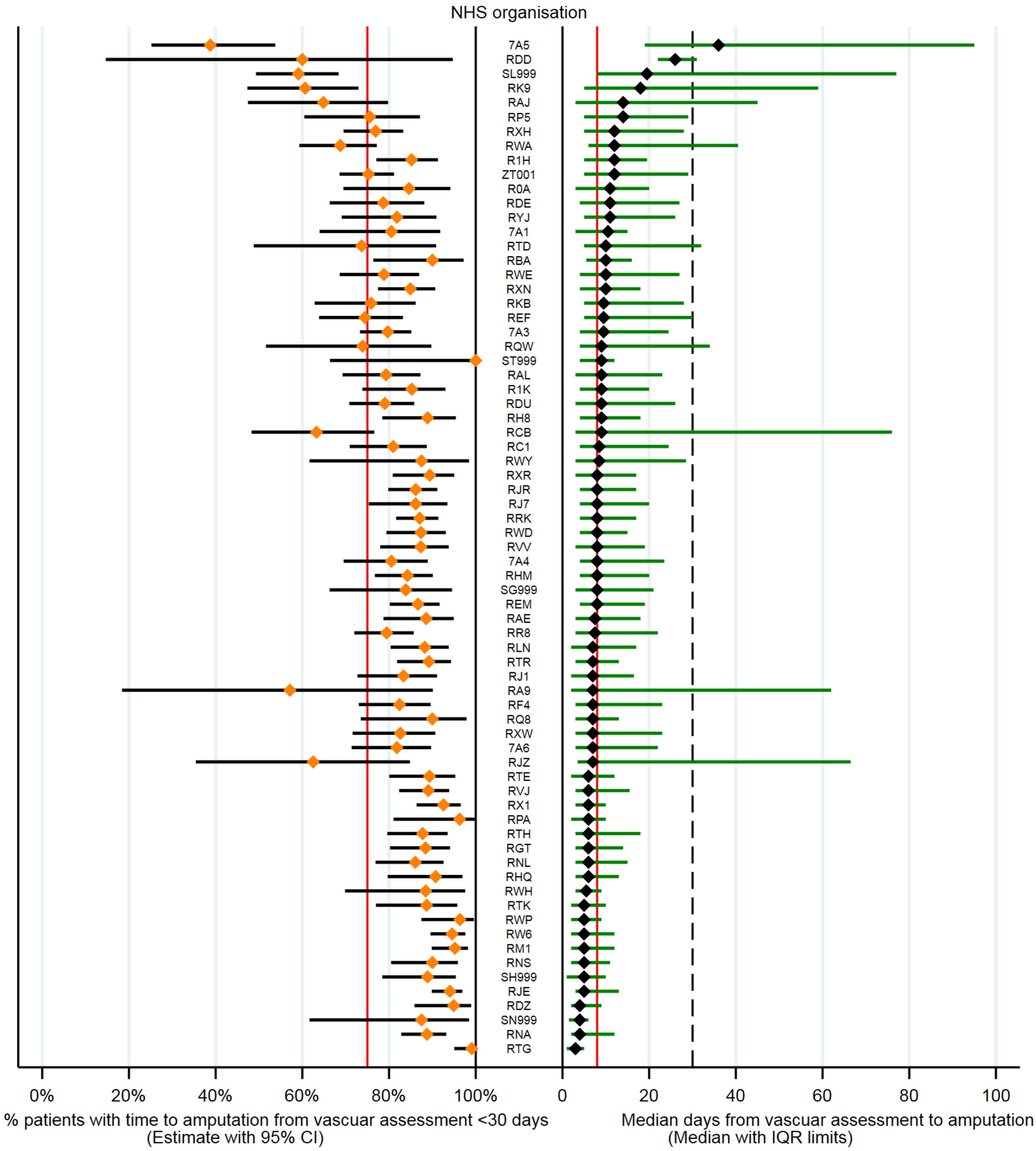
There are various reasons for patients to wait different times for an amputation. In some circumstances, it is necessary to wait for adjunctive procedures which prevent a high-level of amputation or which promote recovery. However, this is unlikely to explain the variation shown in Figure 7.1. Vascular units should investigate the cause of this and attempt to reduce the longer times as much as possible.

***VSGBI: Amputation QIF***

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

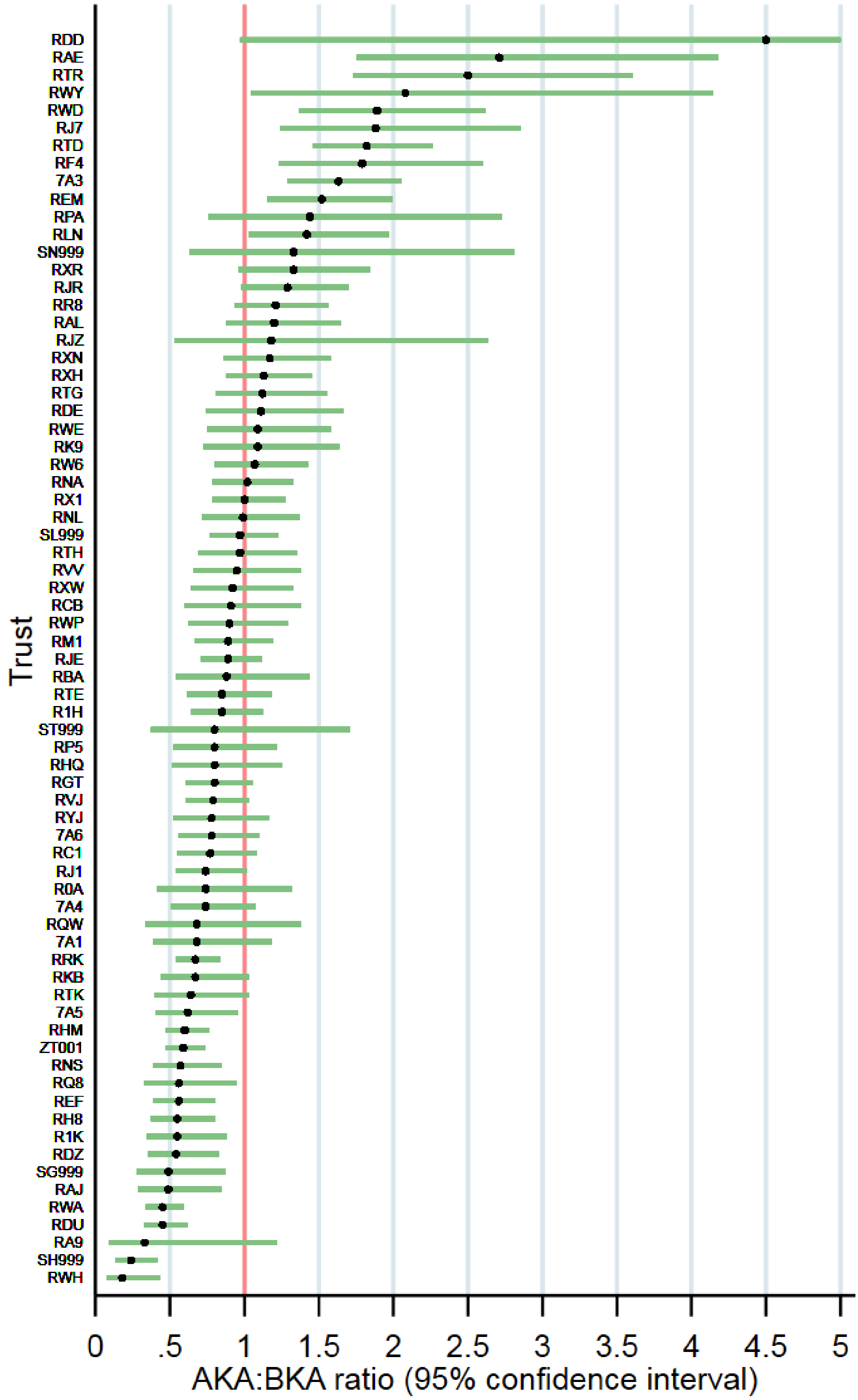
The AKA to BKA ratio by NHS Trust is shown in Figure 7.2. Nationally, over the three-year data collection period, the AKA:BKA ratio was 0.93 (95% CI: 0.89 to 0.96). Most of the NHS Trusts had a ratio of less than one, but 27 organisations had ratios that were above 1.0. 10 organisations had a ratio of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

Figure 7.1: Median (IQR) time from vascular assessment to non-elective amputation for procedures performed between 2017 and 2019, by NHS Trust[1], together with percentage (95% CI) of patients with time to amputation from vascular assessment <30 days.




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

Figure 7.2: Ratio of above knee to below knee amputations for procedures performed between 2017 and 2019, by NHS Trust[1]




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

***VSGBI: Amputation QIF and NCEPOD: Recommendations***

| |
|---|
| Major amputations should be undertaken on a planned operating list during normal working hours. |
| A consultant surgeon should operate or at least be present in the theatre to supervise a senior trainee (ST4 or above) undertaking the amputation. |
| The patient should have routine antibiotic and DVT prophylaxis according to local policy. |

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

- over 80% of major amputations (BKAs and AKAs) were performed during the day
- a consultant surgeon was present for just over three-quarters of the procedures
- prophylactic antibiotics and DVT medication were recorded for just over 60% of patients.

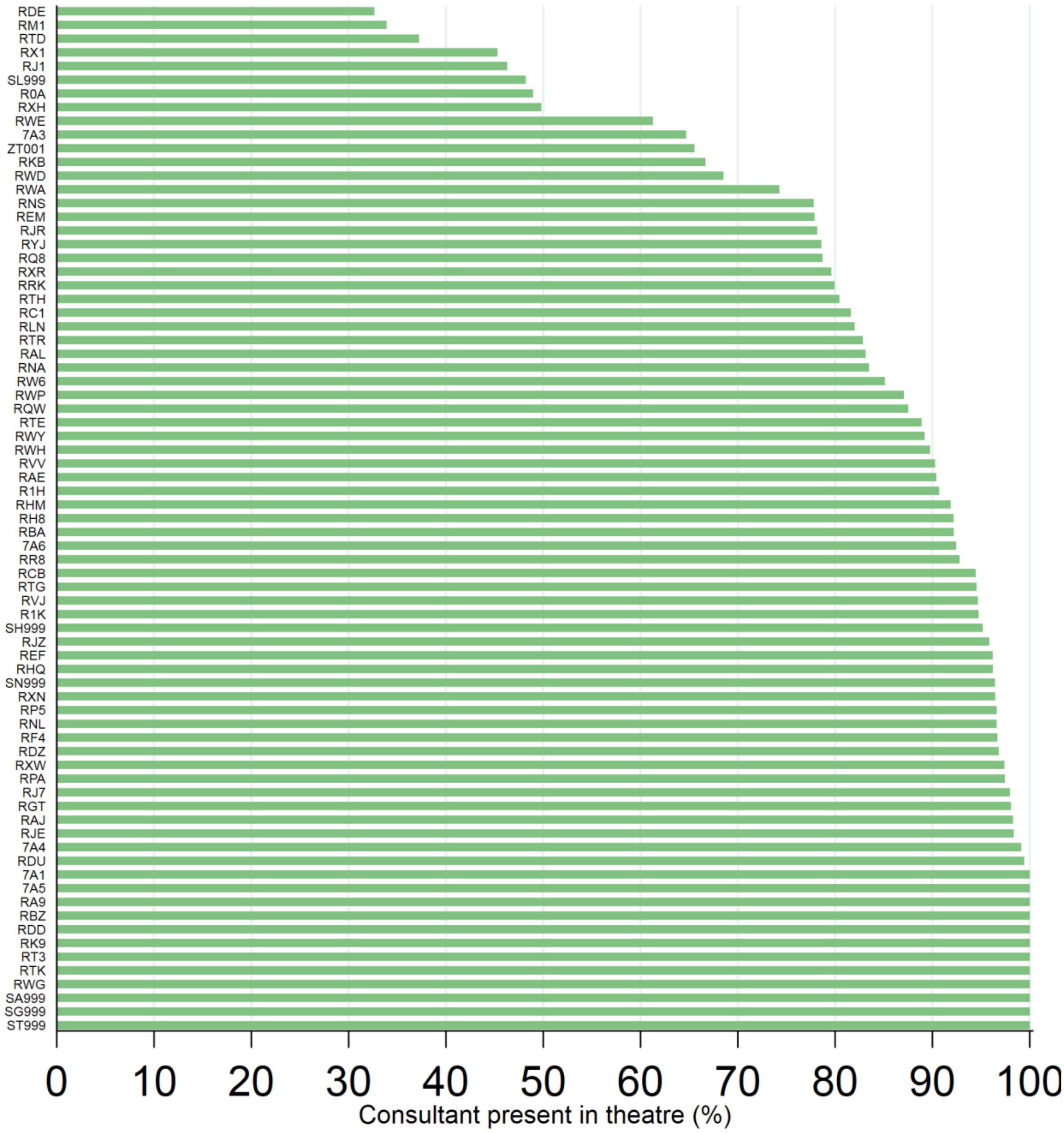
Whilst many NHS Trusts followed the recommendation that a consultant should be present in theatre during the audit period, there is some variation in practice across NHS organisations (Figure 7.3). Vascular units should investigate the reasons for this variation.

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

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

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

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




## 7.3 In-hospital outcomes following major amputation

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

The overall median length of hospital stay associated with major lower limb amputations was 23 days (IQR: 13 to 39 days). Most patients were returned to the ward following amputation, although approximately 13% of BKA patients and 23% of AKA patients were admitted to critical care (level 2 or level 3).

Most patients were discharged alive, but around 5% of BKA patients and 10% of AKA patients died in hospital. Over 20% of patients suffered more than one reported complication following major amputation:

- respiratory problems occurred in 6.4% of BKAs and 10.3% of AKAs
- cardiac complications were also common, occurring in 4.1% of BKA patients and 6.2% of AKA patients
- in 2019, 4.6% had surgical site infection for BKAs and 4.1% for AKAs, compared with 2.1% of BKAs and 2.4% of AKAs in 2018
- 2.1% of BKAs and 3.5% of AKAs resulted in postoperative confusion in 2019, compared with 0.8% of BKAs and 1.3% AKAs in 2018.

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

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

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

Outcomes for patients undergoing major amputations are summarised in Table 7.4, by preoperative length of stay. Just over half of the patients (56%) underwent amputation within 5 days of being admitted. In comparison with the results for lower limb bypass and endovascular revascularisation, the differences in outcomes were small between patients with comparatively short and long times from admission to surgery.

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

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

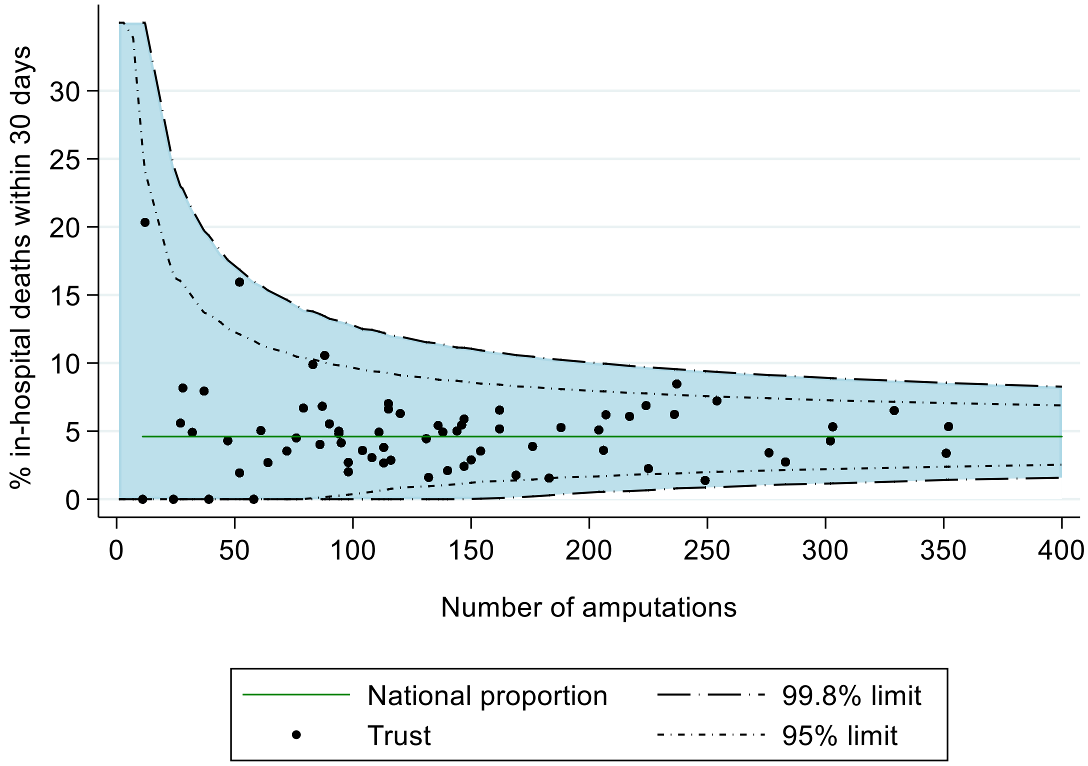
Adjusted 30-day in-hospital mortality figures following major unilateral lower limb amputation for NHS Trusts are shown in Figure 7.4.

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

For elective cases, the rates were adjusted for age, sex, ASA grade (1-3 vs 4-5), level of amputation (below or above the knee) and the presence of comorbid chronic renal disease and active/managed cancer. In addition for non-elective cases, the rates were also adjusted for the presence of comorbid chronic lung disease.

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

Figure 7.4: Risk-adjusted 30-day in-hospital death rate following major amputation for the audit period 2017-19[1], shown in comparison to the overall national average of 4.6%




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

## 7.4 Discharge and follow-up

Discharge and follow-up of patients undergoing lower limb amputations, among patients discharged alive, are summarised in Table 7.5. Most patients' wounds had healed by 30 days. Around 84% of patients undergoing BKAs were referred to rehabilitation units or limb fitting centres, compared with 71% of patients undergoing AKAs. Approximately 1 in 10 patients were readmitted to hospital within 30 days of the amputations and after discharge from hospital.

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

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

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

# 8. Carotid Endarterectomy

## 8.1 Background

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

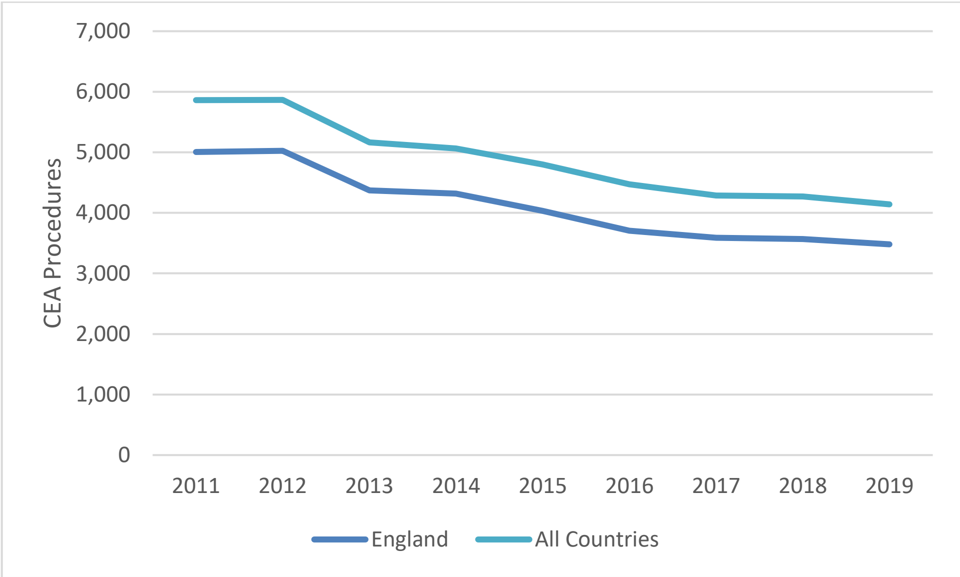
The information in this report focuses on carotid procedures performed within NHS hospitals between 1 January 2019 and 31 December 2019. The NVR continues to achieve high levels of case-ascertainment (Table 8.1), with estimated case-ascertainment figures for the four nations in 2019 being: 97% for England, 100% for Northern Ireland, 81% for Scotland and 100% for Wales.

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

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

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

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




## 8.2 Treatment pathways

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

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

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

***VSGBI Provision of services***

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

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

***NICE guideline (NG128)***

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

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

The median time from symptom onset to surgery for symptomatic patients in 2019 was 12 days (IQR 8-22). For the three distinct phases within this pathway, the median time delays were:

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

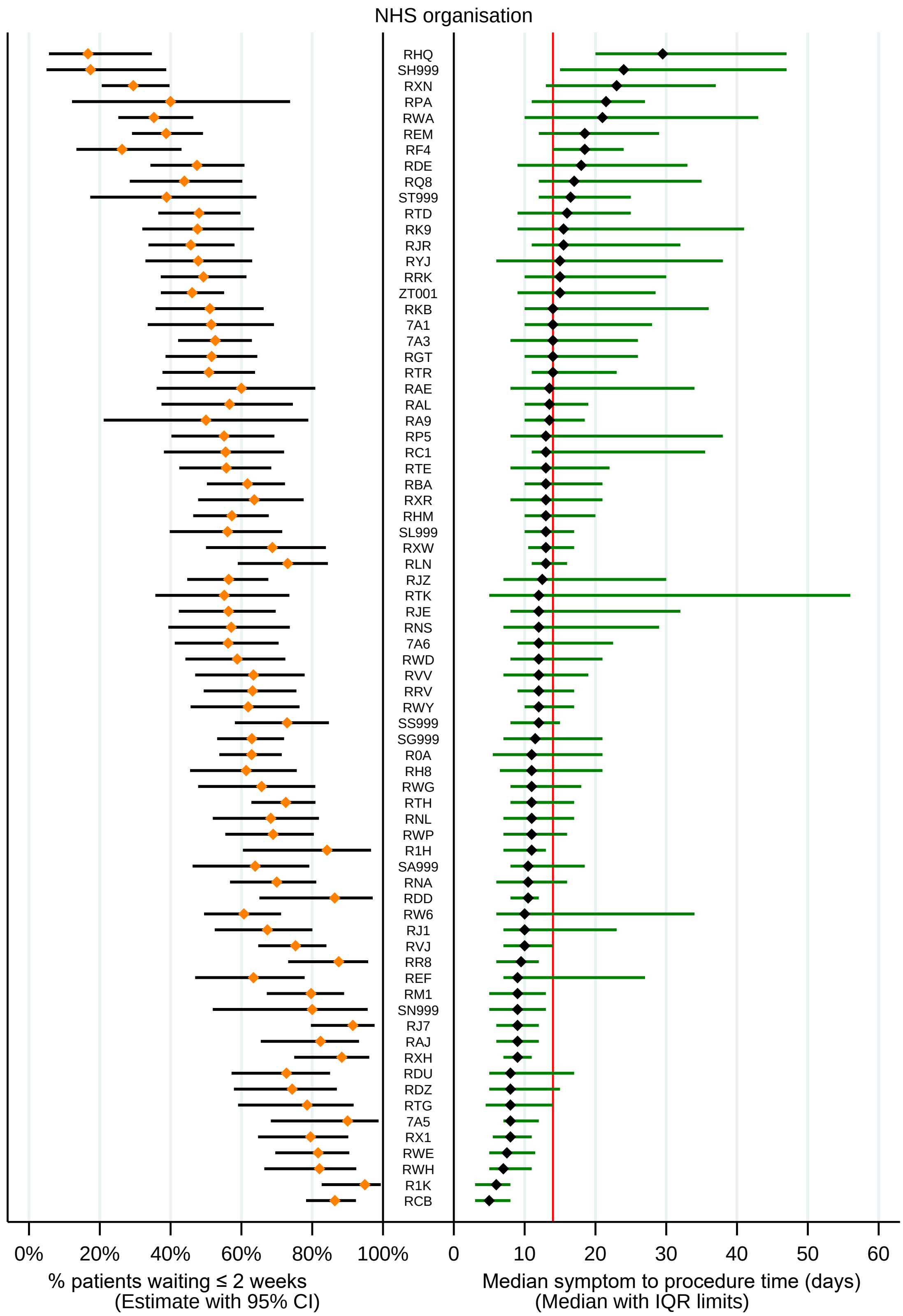
The distribution of symptom to operation times (right panel) and the proportion operated on within 14 days (left panel) for all NHS Trusts is summarised in Figure 8.2. The grey horizontal bars represent their 95% confidence intervals. The graph contains figures for all organisations that performed 10 or more procedures for symptomatic cases with known symptom and procedure dates. The NICE guidance standard of 14 days is included on the graph as a vertical red line.

There was considerable variation among NHS Trusts in the median time to surgery during 2019 (right panel, Figure 8.2):

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

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

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



## 8.3 Outcomes after carotid endarterectomy

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

The complication rates for the nearly 12,700 procedures performed in NHS hospitals between 2017 and 2019 are summarised in Table 8.2. The rates of the different complications tended to be around 2% and have remained fairly consistent over the last few NVR annual reports.

Over this 3-year period:

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

Table 8.2: Postoperative outcomes following carotid endarterectomy

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

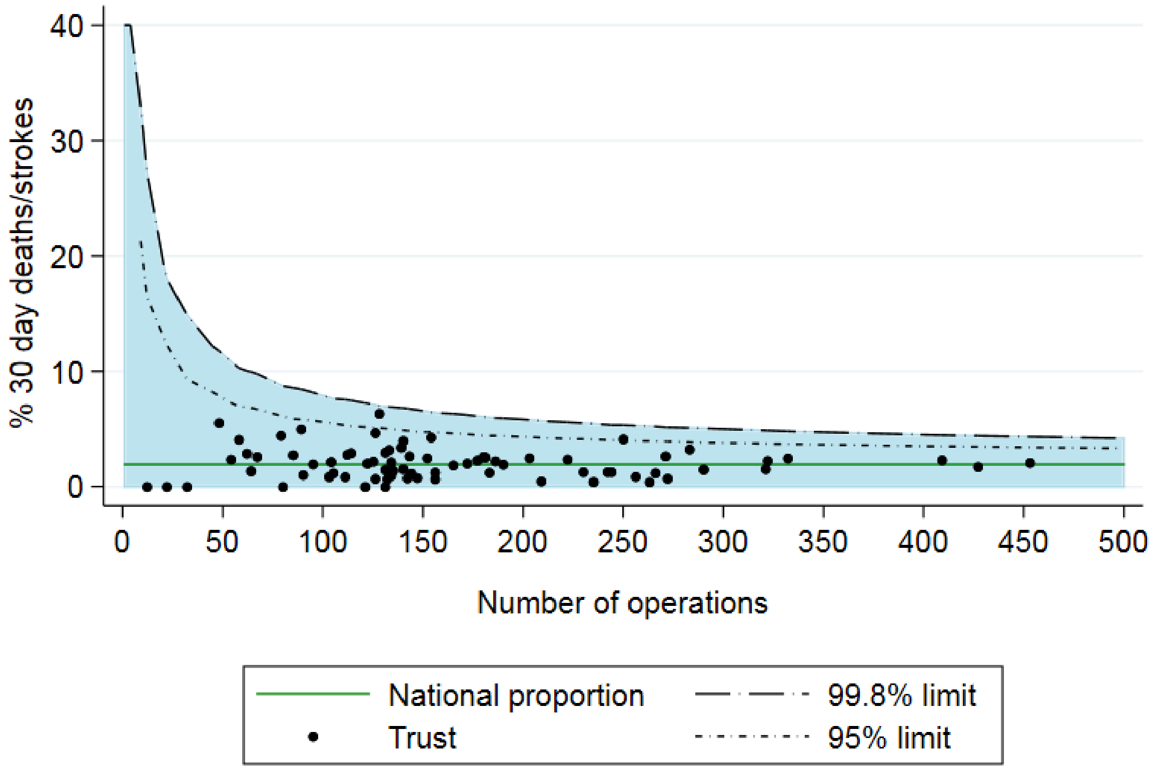
## 8.4 Rates of stroke/death within 30 days among NHS Trusts

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

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

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

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




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

# Appendix 1: NVR Governance structure

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

**Members of Audit and Quality Improvement Committee of the Vascular Society**

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

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

**Members of Project Board**

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

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

# Appendix 2: NHS organisations that perform vascular surgery

| Code | Organisation Name | CEA | AAA | Bypass | Angio | Amp |
|---|---|---|---|---|---|---|
| 7A1 | Betsi Cadwaladr University Health Board | Yes | Yes | Yes | Yes | Yes |
| 7A3 | Swansea Bay University Health Board | Yes | Yes | Yes | Yes | Yes |
| 7A4 | Cardiff and Vale University Health Board | Yes | Yes | Yes | Yes | Yes |
| 7A5 | Cwm Taf University Health Board | Yes | Yes | Yes | Yes | Yes |
| 7A6 | Aneurin Bevan University Health Board | Yes | Yes | Yes | Yes | Yes |
| R0A | Manchester University NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| R1H | Barts Health NHS Trust | Yes | Yes | Yes | Yes | Yes |
| R1K | London North West Healthcare NHS Trust | Yes | Yes | Yes | Yes | Yes |
| RA9 | Torbay and South Devon NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RAE | Bradford Teaching Hospitals NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RAJ | Southend University Hospital NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RAL | Royal Free London NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RBD | Dorset County Hospital NHS Foundation Trust | No | No | No | Yes | No |
| RBN | St Helens & Knowsley Teaching Hospitals NHS Trust | No | No | No | Yes | No |
| RBZ | Northern Devon Healthcare NHS Trust | No | No | No | Yes | Yes |
| RC1 | Bedford Hospital NHS Trust | Yes | Yes | Yes | Yes | Yes |
| RCB | York Teaching Hospital NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RDD | Basildon and Thurrock University Hospitals NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RDE | East Suffolk and North Essex NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RDU | Frimley Health NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RDZ | Royal Bournemouth and Christchurch Hospitals NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| REF | Royal Cornwall Hospitals NHS Trust | Yes | Yes | Yes | Yes | Yes |
| REM | Liverpool University Hospitals NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RF4 | Barking, Havering And Redbridge University Hospitals NHS Trust | Yes | Yes | Yes | Yes | Yes |
| RGN | North West Anglia NHS Foundation Trust | No | No | No | Yes | No |
| RGR | West Suffolk NHS Foundation Trust | No | No | No | Yes | No |
| RGT | Cambridge University Hospitals NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RH8 | Royal Devon and Exeter NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |
| RHM | University Hospital Southampton NHS Foundation Trust | Yes | Yes | Yes | Yes | Yes |

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

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

**Key**

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

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


For interactive version, please visit:
https://batchgeo.com/map/84810d35d57465b318df86c46b21b428

# Appendix 3: Summary of procedures and patient characteristics

**Elective repair of infra-renal AAAs**

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

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

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

**Repair of ruptured abdominal aortic aneurysms**

Compared to patients who had an elective repair of an infra-renal AAA, the patients who had surgery for a ruptured AAA were older on average, with most aged over 76 years at the time of surgery and tended to have a larger diameter of the aneurysm (Table A3.2). In comparison to patients undergoing an open repair, patients having EVAR had a smaller AAA diameter, on average, and a greater proportion had also undergone AAA surgery previously.

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

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

## Lower limb bypass

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

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

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

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

**Lower limb angioplasty / stenting**

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

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

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

110 missing values for age

## Lower limb major amputation

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

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

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

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

Preoperative risk factors are summarised in Table A3.7. The majority of patients had one or more comorbid conditions. The most common comorbidities in both BKA and AKA groups were hypertension, diabetes and ischaemic heart disease. A large majority of patients in both groups were taking antiplatelet medication or statins, and about a quarter to a third of the patients were on beta blockers, ACE inhibitors or Angiotensin II receptor blockers (ARBs).

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

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

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

**Carotid endarterectomy**

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

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

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

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

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

# Appendix 4: Audit methodology

**Method of data collection**

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

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

**Data collected on patients, their surgery and outcomes**

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

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

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

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

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

**Analysis**

In this report, we present summary information on patient characteristics and hospital activity, for the NHS as a whole and for individual NHS Trusts / Health Boards. Results are typically presented as totals and/or percentages, medians and interquartile ranges (IQR), with numerators and denominators stated where appropriate. In a few instances, the percentages do not add up exactly to 100%, which is typically due to the rounding up or down of the individual values. Measures of outcome are presented with 95% confidence intervals to describe the level of uncertainty associated with the estimates value. Stata 15 (StataCorp LP, College Station, TX, USA) was used for all statistical calculations.

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

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

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

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

**Graphical presentation**

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

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

# References

Boyle JR. Is In Hospital Mortality Following EVAR Still a Valid Outcome Measure?. *Eur J Vasc Endovasc Surg*. 2019;57(4):520. doi:10.1016/j.ejvs.2018.10.020

Conte MS, Bradbury AW, Kolh P, et al. Global vascular guidelines on the management of chronic limb-threatening ischemia [published correction appears in J Vasc Surg. 2019 Aug;70(2):662]. *J Vasc Surg*. 2019;69(6S):3S-125S.e40. doi:10.1016/j.jvs.2019.02.016

Department of Health. National Stroke Strategy (December 2007) https://webarchive.nationalarchives.gov.uk/20130104224925/http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_081059.pdf

Department of Health Stroke Policy Team. Implementing the National Stroke Strategy - an imaging guide (2008). Available at: https://webarchive.nationalarchives.gov.uk/20130123193818/http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_085146

Horrocks M. Vascular Surgery GIRFT Programme National Specialty Report. March 2018. Available at: http://gettingitrightfirsttime.co.uk/vascular-surgery-report/

Johal AS, Loftus IM, Boyle JR, Naylor AR, Waton S, Heikkila K, Cromwell AS. Changing patterns of carotid endarterectomy between 2011 and 2017 in England. doi: 10.1161/STROKEAHA.119.025231. [Epub ahead of print]

Meecham L, Jacomelli J, Davies M, Pherwani A, Lees T, Earnshaw J. Outcomes in men from the the NHS Abdominal Aortic Screening Programme with a large aneurysm referred for intervention. Eur Jr Vasc Endovasc Surg 58;6 Sup 1, e62-63 Dec 2019. In press. doi:https://doi.org/10.1016/j.ejvs.2020.09.009

National Confidential Enquiry into Patient Outcomes and Deaths. Lower Limb Amputation: Working Together 2014. London: NCEPOD, 2014

National Institute for Health and Clinical Excellence (NICE). Stroke: The diagnosis and acute management of stroke and transient ischaemic attacks. May 2019. Available at: https://www.nice.org.uk/guidance/ng128

National Institute for Health and Clinical Excellence (NICE). Guidance for peripheral arterial disease. August 2012. Available at: http://www.nice.org.uk/guidance/CG147

NHS Abdominal Aortic Aneurysm Screening Programme. Quality Standards and Service Objectives. August 2009. Available at: http://aaa.screening.nhs.uk/standards

Peach G, Griffin M, Jones KG, Thompson MM, Hinchliffe RJ. Diagnosis and management of peripheral arterial disease. BMJ. 2012; 345: e5208.

Powell JT, Sweeting MJ, Thompson MM, et al. Endovascular or open repair strategy for ruptured abdominal aortic aneurysm: 30 day outcomes from IMPROVE randomised trial. BMJ. 2014; 348: f7661. doi: 10.1136

Spiegelhalter DJ, Funnel plots for comparing institutional performance. Stat Med 2005; 24(8): 1185-202.

Vascular Society of Great Britain and Ireland (VSGBI). Outcomes after Elective Repair of Infra-renal Abdominal Aortic Aneurysm. A report from The Vascular Society. London: The Vascular Society, March 2012. Available at: https://www.vascularsociety.org.uk/_userfiles/pages/files/Document%20Library/VSGBI-Mortality-Report.pdf

Vascular Society of Great Britain and Ireland (VSGBI). Abdominal Aortic Aneurysm Quality Improvement Programme (AAAQIP) Team. Delivering a national quality improvement programme for patients with abdominal aortic aneurysms. London: The Vascular Society, September 2012. Available at: https://www.vascularsociety.org.uk/_userfiles/pages/files/Document%20Library/Final-AAAQIP-Public-Report-_VSGBI-August-2012_310812.pdf

Vascular Society of Great Britain and Ireland (VSGBI). A Best Practice Clinical Care Pathway for Major Amputation Surgery. London: The Vascular Society, April 2016. Available at: https://www.vascularsociety.org.uk/_userfiles/pages/files/Resources/Vasc_Soc_Amputation_Paper_V2.pdf

Vascular Society of Great Britain and Ireland (VSGBI). The Provision of Services for Patients with Vascular Disease. London: The Vascular Society, November 2018. Available at: https://www.vascularsociety.org.uk/_userfiles/pages/files/Document%20Library/VS%202018%20Final.pdf

Vascular Society of Great Britain and Ireland (VSGBI). A Best Practice Clinical Care Pathway for Critical Limb Ischaemia. London: The Vascular Society, April 2019. Available at: https://www.vascularsociety.org.uk/_userfiles/pages/files/Resources/PAD%20QIF%20March%202019%20v2.pdf

White IR, Royston P, Wood AM. Multiple imputation using chained equations: Issues and guidance for practice. Stat Med. 2011; 30(4):377-99.

# Glossary

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

| | |
|---|---|
| Confidence Interval (CI) | A statistical term used to describe the range of values that we are confident the metric lies within. |
| Endovascular Aneurysm Repair (EVAR) | A method of repairing an abdominal aortic aneurysm by placing a graft within the aneurysm from a small cut in the groin. |
| Fontaine Score | An internationally recognised scoring system or classification of the severity of peripheral arterial disease. |
| Hospital Episode Statistics (HES) | HES is the national statistical data warehouse for England regarding the care provided by NHS hospitals and for NHS hospital patients treated elsewhere. There are equivalent agencies in Northern Ireland, Scotland and Wales but in this report, the term HES is used generically to describe data that are collected by any of these national agencies. |
| Infra-renal AAA | An abdominal aneurysm that is located below the point where the arteries branch off the aorta to the kidneys. |
| Interquartile range (IQR) | Once the data are arranged in ascending order, this is the central 50% of all values and is otherwise known as the 'middle fifty' or IQR. |
| Hybrid operating theatre | An operating theatre with built-in radiological imaging capabilities. The imaging equipment is able to move and rotate around a patient and multiple monitors provide good visibility around the operating table. |
| Median | The median is the middle value in the data set; 50% of the values are below this point and 50% are above this point. |
| Myocardial Infarct (MI) | Otherwise known as a Heart Attack, MI involves the interruption of the blood supply to part of the heart muscle. |
| Occluded artery | An artery that has become blocked and stops blood flow. |
| National Abdominal Aortic Aneurysm Screening Programme (NAAASP) | A programme funded by the Department of Health to screen men over the age of 65 years for AAA |
| OPCS | Office of Population and Censuses Surveys. A procedural classification list for describing procedures undertaken during episodes of care in the NHS |
| Peripheral arterial disease (PAD) | Peripheral arterial disease (PAD) is a restriction of the blood flow in the lower-limb arteries. The disease can affect various sites in the legs, and produces symptoms that vary in their severity from pain in the legs during exercise to persistent ulcers or gangrene. |

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|---|---|
| Plaque | Scale in an artery made of fat, cholesterol and other substances. This hard material builds up on the artery wall and can cause narrowing or blockage of an artery or a piece may break off causing a blockage in another part of the arterial circulation. |
| Stroke | A brain injury caused by a sudden interruption of blood flow with symptoms that last for more than 24 hours. |
| Symptomatic | A patient showing symptoms is known to be symptomatic. |
| Transient ischaemic attack (TIA) | A "mini-stroke" where the blood supply to the brain is briefly interrupted and recovers after a short time (e.g., within 24 hours). |
| Trust or Health Board | A public sector corporation that contains a number of hospitals, clinics and health provisions. For example, there were 4 hospitals in the trust and 3 trusts in the region. |
| Vascular Society of Great Britain and Ireland (VSGBI) | The VSGBI is a registered charity founded to relieve sickness and to preserve, promote and protect the health of the public by advancing excellence and innovation in vascular health, through education, audit and research. The VSGBI represents and provides professional support for over 600 members and focuses on non-cardiac vascular disease. |