Australasian Vascular Audit Public Report – 2018-2020

Contents

Foreword

The ANZSVS is pleased to present the 4th cumulative report of the Australasian Vascular Audit (AVA) since it commenced on January 1, 2010. It covers years 2018-2020 inclusive. Individual annual reports have been regularly published since the inception of the AVA. With the inclusion of peripheral endovascular interventions as a mandatory index procedure for data entry purposes commencing in 2020, the AVA continues to evolve to maintain its relevance to the practice of the contemporary vascular surgeon in Australia and New Zealand. The cumulative nature of the data for the triennium does not allow particular analysis of the impact of the Covid19 pandemic in Australia and New Zealand but it is unlikely of significant impact given the low rates of community infections and the capability of health systems in both Australia and New Zealand to continue with emergency and urgent surgery during the relatively short periods of lock-down in both jurisdictions when compared to other similar developed countries.

Clinical audit has a long history of describing outcomes and establishing benchmarks of standards of care. Whilst there is little doubt that health care funders in both the public and private sectors in Australia and New Zealand have a vested interest in audit as markers of financial performance, the role of a clinical audit such as the AVA, remain a proven methodology for standard setting, benchmarking and a reliable quality initiative tool of clinical performance. Attitudes (and participation rates) towards audit in Australia and New Zealand have improved with a better understanding of the role of audit as a tool to examine and refine standards of practice.

Whilst a mandatory requirement for membership of the ANZSVS, the inherent value of a unique, robust and longstanding bi-national, web-based audit of key vascular surgical procedures is the fundamental driver of participation in both public and private sectors with an increasing number of private hospital operators in Australia and New Zealand requiring AVA participation in the credentialing of vascular surgeons for their facilities.

With recognition of evolving digital technologies and potential improvements for ease of entry and analysis in the decade since the development of the AVA in 2008, the ANZSVS has commissioned a review of options to enhance the AVA platform and to build on the success of the AVA.

The ANZSVS records a debt of gratitude to Barry Beiles, the AVA Administrator since its inception, the Audit and the Audit Monitoring Committees for their work in producing this report.

Peter Subramanian

President ANZSVS

Introduction

The Australasian Vascular Audit (AVA) has just completed its 11th year of data collection. It was established in 2008 after constitutional changes had been adopted following a ballot with an overwhelming majority by the membership of the Australian and New Zealand Society for Vascular Surgery (ANZSVS). This had been a long-term goal of the Society with the aim of amalgamating the existing vascular audits throughout Australia and New Zealand. The audit is compulsory, with membership of the ANZSVS conditional upon participation in audit. Both public hospital and private practice data are collected at 2 points in the admission episode; at admission/operation and after discharge and only patients undergoing a surgical or endovascular procedure are entered in the database. Although all procedures are captured in the database, the following index procedures were selected for audit:

1. Aortic surgery –includes both aneurysmal and occlusive disease (survival)

   i. Open elective and emergency

   ii. Non-fenestrated elective and emergency endografts

   iii. Fenestrated endografts

2. Carotid procedures (freedom from stroke/death)

   i. Open carotid endarterectomy

   ii. Carotid stents

3. Infrainguinal bypasses (patency and limb salvage)

4. AV Fistula for dialysis (patency)

5. Endovascular procedures for lower limb peripheral arterial disease (complications, amputation and death) -commenced in 2020

Audit monitoring committee

The executive committee of the ANZSVS has established an Audit Monitoring Committee (AMC), which consists of 4 members; the Chairman of the AMC, the immediate past-president of the ANZSVS, the administrator of the AVA (a vascular surgeon with computer and statistical skills) and the president or immediate past-president of the Vascular Society of New Zealand (VSNZ). These members are elected and are senior members of the ANZSVS engaged in active vascular surgical practice. Their roles and responsibilities are:

- to oversee protection of the collected data
- to ensure confidentiality of participants (both surgeon and patient alike)
- to monitor the collection of the audit data and to facilitate maximal compliance
- to prevent misuse of the data (including addressing complaints about misuse of the data)

- to investigate and verify statistical outliers according to a pre-determined algorithm
- to assess applications to determine suitability for participation in the AVA.
- to assess applications to use the collected data for non- audit purposes.
- to oversee the AVA verification process
- to provide an annual report of the AVA results for the ANZSVS AGM.
- to identify opportunities for performance improvement
- to identify opportunities for external publication
- to provide annual certificates of satisfactory vascular surgical audit participation
- to oversee the disclosure of audit data to a third party at the instigation of a participating member

Overview

This is another multi-year audit, which occurs every 3 years in order to capture the small numbers of procedures performed by some surgeons in any single calendar year. There were 129,569 operations entered in 2018-2020; 115,570 from Australia and 13,999 from New Zealand (Fig 1). Although the demographic data applies to all operations, the outcome analyses are based on the 128,411 discharged patients (99.1%).

Fig 1. Volume of vascular surgery by country 2018-2020

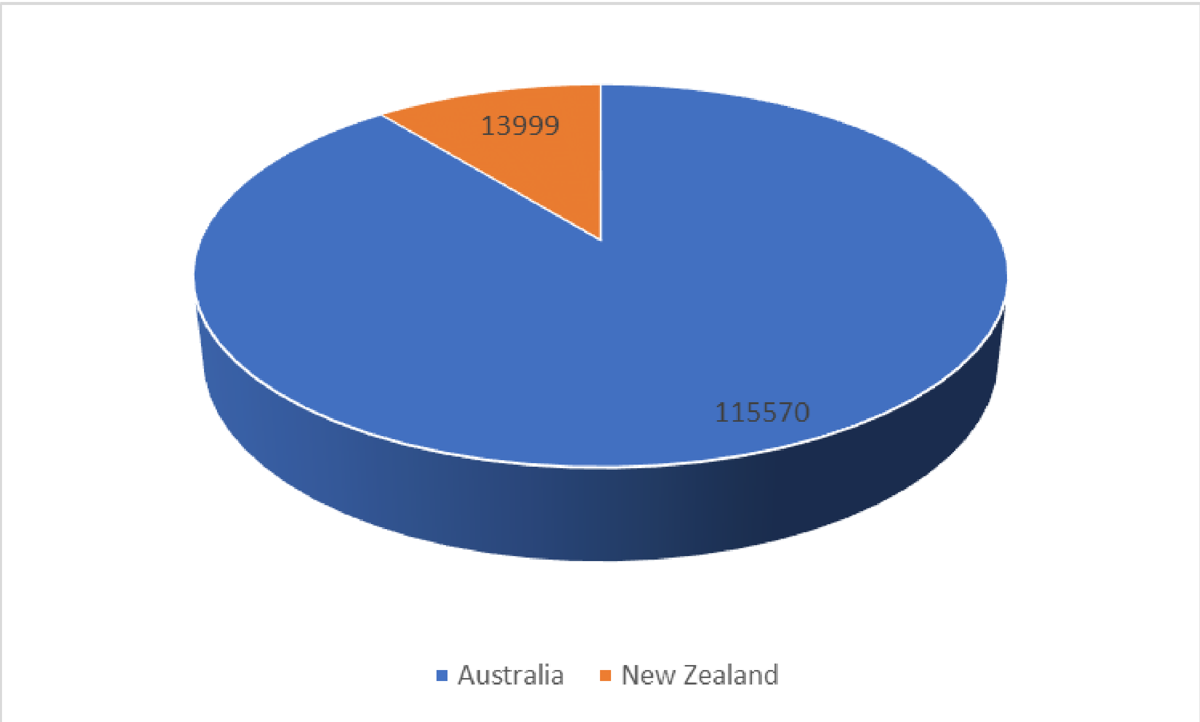
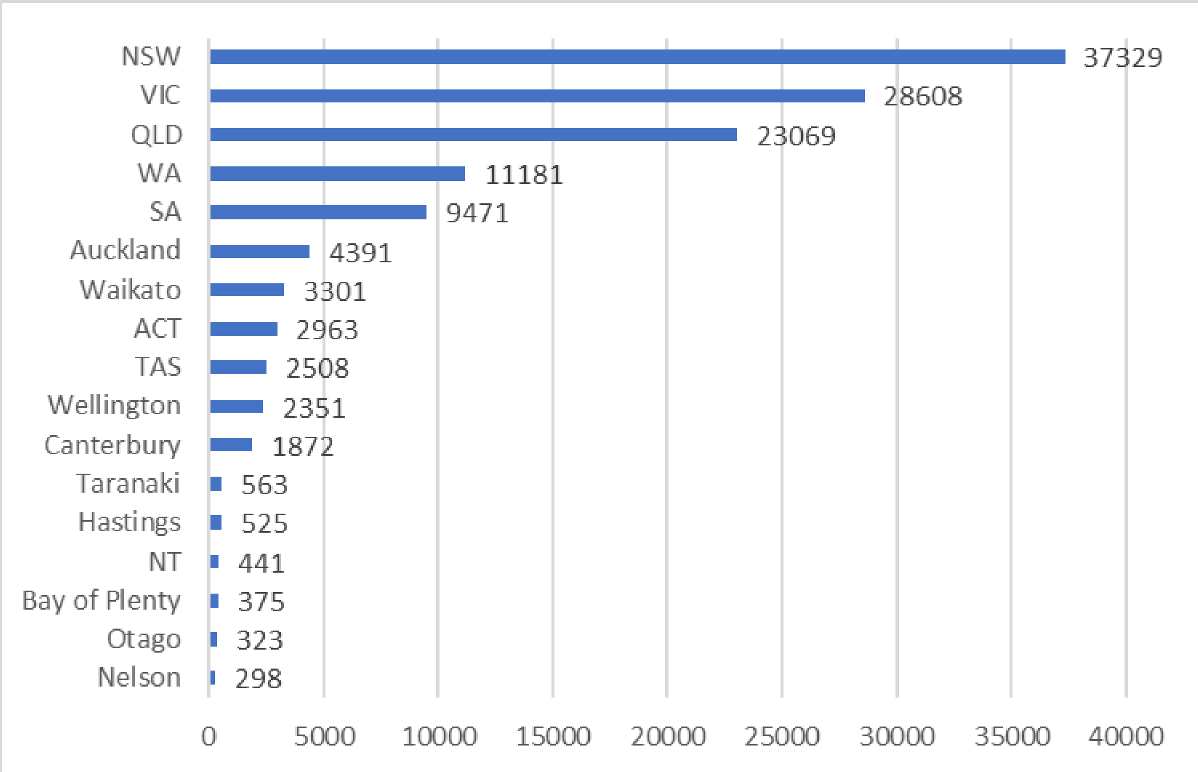


Fig 2. Operations by Australian State and New Zealand Region 2018-2020



276 consultants entered data from 233 hospitals/clinics which are shown alphabetically in the following table. The mean number of operations was 469.

Albany Day Hospital-Mira Mar
Alfred Hospital-Melbourne
Allamanda Private Hospital-Southport
Armadale Kelmscott District Hospital-Armadale
Ascot Hospital-Remuera
Ashford Hospital-Ashford
Auburn Hospital-Auburn
Auckland City Hospital-Auckland
Austin Hospital-Heidelberg
XXX rooms-QLD
Ballarat Base Hospital-North Ballarat
Ballina District Hospital-Ballina
Bankstown Hospital-Bankstown
Baringa Private Hospital-Coff's Harbour
Beleura Private Hospital-Mornington
Bentley Health Service-Bentley
Berkeley Vale Private Hospital-Berkeley Vale
Blacktown Hospital-Blacktown
Blue Mountains Hospital-Katoomba
Box Hill Hospital-Box Hill

Brisbane Waters Private Hospital-Woy Woy
Buderim Private Hospital-Buderim
Cabrini Hospital-Brighton
Cabrini Hospital-Malvern
Cairns Base Hospital-Cairns
Cairns Private Hospital-Cairns
Calvary Adelaide Hospital-Adelaide
Calvary Hospital-Central Districts
Calvary Hospital-Lenah Valley
Calvary Hospital-North Adelaide
Calvary Hospital-Wagga Wagga
Calvary John James Hospital-Deakin
Calvary Private Hospital-Bruce
Calvary Public Hospital-Bruce
Calvary Wakefield Hospital-Adelaide
Canberra Hospital-Garran
Canterbury Charity Hospital-Christchurch
Casey Hospital-Berwick
Christchurch Public Hospital-Addington
Christchurch Vascular Group-Christchurch
Coffs Harbour Health campus-Coffs Harbour
Concord Private Hospital-Concord
Concord Repatriation Hospital-Concord
Dandenong Hospital-Dandenong
Darwin Private Hospital-Tiwi
Dubbo Base Hospital-Dubbo
Dunedin Public Hospital-Dunedin
Epworth Eastern Hospital-Box Hill
Epworth Hawthorn-Hawthorn
Epworth Hospital-Geelong
Epworth Hospital-Richmond
Fairfield District Hospital-Prairiewood
Figtree Private Hospital-Figtree
Fiona Stanley Hospital-Murdoch
Flinders Medical Centre-Bedford Park
Flinders Private Hospital-Bedford Park
Frankston Hospital-Frankston
Freemasons Hospital-East Melbourne
Fremantle Hospital-Fremantle
Friendly Society Private Hospital-Bundaberg West
Geelong Private Hospital-Geelong
Geelong Public Hospital-Geelong
Gold Coast Hospital Robina-Robina
Gold Coast Private Hospital-Parklands
Gold Coast Public Hospital-Southport

Gold Coast University Hospital-Southport
Gosford District Hospital-Gosford
Grace Hospital-Tauranga
Greenslopes Private Hospital-Greenslopes
Gretta Volum Day Surgery Centre-Geelong
Hastings Memorial Hospital-Camberley
Hawke's Bay Hospital-Camberley
Hobart Private Hospital-Hobart
Hollywood Private Hospital-Nedlands
Hollywood rooms-Nedlands
Holmesglen Private Hospital-Moorabbin
Hornsby Ku-ring-gai Hospital-Hornsby
Hurstville Private Hospital-Hurstville
Innisfail Hospital-Innisfail
John Fawkner Hospital-Coburg
John Flynn Private Hospital-Tugun
John Hunter Hospital-New Lambton
Joondalup Health Campus-Joondelup
Kareena Private Hospital-Caringbah
Katherine District Hospital-Katherine
Knox Private Hospital-Wantirna
La Trobe Regional Hospital-Traralgon
Lady Cilento Childrens Hospital-South Brisbane
Lake Macquarie Private Hospital-Gateshead
Launceston General Hospital-Launceston
Linacre Private Hospital-Hampton
Lingard Private Hospital-Merewether
Lismore Base Hospital-Lismore
Liverpool Hospital-Liverpool
Lyell McEwin Hospital-Elizabeth Vale
Macquarie University Hospital-North Ryde
Manly Hospital-Manly
Manukau Surgical Centre-Manurewa
Mater Adult Hospital-South Brisbane
Mater Hospital-Hyde Park-Townsville
Mater Hospital-Pimlico-Townsville
Mater Private Hospital-North Sydney
Melbourne Private Hospital-Parkville
Mercy Hospital-Epsom
Miami Day Hospital-Miami
Mid North Coast Diagnostic Imaging-Port Macquarie
Middlemore Hospital-Otahuhu
Mildura Private Hospital-Mildura
Mitcham Private Hospital-Mitcham
Monash Medical Centre-Clayton

Moorabbin Hospital-East Bentleigh
Mount Barker Hospital-Mt Barker
Mulgrave Private Hospital-Mulgrave
Nambour Selangor Private Hospital-Nambour
National Capital Private Hospital-Garran
Nelson Hospital-Nelson
New Bendigo Hospital-Bendigo
Newcastle Private Hospital-New Lambton Heights
Noarlunga Hospital-Noarlunga
Noosa Hospital-Noosaville
North Gosford Private Hospital-North Gosford
XXX rooms-Geelong
North Shore Private Hospital-St Leonards
North West Private Hospital-Burnie
North West Private Hospital-Everton Park
Northern Beaches Hospital-Frenchs Forest
Northern Hospital-Epping
Northpark Private Hospital-Bundoora
Norwest Private Hospital-Baulkham Hills
Norwest Private Hospital-Bella Vista
Ormiston Hospital-Botany Junction
Osborne Park Hospital-Stirling
Peninsula Private Hospital-Frankston
Perth Childrens Hospital-Nedlands
Pindara Private Hospital-Benowa
Port Macquarie Base Hospital-Port Macquarie
Port Macquarie Private Hospital-Port Macquarie
Prince of Wales Private Hospital-Randwick
Prince of Wales Public Hospital-Randwick
Princess Alexandra Hospital-Woolloongabba
Queen Elizabeth Hospital-Woodville West
Repatriation General Hospital-Daw Park
Riverland Regional Hospital-Berri
Rosebud Hospital-Rosebud
Royal Adelaide Hospital-Adelaide
Royal Brisbane and Womens Hospital-Herston
Royal Childrens Hospital-Parkville
Royal Darwin Hospital-Casuarina
Royal Hobart Hospital-Hobart
Royal Melbourne Hospital-Parkville
Royal Melbourne Transplant Unit-Parkville
Royal North Shore Hospital-St Leonards
Royal Perth Hospital-Perth
Royal Prince Alfred Hospital-Camperdown
Royal Womens Hospital-Parkville

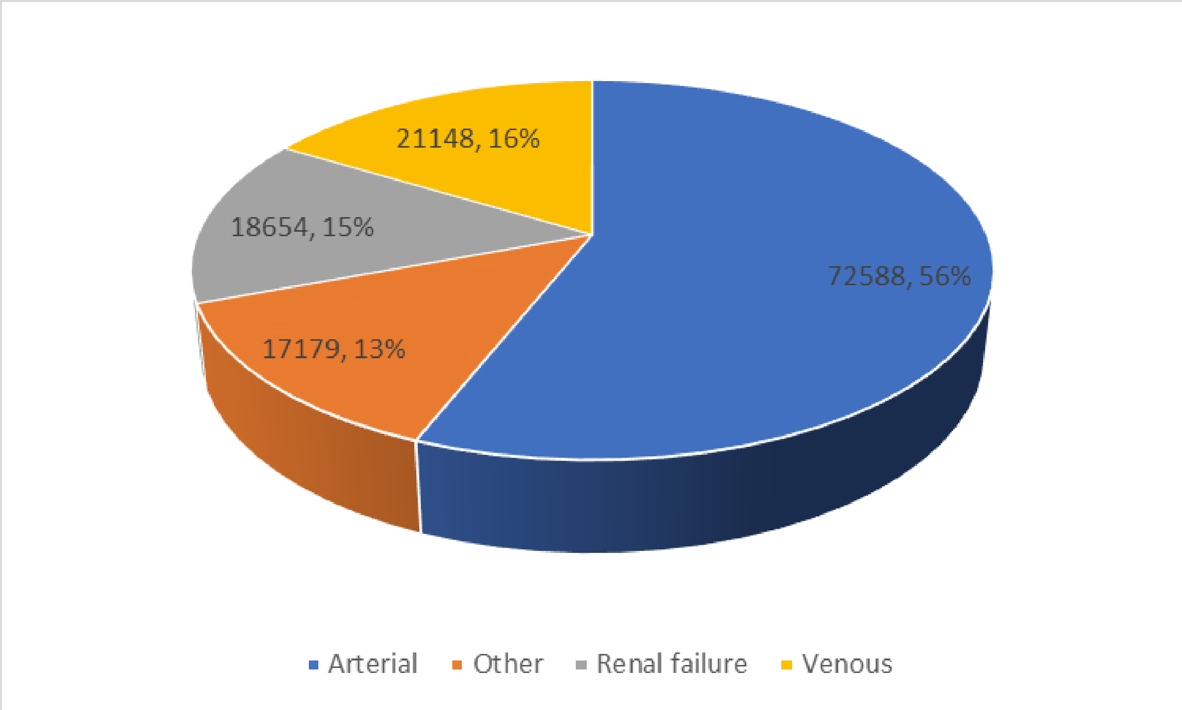
Sir Charles Gairdner Hospital-Nedlands
Southern Cross Hospital-Christchurch
Southern Cross Hospital-Glenfield
Southern Cross Hospital-Wellington
Southern Highlands Private Hospital-Bowral
St Andrews Private Hospital-Adelaide
St Andrews Private Hospital-Ipswich
St Andrews Private Hospital-Toowoomba
St Andrews War Memorial Hospital-Brisbane
St George District Hospital-Kogarah
St George Private Hospital-Kogarah
St Georges Hospital-Christchurch
St JOG Hospital-Bendigo
St JOG Hospital-Berwick
St JOG Hospital-Bunbury
St JOG Hospital-Geelong
St JOG Hospital-Midland
St JOG Hospital-Murdoch
St JOG Hospital-North Ballarat
St JOG Hospital-Subiaco
St JOG Rooms-Subiaco
St John's Hospital-South Hobart
St Vincents Private Hospital-Darlinghurst
St Vincents Private Hospital-East Lismore
St Vincents Private Hospital-Fitzroy
St Vincents Private Hospital-Griffith
St Vincents Private Hospital-Launceston
St Vincents Private Hospital-Northside
St Vincents Private Hospital-Werribee
St Vincents Public Hospital-Darlinghurst
St Vincents Public Hospital-Fitzroy
Steele Street Clinic-Devonport
Stirling Hospital-Stirling
Strathfield Private Hospital-Strathfield
Sunshine Coast Private Hospital-Buderim
Sunshine Coast University Private Hospital-Birtinya
Sunshine Coast University Public Hospital-Birtinya
Sunshine Hospital-St Albans
Sutherland District Hospital-Caringbah
Sydney Adventist Hospital-Wahroonga
Sydney South West Private Hospital-Liverpool
Tamworth Base Hospital-Tamworth
Taranaki Base Hospital-Westown
Tauranga Public Hospital-Tauranga
The Bays Hospital-Mornington

The Mount Hospital-Perth
The Nepean Hospital-Penrith
The Nepean Private Hospital-Kingswood
The Prince Charles Hospital-Chermside
The Surgery Centre-Hurstville
The Tweed Hospital-Tweed Heads
The Vein Centre-Richmond
The Wesley Hospital-Auchenflower
Timaru Public Hospital-Timaru
Toowoomba Base Hospital-Toowoomba
Townsville Hospital-Townsville
Varsity Lakes Day Hospital-Varsity Lakes
Vascular Solutions-Subiaco
VCCC (Peter Mac)-Parkville
WA Vascular Centre-Bassendean
Wagga Wagga Base Hospital-Wagga Wagga
Wagga Wagga Rural Referral Hospital-Wagga Wagga
XXX rooms-Melbourne
Waikato Hospital-Hamilton
Warringal Private Hospital-Heidelberg
Wauchope District Hospital-Wauchope
Waverly Private Hospital-Mt Waverly
Wellington Hospital-Wellington
Western Hospital-Footscray
Western Private Hospital-Footscray
Westmead Hospital-Westmead
Westmead Private Hospital-Westmead
Williamstown Hospital-Williamstown
Wimmera Base Hospital-Horsham
Wollongong Day Surgery-Wollongong
Wollongong Hospital-Wollongong
Wollongong Private Hospital-Wollongong
Wyong Public Hospital-Kanwal

The mean number of operations per hospital was 556 with a range of 1-3,851

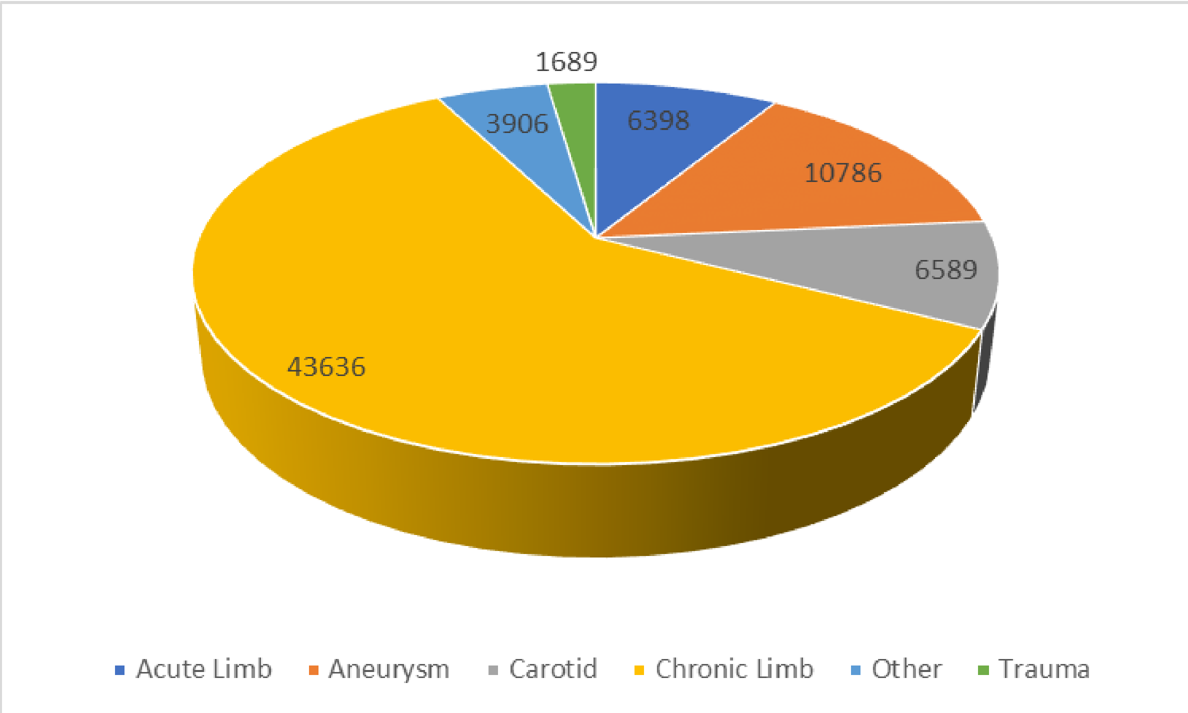
The distribution of procedures by patient type is shown in Fig. 3. The majority were arterial patients followed by venous disease then renal disease.

Fig 3. Patient type 2018-2020



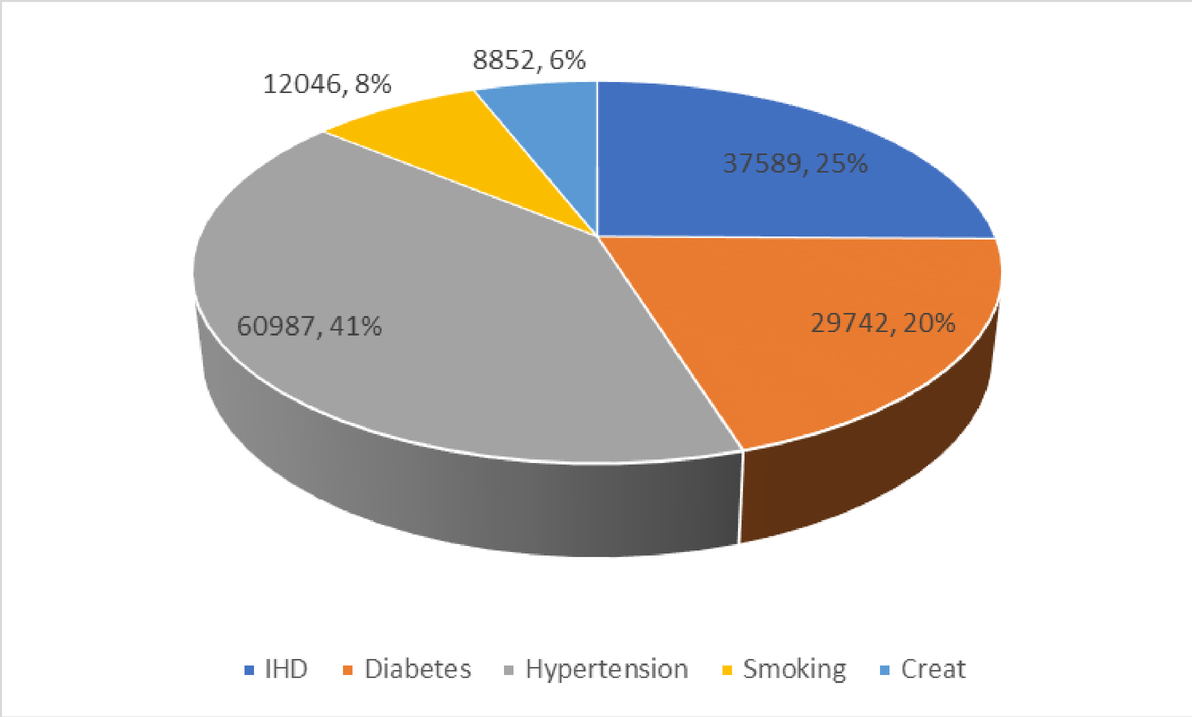
The distributions of procedures in the arterial category are shown in Fig. 4. The majority were for chronic limb operations (60%) followed by aneurysms (15%) then carotid procedures (9%).

Fig 4. Arterial categories 2018-2020 (n=73,004)



In the arterial operations the risk factors present are shown in Fig. 5. Hypertension was the most frequent risk factor recorded followed by ischaemic heart disease (IHD) then diabetes.

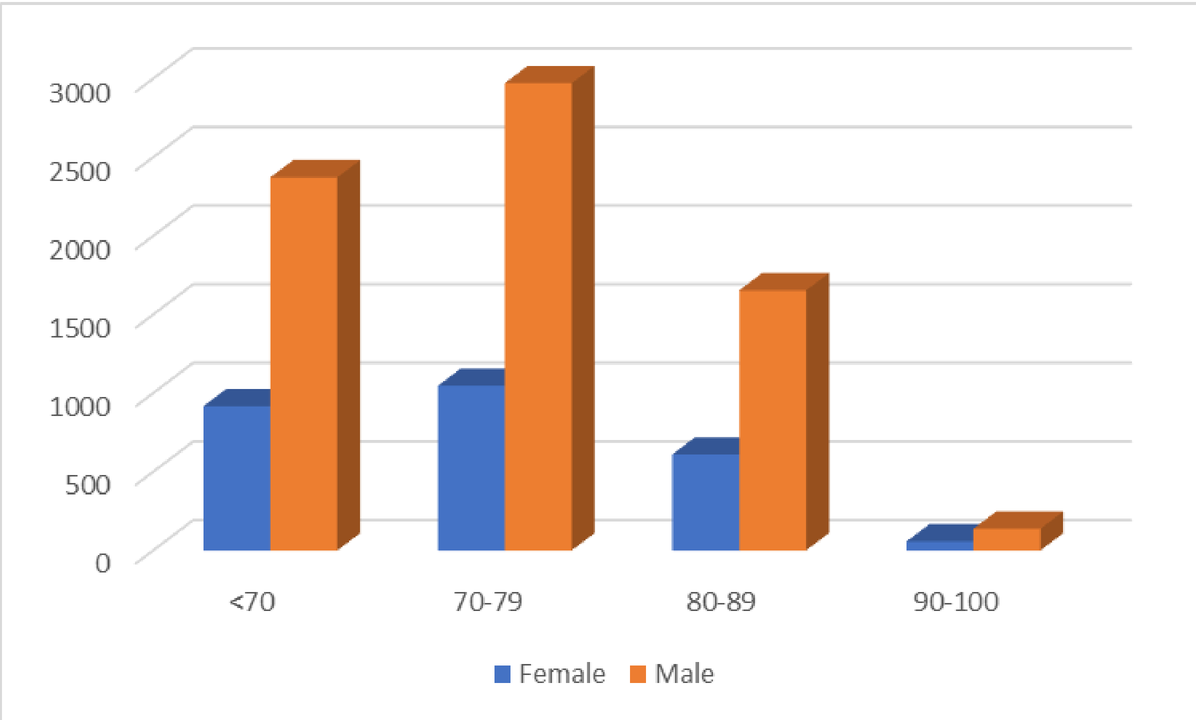
Fig 5. Risk factors in arterial operations 2018-2020 (Creatinine = >150mMol/L, Smoking = current)



Aortic Surgery

There were 9,765 Aortic (discharged) procedures performed in 2018-2020. This category includes aneurysmal disease (emergency and elective), open and endoluminal (ELG) procedures and aortic operations for non-aneurysmal disease.

Age and gender are shown in Fig. 6



The distribution of procedures is shown in Table 1.

Table 1. Aortic surgery raw data

Category	Total
All Aortic procedures	9764
Open Aortic surgery	3079
Open AAA	1712
Open AAA-elective	1116
Open AAA-ruptured	369
AAA-EVAR-elective	4323
AAA-EVAR-ruptured	268
Non-aneurysm abdominal aortic surgery	1219
Thoracic ELG	851
Open Thoracoabdominal	33

i) Open aortic surgery

This includes all aneurysm and non-aneurysm surgery performed by 236 surgeons. The indications for the 1219 non-AAA procedures are shown in Table 2.

Table 2. Non-aneurysm open aortic surgery

Indication	Total
Acute ischaemia	299
Claudication	271
Rest pain	195
Mesenteric ischemia	179
Ulcer/gangrene(arterial)	92
Bypass / Stent graft / Patch sepsis	59
Neoplasm-malignant	22
Trauma(iatrogenic)-haemorrhage	16
Dissection	15
Aortoenteric fistula-secondary	12
Trauma(non iatrogenic)-haemorrhage	10
Aneurysm-false(iatrogenic trauma)	8
Entrapment	8
Infection	8
Retrieval device/FB	8
Trauma(non iatrogenic)-occlusion	5
Renal a stenosis/refractory hypertension	4
Aortoenteric fistula-primary	3
Trauma(iatrogenic)-occlusion	3
Arteritis/collagenosis	2

Open AAA

217 surgeons operated upon 1,712 patients. This dataset was restricted to patients with abdominal aneurysm repair, excluding thoraco-abdominal aneurysms. This allowed comparison of postoperative complications between 1,343 intact (elective, mycotic, painful, occluded) aneurysms and 369 ruptured AAA (Table 4). Mean aneurysm diameter was 66mm.

Table 3. Complications after intact and ruptured AAA repair

Complication	Intact AAA (1343)	Ruptured AAA (369)
AMI	30(2.2%)	22(6.0%)
Gut ischaemia	32(2.4%)	31(8.4%)
Renal failure/impairment	84(6.3%)	72(19.5%)
Ureteric injury	6(0.4%)	0
Died	55(4.1%)	120(32.5%)

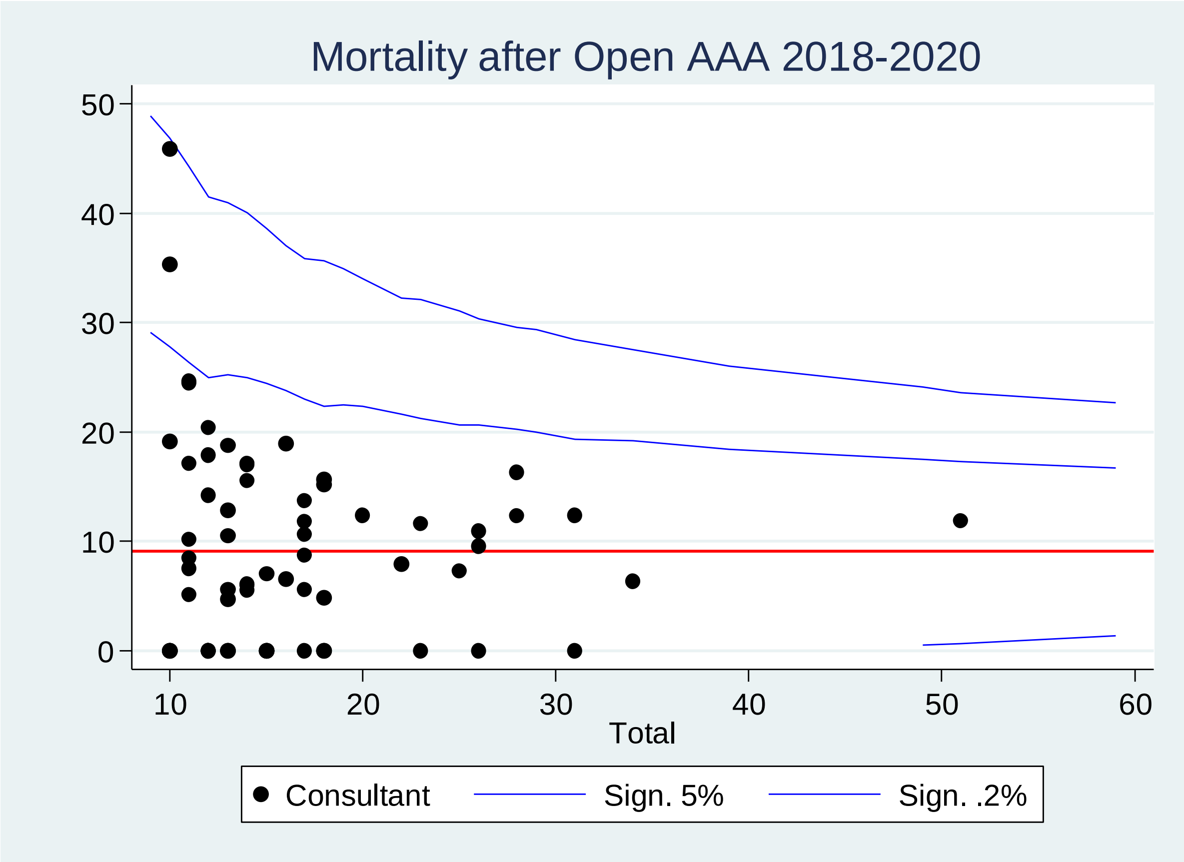
Outcomes

Predictive variables for the model are shown in table 5. Excellent discrimination was obtained with a c-statistic of 0.87. A multilevel model was not used as it was not significantly different from the binary logistic regression model.

Table 4. Significant variables in the Open AAA model 2018-2020.

Parameter	Odds Ratio	95% Conf. Int.	P (>|Z|)
Blood loss 4L+	5.218133	(3.317306 to 8.20814)	P < 0.0001
Emergency	5.314799	(3.340564 to 8.455785)	P < 0.0001
ASA Status(4)	2.487473	(1.534249 to 4.032933)	P = 0.0002
ASA Status(5)	2.415158	(1.388043 to 4.202313)	P = 0.0018
IHD	1.741051	(1.197484 to 2.531355)	P = 0.0037
71-79	2.137712	(1.381389 to 3.308128)	P = 0.0006
80+	3.666072	(2.155247 to 6.235982)	P < 0.0001

Fig 7. Risk-adjusted funnel plot for open AAA repair where surgeons performed 10 or more cases (64)



Outliers: There were no outliers for open AAA surgery.

iii) Endoluminal abdominal aortic surgery

Abdominal aortic aneurysm

237 surgeons inserted 5,209 non-thoracic ELG during 2018-2020. 85% patients had percutaneous access with closure device. Mean aneurysm diameter was 58mm. There were 107 type 1, 119 type 2

and 18 type 3 endoleaks. There were 51 occluded limbs and 9 conversions to an open repair. There were 27 cases with device failure/malposition, 4 of whom had conversion to open. GA was used in 94.1%.

The indication for EVAR was not confined to AAA as shown in Table 5.

Table 5. Indications for EVAR 2018-2020

Indication	Total
Aneurysm-elective	4323
Aneurysm-pain	360
Aneurysm-ruptured	268
Endoleak	85
Aneurysm-mycotic	56
Claudication	27
Aneurysm-occluded	24
Dissection	15
Aortoenteric fistula-secondary	10
Aortoenteric fistula-primary	9
Rest pain	7
Acute ischemia	5
Bypass / Stent graft / Patch sepsis	5
Aneurysm-false(non iatrogenic trauma)	4
Ulcer/gangrene(arterial)	4
Aneurysm-false(iatrogenic trauma)	3
Penetrating aortic ulcer	3
Trauma(iatrogenic)-haemorrhage	1

Comparison of complications between intact and ruptured ELG insertion is shown in Table 7 (the intact group includes AAA and other ELG inserted for non-AAA).

Table 6. Complications after intraabdominal ELG (n = 5,209)

Complication	Intact Aorta (4,941)	Ruptured AAA (268)
Conversion	6	3
AMI	28	7
Gut ischaemia	15	5
Renal failure/impairment	82	25
Endoleak type 1	98	9
Endoleak type 2	117	2
Endoleak type 3	17	1
Died	51(1%)	39(15%)

The type of device used for ELG is shown in table 7.

Device	Total
Endurant	1688
Excluder	740
Cook low profile	739
Zenith Alpha	638
Zenith Fenestrated	440
Cook low profile with spiral limb(s)	328
Zenith Flex(non-fenestrated)	130
Cook with side branches	123
Endologix	93
Other hybrid combination	86
Anaconda(non-fenestrated)	44
Cordis Incraft	38
Zenith T Branch	29
Nellix	19
Aorfix	16
Zenith body with Gore limb(s)	16
Trivascular Ovation (Prime)	15
Zenith body with Anaconda limb(s)	8
Zenith body with Endurant limb(s)	7
Anaconda(fenestrated)	4
Ancure	3
Talent	2
Zenith limb only	2
Talent body with Endurant limb(s)	1

iv) Fenestrated and branched ELG

The configuration of all ELG is shown in Table 9. The subsets of branched and fenestrated grafts are evident; 11 % were fenestrated. Endoleaks occurred in 4.6% of non-fenestrated vs 5% in fenestrated ELG (ns).

Table 8. Configuration of ELG 2018-2020

Configuration	Total
Bifurcated	4065
Tube	257
Fenestrated Renal(s)-SMA-Coeliac	239
Fenestrated Renal(s)-SMA	162
Bifurcated-bifurcated(+/- IBD)	95
Fenestrated both Renals	83
Fenestrated + Branched endograft	72
Aorto-uni-Iliac and Fem fem bypass	70
Branched endograft R Iliac	44
Aorto-uni-iliac-no x-over	41
Branched endograft L Iliac	32
BREVAR Renal(s)-SMA-Coeliac	17
Fenestrated L Renal	11
Scalloped	5
Fenestrated R Renal	4
BREVAR Renal(s)-SMA	3
BREVAR both Renals	2
BREVAR-SMA	2
Fenestrated SMA-Coeliac	2
Branched endograft L Iliac; Branched endograft R Iliac; Bifurcated-bifurcated(+/- IBD)	1
Branched endograft L Iliac; Fenestrated Renal(s)-SMA-Coeliac	1
Fenestrated Renal(s)-Coeliac	1

iv) Thoracic and thoraco-abdominal procedures

Endoluminal. Of the thoracic and thoracoabdominal ELG (n=851), the group consisted of dissecting aneurysms (78), non-dissecting aneurysms (299), acute dissection (168), chronic dissection (104), traumatic aortic tear (89), fistula (8), infected TEVAR (1), and penetrating ulcer (104). There were 50 deaths (5.9%). 177 surgeons performed ELG during this audit period. Configuration is shown in Table 9.

Configuration	Total
Overlapping Stent grafts	407
Single Stent graft	379
Stent graft(s) with distal bare stent	31
Stent graft(s) with intra-abd fenestration(s)	22
Fenestrated/branched-CCA	10
Fenestrated/branched-Brachioceph	2

The following devices were inserted in patients having stents/stent grafts in the thoracic aorta (Table 10).

Device	Total
Zenith Alpha	**276**
Gore C-TAG	202
Medtronic	195
Zenith TX2	148
Custom Cook (fenestrated/branched)	12
Excluder	10
Endospan Nexus	4
Bolton	2
Gore C-TAG with Zenith Alpha extension	2

There were 21 patients with paraplegia (2.5%) and 20 strokes (2.4%) following TEVAR. 23 patients had renal failure or impairment and 4 developed intestinal infarction. There were 12 type 1, 3 type 2 and 1 type 3 endoleaks. 2 patients required conversion to open. Breakdown of complications by aetiology is shown in Table 11.

Table 11. Complications according to the main pathology types (n=851)

Pathology	Total	Mortality	Stroke	Paraplegia
Aneurysm(dissecting)	78	3	1	1
Aneurysm(non-dissecting)	299	18	12	11
Dissection-acute	168	12	1	5
Dissection-chronic	104	2	2	1
Traumatic tear	89	8	2	
Penetrating ulcer	104	4	2	3

Outcomes

No predictive model was produced because of poor calibration. A non-risk adjusted funnel revealed no outliers in the 20 surgeons that had performed 10 or more cases in 2018-2020.

Open. There were 33 open thoracoabdominal procedures. They were performed by 18 surgeons. Mean diameter of the aneurysms was 64mm.

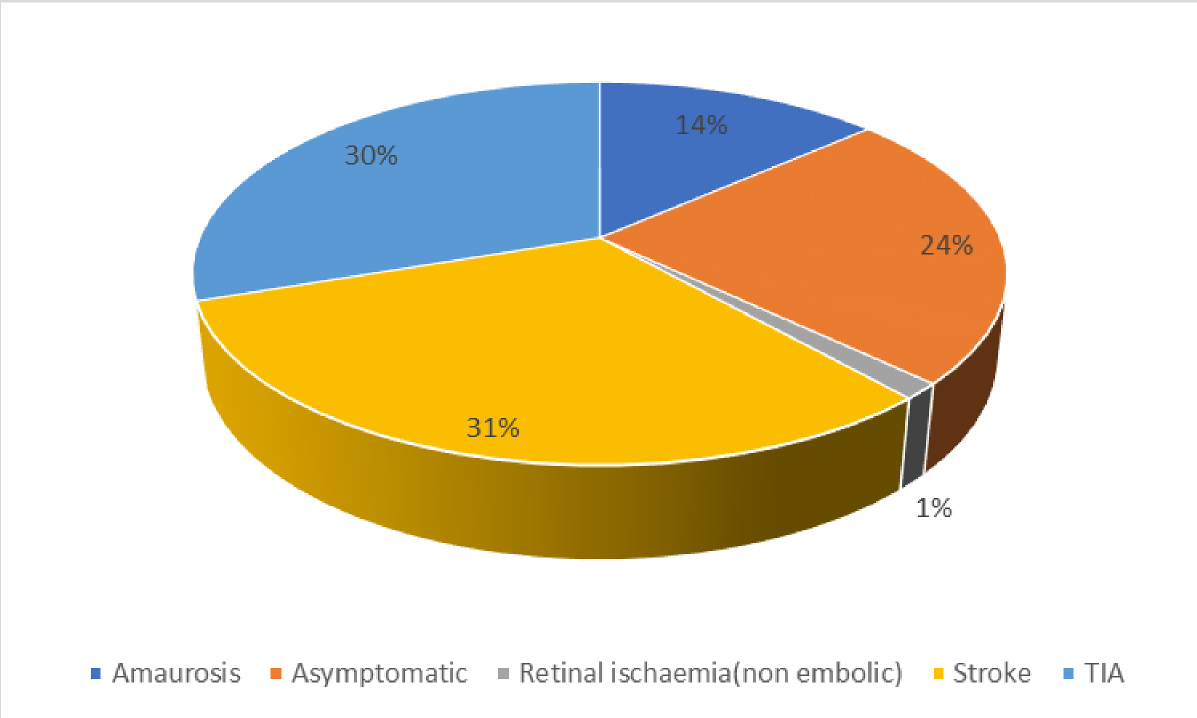
Carotid Surgery

There were 6,540 carotid interventions, 5,992 carotid endarterectomies (CEA) and 494 carotid stents (CAS) in 2018-2020.

i) Carotid Endarterectomy

244 surgeons performed CEA in this audit period. The indications for CEA are shown in Fig.12 with 24% having no symptoms. In the 2010 report 31% were asymptomatic.

Fig 8. Indication for CEA



The time from onset of symptoms to surgery in symptomatic patients was < 48 hours in 1%, < 2 weeks in 59%, 2-4 weeks in 20% and > 4 weeks in 21%. NICE guidelines recommend that the goal should be to operate within 2 weeks from the onset of symptoms to have the lowest stroke incidence. General anaesthesia was used in 80% of the patients.

Eversion endarterectomy was performed in 12.8% of patients and 44% were shunted. Patches were used in 88% of CEA (Table 12).

Table 12. Patches after CEA.

Patch	Total
Polyurethane	2298
Pericardium	1738
Dacron	637
PTFE	233
Prosthetic (Other)	153
GSV-reversed	79
Neck vein	46
Vein (Other)	24
GSV-non reversed	12
Ext carotid	11
Homograft	6
Arm vein	4
Peritoneum	2

Complications after CEA are shown in table 13.

Table 13. Complications after CEA (n= 5,992)

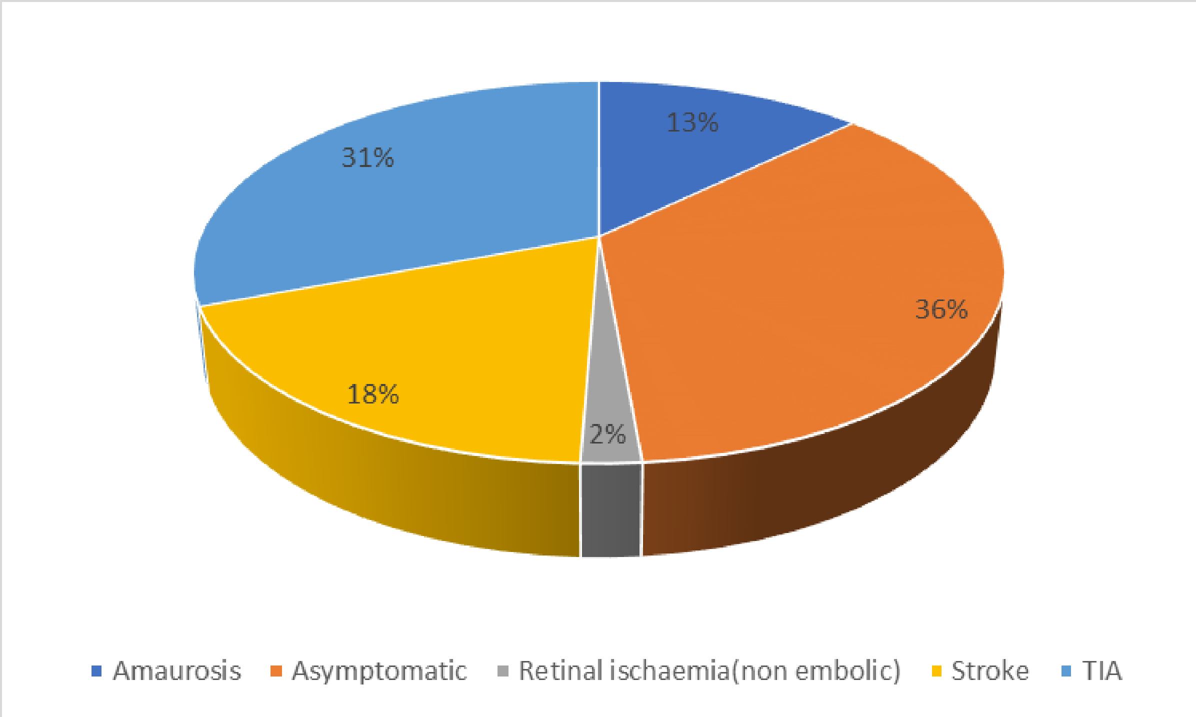
Complication	Percent
Haemorrhage requiring exploration	2.5
Cranial nerve trauma	0.8
Myocardial infarction	0.3
Major/minor stroke	0.8
TIA	0.2
Hyperperfusion	0.3
Death	0.3
Stroke or death	1.1

Outliers. There were no outliers for CEA for 2018-2020

ii) Carotid Stents

76 surgeons placed 494 carotid stents in 2018-2020.

Indications for CAS are shown in Fig 14, with the most frequent being asymptomatic, then TIA.



Technical details. n=494

Access was via a long sheath in 344 and via a short sheath with guiding catheter in 150. There was a type 1 arch in 255, type 2 in 203 and type 3 in 36 patients.

Cerebral protection devices used are shown in table 15. No protection device was employed in 37 patients. Post-dilatation was used in 337.

Filter	Total
Emboshield	185
Nav 6	153
Angioguard	49
None	37
Filterwire EX	36
SpiderFX	29
Accunet	2
Flow Reversal (Parodi)	1
Neuroshield	1
Trap	1

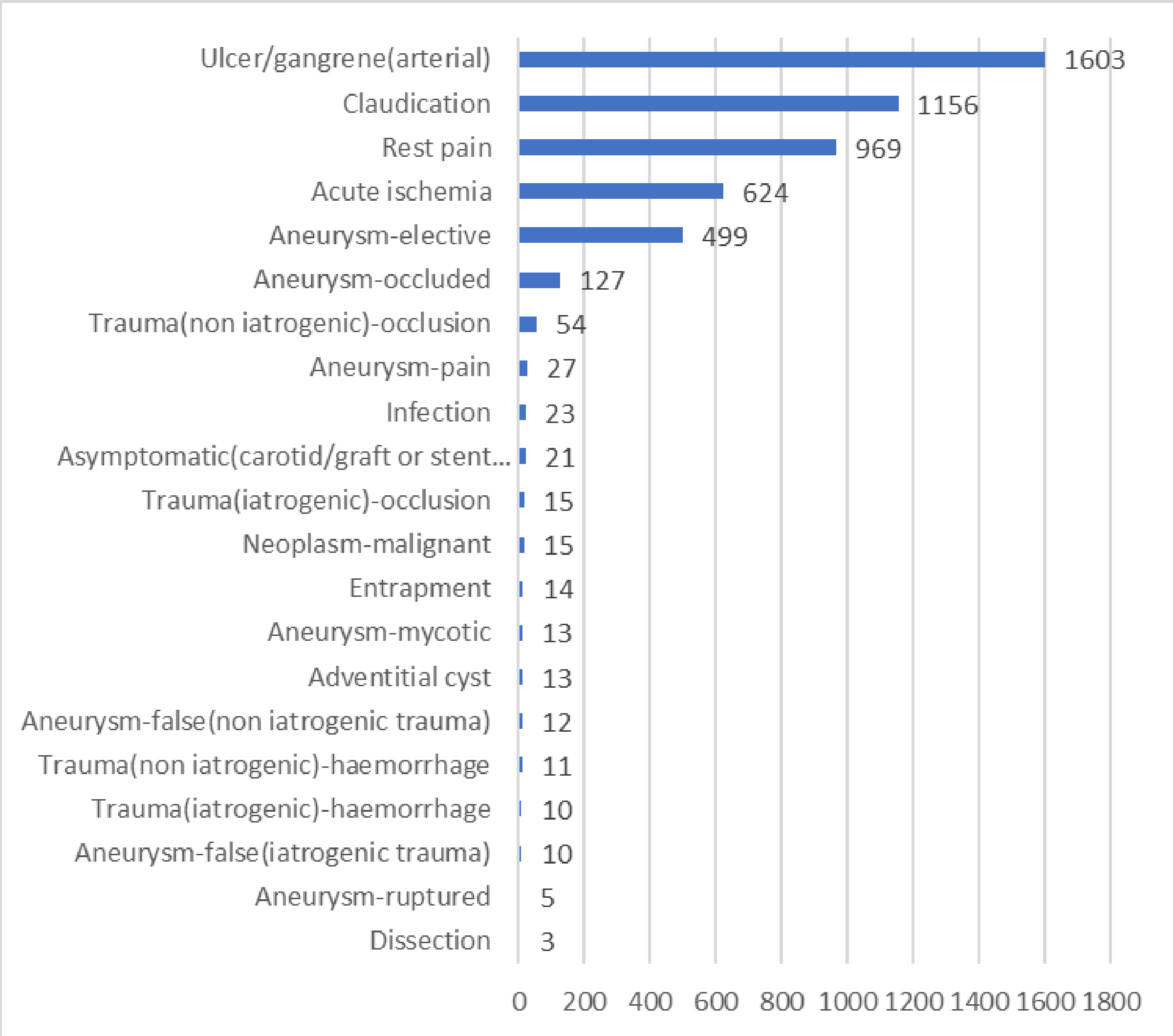
Stent types are shown in table 16.

Stent	Total
Xact	306
Precise	71
Wallstent	33
Covered stent	23
Casper	21
CGuard	18
ProtegeRX	10
Tapered	7
Acculink	2
Smart	2
Medtronic Cristallo	1

Infrainguinal bypass

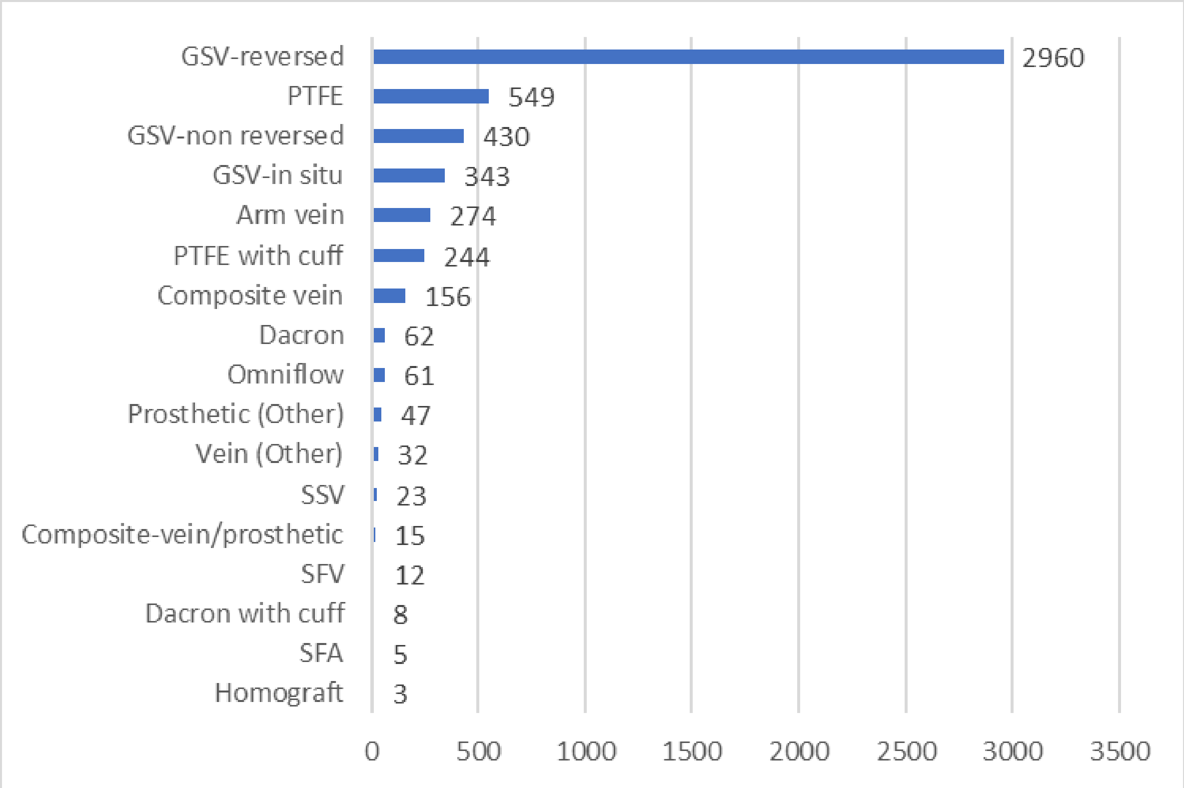
242 surgeons performed 5,224 Infrainguinal bypasses (IIB) in 2018-2020. The average age of patients was 68 with the M: F ratio of 3.6:1. General anaesthetic was used in 97%.

Indications for surgery are shown in Fig 9 with tissue loss being the most frequent.

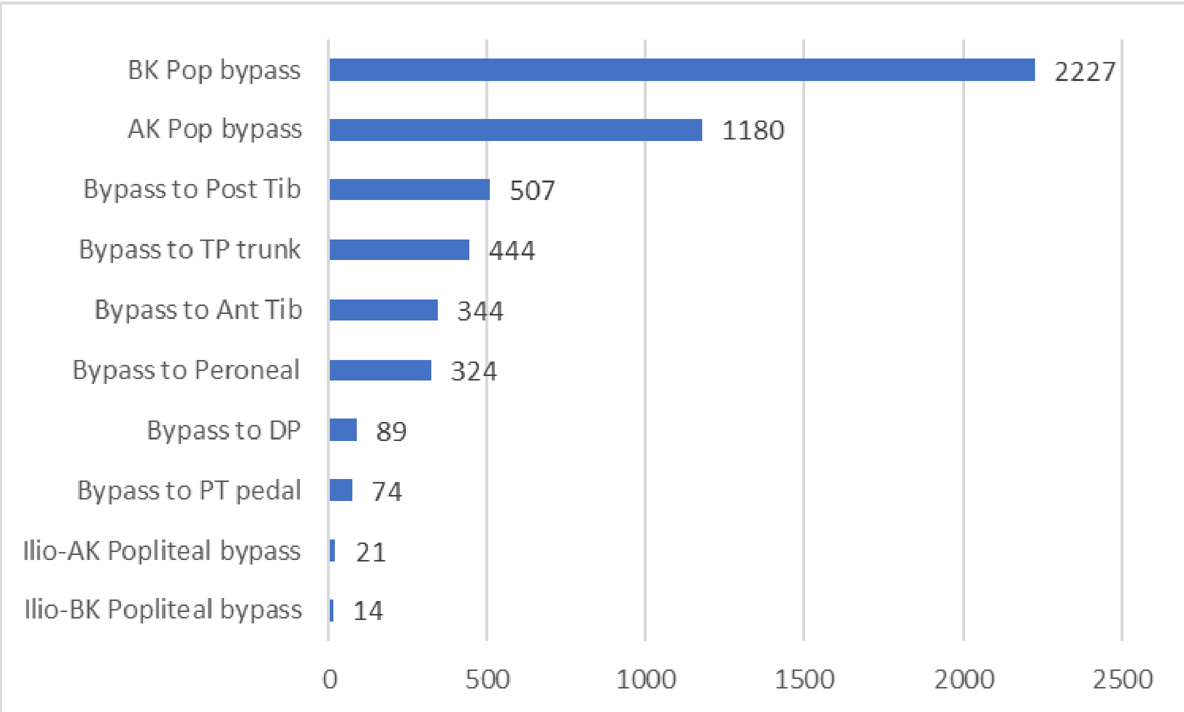


Ulcer/gangrene(arterial)
Claudication
Rest pain
Acute ischemia
Aneurysm-elective
Aneurysm-occluded
Trauma(non iatrogenic)-occlusion
Aneurysm-pain
Infection
Asymptomatic(carotid/graft or stent...
Trauma(iatrogenic)-occlusion
Neoplasm-malignant
Entrapment
Aneurysm-mycotic
Adventitial cyst
Aneurysm-false(non iatrogenic trauma)
Trauma(non iatrogenic)-haemorrhage
Trauma(iatrogenic)-haemorrhage
Aneurysm-false(iatrogenic trauma)
Aneurysm-ruptured
Dissection
1603
1156
969
624
499
127
54
27
23
21
15
15
14
13
13
12
11
10
10
5
3
0
200
400
600
800
1000
1200
1400
1600
1800

Fig. 10 Conduits for infrainguinal bypass.



Bypass configuration is shown in Fig 11.



Post-operative complications are shown in table 17 (n = 5,224)

Complication	Percent
Myocardial infarction	1.1
Stroke	0.2
Renal impairment/ failure	0.6
Wound complications	3.5
Haemorrhage requiring reoperation	2.3
Graft occlusion	4.8
Amputation	1.0
Death	1.1

Outcomes

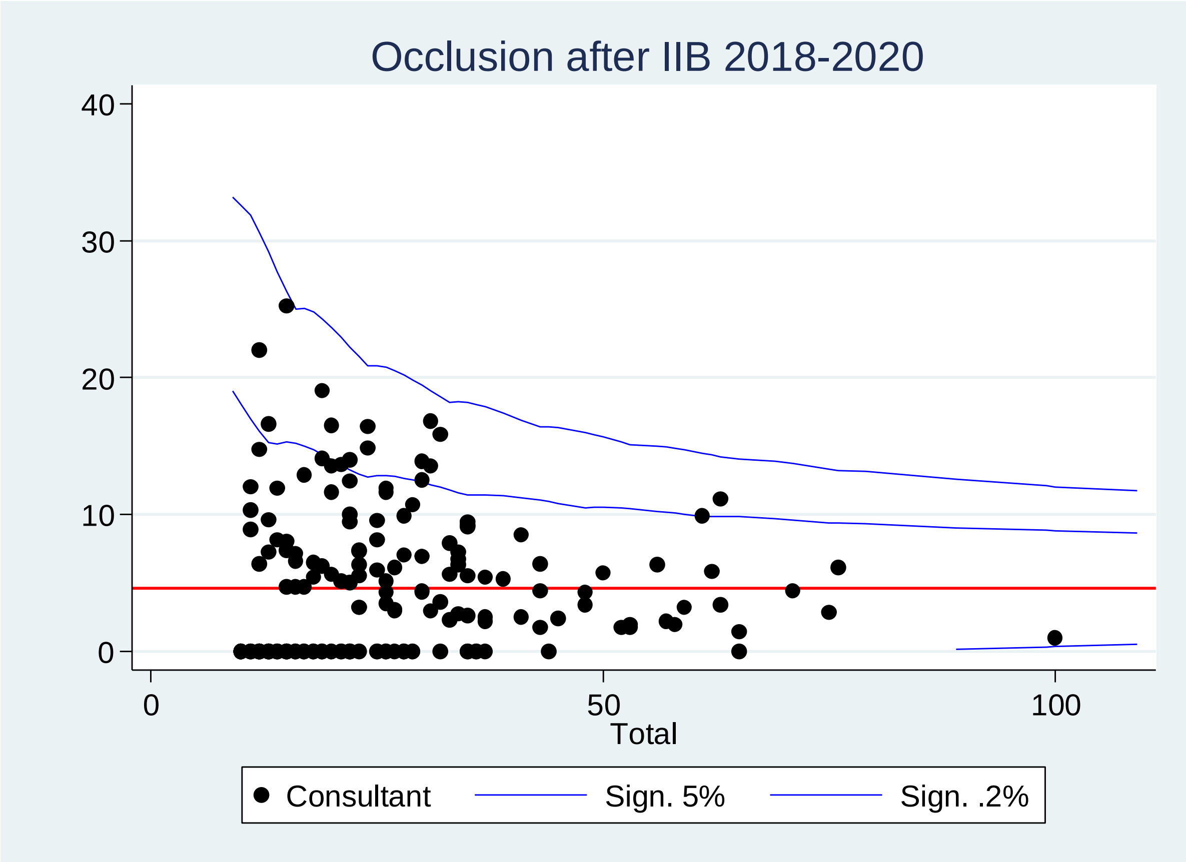
i) Occlusion

A multilevel logistic regression model for occlusion after IIB was not obtained. Variables in the logistic regression included are shown in table 18.

Parameter	Odds Ratio	95% Conf. Int.	P (>|Z|)
1 vessel runoff	2.194724	(1.693793 to 2.843802)	P < 0.0001
Omniflow/homograft	2.620757	(1.1684 to 5.878439)	P = 0.0194
Composite V	2.541755	(1.538724 to 4.198622)	P = 0.0003
Acute Ischemia	2.284614	(1.673515 to 3.118862)	P < 0.0001
Trauma-Occlusion	2.80704	(1.255528 to 6.275822)	P = 0.0119
Female	1.478733	(1.112106 to 1.966227)	P = 0.0071

Occlusion rates were assessed using a risk adjusted funnel plot for those consultants that performed 10 or more bypasses (Fig 12). No outliers were detected for 2018-2020.

Fig 12. Risk adjusted funnel plot for occlusion after IIB 2018-2020 (10 or more cases) n=181



Popliteal Aneurysm: There were 658 bypasses for aneurysm (elective, occluded, pain or rupture). The graft occlusion rate for these was 2.4% and there was 1 major amputation. In non-aneurysm patients the graft occlusion rate was 5.2% and the amputation rate was 0.9 %. 213 patients had a popliteal stent graft placed as the primary treatment modality.

Claudicants *vs* tissue loss: In the 1,156 claudicants, the occlusion rate was 2.7.% and there were 2 amputations. In 1,603 patients with tissue loss the occlusion rate was 4.8% and the amputation rate was 1.4%.

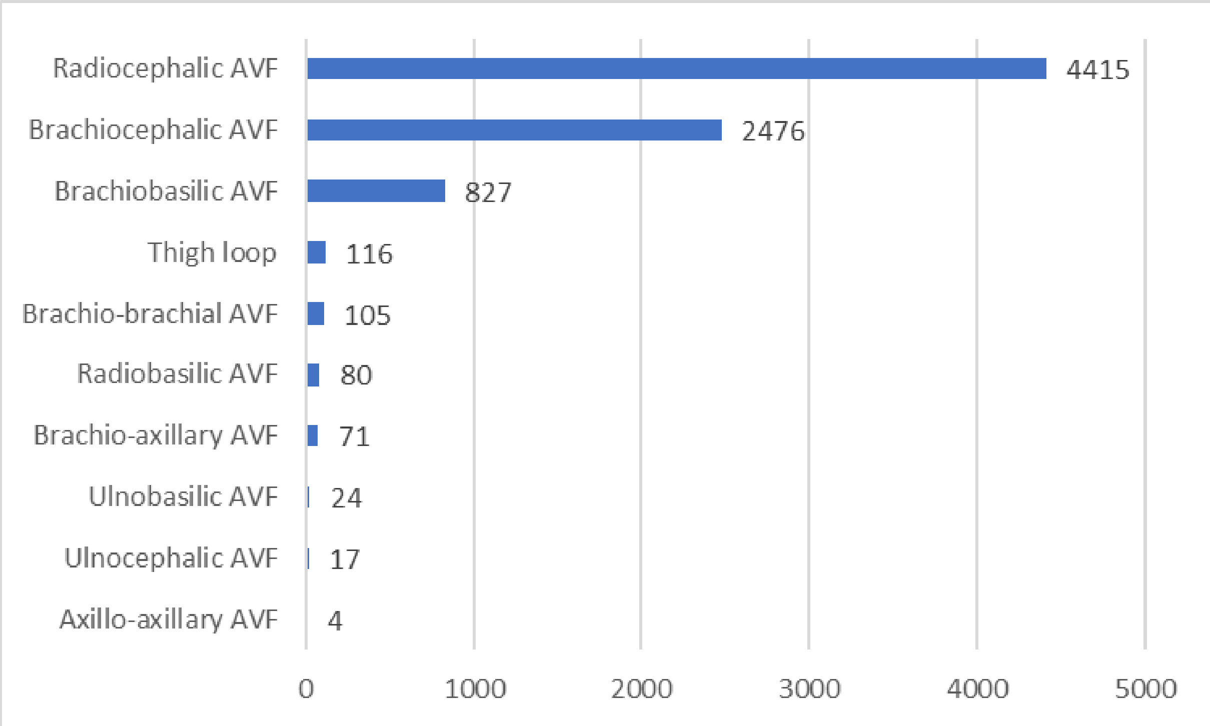
ii) Amputation

The limb salvage rate was 99%. 55 limbs were amputated and 14 of these occurred with a patent graft. 7 patients in this subgroup were diabetic.

Arteriovenous Fistulae

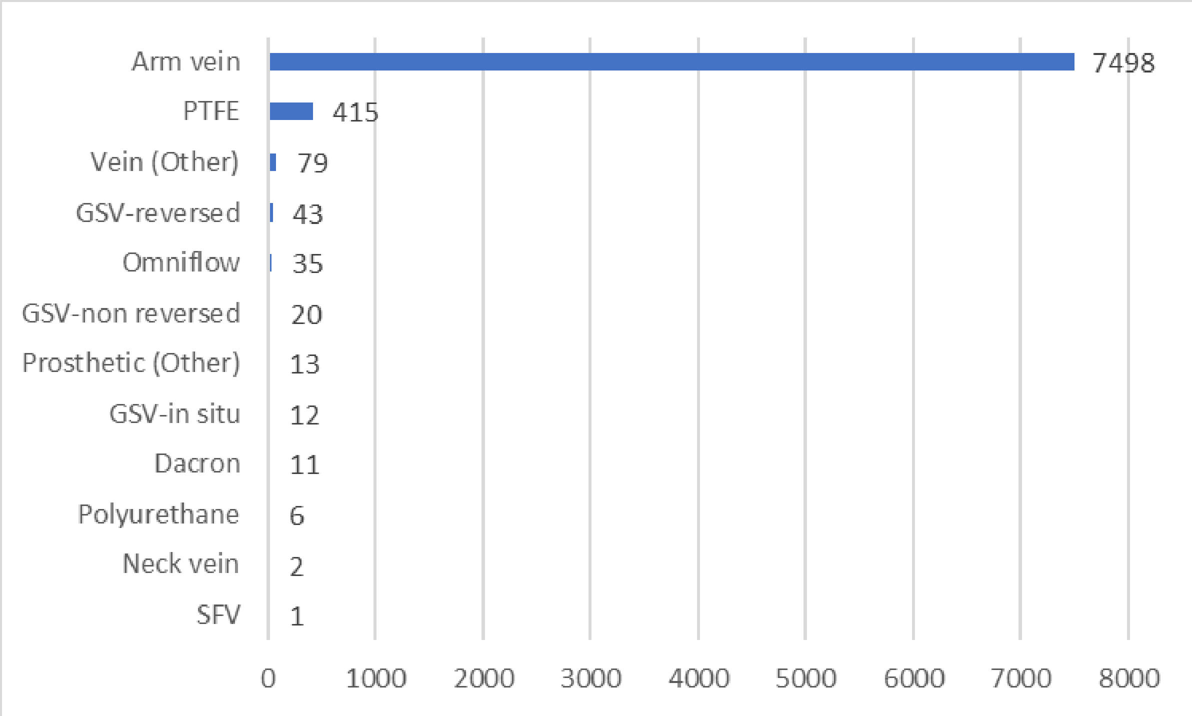
8,315 patients had an arteriovenous fistula (AVF) placed by 225 surgeons in 2018-2020. The locations of AVF are shown in Fig 13.

Fig 13. AVF configuration



The majority of AVF were autogenous (7,668) and 5.7% were prosthetic. The conduits used are shown in Fig 14.

Fig 14. Conduits used



Outcomes

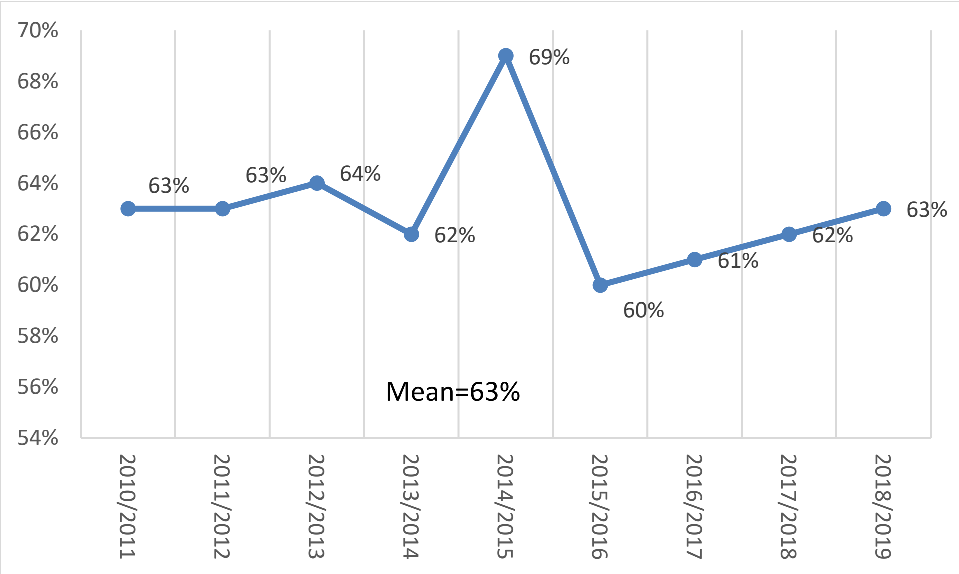
There were 149 occlusions (1.8%). Autogenous fistulae occluded in 131/7668(1.7%) and prosthetic fistulae occluded in 18/467(3.9%). 14 patients had a steal syndrome, 2 of these were in a thigh loop and 4 occurred in a wrist fistula. The other 7 were in brachial-level AVF.

Endovascular treatment for PAD

From 2020 this category was added to the index procedures and just this year's cases form this part of the report. There were 10,265 interventions performed by 225 surgeons, with a mean of 45. Hybrid open + endovascular procedures were excluded from this analysis. There were 5,698 PTA and 4,567 stents. 80 patients died (0.8%) and there were only 4 amputations. Combined complications, amputation and death was 5.9% and complications included both endovascular and general categories.

Data validation and conclusions

This audit report has been the culmination of much hard work by the committee and the contributing membership. The most important conclusion is that the standard of Australasian vascular surgery remains high with excellent outcomes in all the selected areas of audit. The outcomes chosen for audit in these 5 procedures are the best method of assessing the clinical and technical skill of a vascular surgeon. The most important facet of an activity such as this remains the "audit of the audit", and there are methods that were established during the inaugural year for both external and internal validation of this activity. External validation for Australian data has compared data capture between the AIHW database and the AVA (by financial year for the preceding years as data becomes available). Overall capture in the AVA for all Australian private and public hospital operations in the 4 index procedures has been shown to be 63% compared to AIHW data up to the 2018/9 financial year (Fig 15).



Data validation in the private sector only is available by accessing Medicare data. This is available for all billed procedures, which excludes VA and public patients. This data has been analysed for calendar years 2010-2020 for the following categories of patient (Australia only):

Carotid endarterectomy

Item numbers 33500 and 32703

Intact AAA (open)

Item numbers 33112, 33115, 33118, 33121, 33124, 33127

Infrainguinal bypass

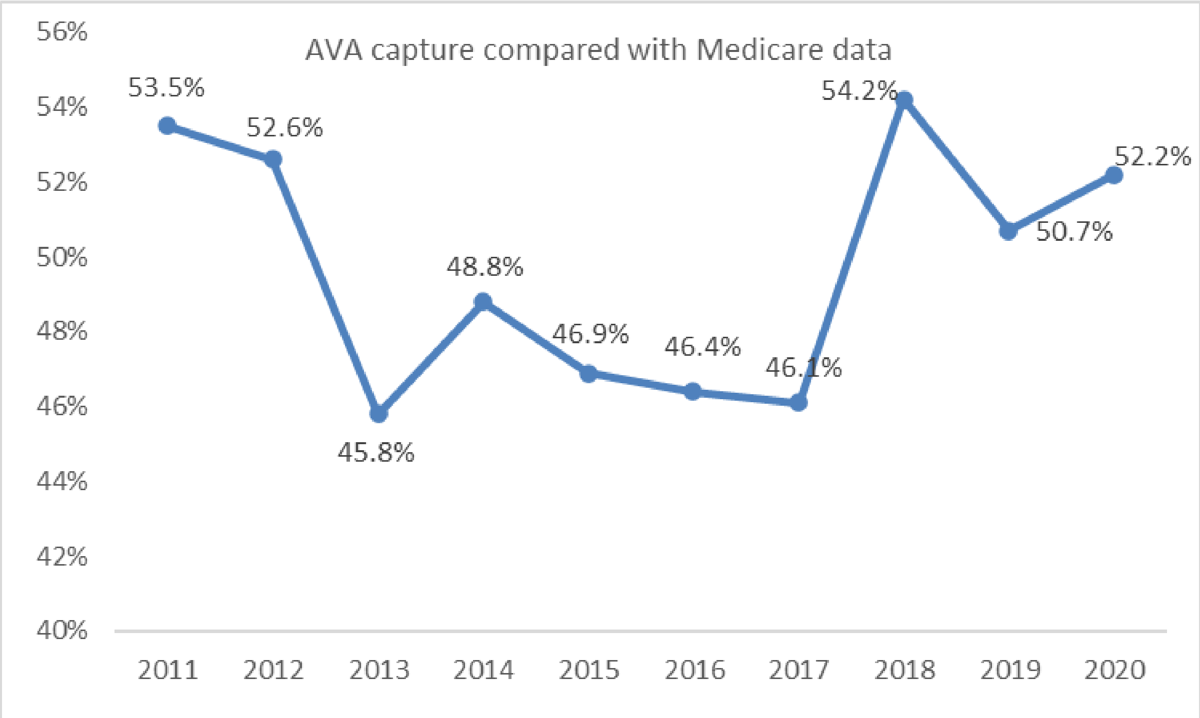
Item numbers 32739, 32742, 32745, 32748, 32751, 32754, 32757, 32763, 33050, 33055

AV Fistula

Item numbers 34503, 34509, 34512

This data was compared with AVA data over the same period after exclusion of public and VA patients. This shows that there is poor entry of private data, but is just over 50% again. Further measures are required to increase this percentage, which is unacceptable low. Private audit is generally not as robust as the M and M meetings in public teaching hospitals.

Fig 16. Private practice participation in the AVA for Australia 2010-2020

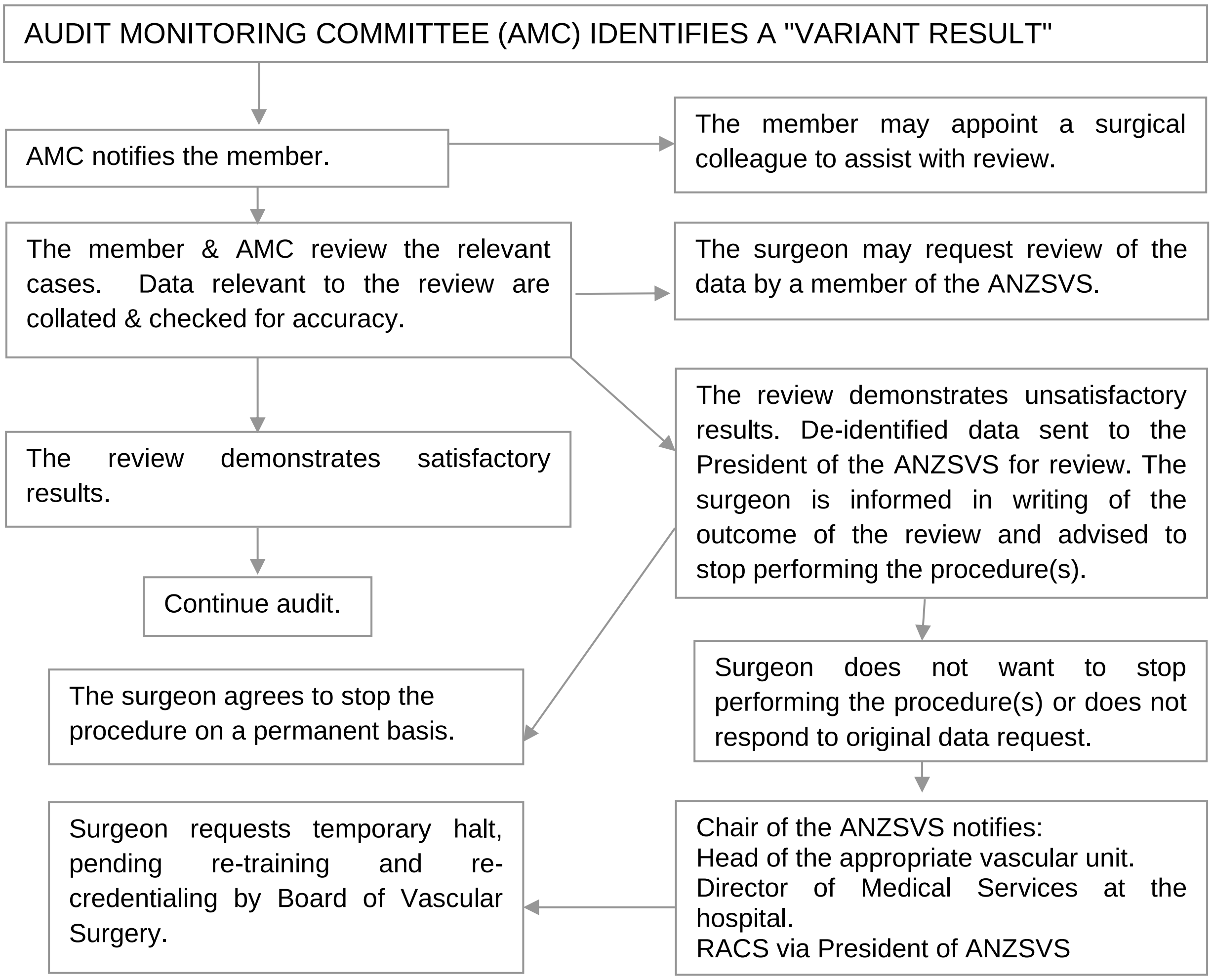


Internal validation was performed in 2020 comparing a 5% sample of patients with the actual case notes by nominated members at each hospital. This showed that data entry was of high quality with only 2.7% having incorrect field data entered out of a total of 4,216 fields studied. This study is repeated every 3 years. Performance of vascular surgery in Australasia is at a high standard and our Society is enhanced by the existence of the AVA, especially with its unique audit loop. Members can continue to participate in the knowledge that it is a completely confidential activity, monitored by a committee that has a dual role of scrutiny of outcomes together with a genuine concern for the natural justice of members.

C Barry Beiles, Administrator

Appendix 1

Algorithm for audit



Note 1. The members of the ANZSVS Audit Monitoring Committee (AMC) are responsible for determining the thresholds for complications warranting review, after discussion and agreement by the members. Where appropriate, the thresholds used by the ACHS may be the limit chosen.

Note 2. If it is not possible for the independent reviewer chosen by the member and the AMC to reach consensus, the issue will be referred to the Board of Vascular Surgery for a final determination of satisfactory or unsatisfactory performance or other recommendation.

Note 3. The algorithm does not envisage advice to stop all operating unless audit showed unsatisfactory results in all types of operations performed. Thus the surgeon would only cease performing that particular operation that gave unsatisfactory results. Referral to the Medical Board may result in the suspension of all operating rights.

If there are continuing issues with the surgeon performing operations at an unsafe level then notification of the concerns of the AMC may be made to the Medical Board after discussion in writing with the president of the ANZSVS.

Appendix 2

Statistical methods

When performing institutional or individual comparisons for outcomes of health data, it is important to recognise that this has been fraught with difficulties in the past. The now discredited league tables are misleading and have been replaced with funnel plots, which are easy to interpret at a glance. The league table approach has been used to rank institutions based on performance, and this has led to "gaming", whereby institutions tackling the more complicated high-risk cases have avoided these procedures in order to improve their position in the table. There is also a 5% risk that a hospital or surgeon will be at the bottom of the table by chance, as these tables use 95% confidence intervals. It should also be recognised that it is a statistical certainty that an institution or surgeon can have a run of bad luck, and while they might reside at the bottom of the table in 1 year, this may be an isolated phenomenon.

Whichever method is used in assessing performance, some method of risk-adjustment is important, so that those hospitals or surgeons undertaking the high-risk cases will not be disadvantaged. It is recognised that methods of obtaining risk-adjustment are not an exact science, but the most widely utilised technique applied to outcomes that are 'binary' (where the outcome is one of 2 choices, ie. death or survival; patency or occlusion), is multilevel logistic regression analysis. Multilevel analysis determines the effect of the hospital on patients treated by the same surgeon at different locations. The outcome variable is called the dependent variable, and the variables that significantly affect the outcome are called the independent variables. These variables are accepted if the P value is < 0.05. An acceptable model is then produced that aims to provide good predictive qualities (called "discrimination") and this predictive ability should persist for cases with both low and high risk of an adverse outcome (called "calibration"). We have been able to produce good models for mortality following open aortic, open aneurysm, EVAR, stroke/death after carotid endarterectomy, occlusion after lower limb bypass and occlusion after AVF creation. The link test was run after each logistic regression to confirm that the model was correctly specified.

Once a model has been established, it will provide an expected risk of an adverse outcome for each patient in the population studied, based on the presence or absence of the statistically significant variables identified by the logistic regression procedure. This is then applied in the methods chosen to display the data. Statistical analysis was performed using Stata version 13.1 (Statacorp. 4905 Lakeway Drive College Station, Texas 77845 USA) and StatsDirect statistical software (England: StatsDirect Ltd. 2008)

Data display

Funnel plots have been adapted from a technique used to establish publication bias in meta-analyses. The adverse event rate is plotted on the Y axis, with the total number of cases on the X axis and Poisson 95% and 99% confidence intervals using the pooled adverse event rate for the whole group superimposed on the scatter plot. The data is risk adjusted (where a robust predictive model has been obtained) by plotting the adverse event rate as a standardised mortality/event ratio (Observed/ Expected rate x overall event rate expressed as a percentage). The expected rate for each patient is derived from the logistic regression analysis. Non- risk adjusted funnel plots are displayed using the percent adverse event on the Y-axis and using a binomial distribution. These plots were obtained by using the funnelcompar module in Stata. The graph is easily interpreted because any consultant falling outside the upper 95% confidence interval should be scrutinised to see if there is a problem in processes, using careful clinical appraisal. Conversely, consultants falling below the lower 95% confidence interval are performing much better than the majority.

Appendix 3

Features of the AVA application

This is a web-based database in SQL residing on a secure server (Microsoft Azure) within Australia and is compatible with all browser platforms. Data capture is exclusively via the web portal. A mobile-friendly modification has recently been designed.

1. Security and performance:

a) Uptime – Application and database up-time is greater than 99%

b) Backup Services - Daily database and application backup

c) Security services - Enterprise Firewalls, Intrusion Prevention Systems, and Anti-Virus Protection

d) Disaster recovery - Daily backups featuring file recovery, data de-duplication, redundant block elimination, over the wire encryption and offsite storage of backup data

e) Logon is only permitted by Surgeon code and password

f) The ability to view reports is determined by the status of the user. Full members of the ANZSVS have the ability to view all reports, and there is the ability to view the user's outcomes in the 4 categories of audit in real time compared to the peer group. There is also a category of data manager for a unit or hospital (e.g. vascular trainee) that is granted access to enter data for the surgeons who work in their unit. They have no access to the private patient data for those surgeons.

2. Scalability:

The application is capable of handling 200 simultaneous users

3. Role based data updates:

Modification of data entered in the discharge/complication form fields after user logoff is only allowed by the administrator. Addition of data is allowed by all users. Deletion of records is only allowed by the administrator.

4. Privacy and confidentiality:

Compliance with privacy legislation is current and patient identifiers are encrypted and the database is securely stored by the Server. Confidentiality of patient details is thus assured. Ethics committee approval has been obtained for this activity. Confidentiality of member's identity is assured by the storage of the surgeon code with legal representatives of the ANZSVS. The only situation where the identity of a surgeon would be allowed is in the event of the examination of the member by the AMC after possible underperformance has been identified by the statistical analysis. Commonwealth legislation identifying the AVA as a privileged quality assurance activity has been obtained in both Australia and New Zealand. Any identification of participating members outside of the strict algorithm of the audit process is punishable by a significant financial penalty and a maximum 2 year custodial sentence. An important feature of the AVA is the independence provided by total ownership of the data. This has been possible because the ANZSVS has self-funded the establishment and maintenance costs.

5. Data reliability:

Strict data validation criteria prevent erroneous data entry and there is no ability for free text data entry, except for 2 "comment" boxes in the operation and discharge forms. Drop down menus allow choices to appear that are based upon selections made in previous fields. This diminishes the ability to enter incorrect data.

6. Flexibility:

The application has been designed to allow alterations to the menu choices by the administrator. This has ensured that unusual operations can be entered. The application captures all endovascular procedures where appropriate and the vascular surgical trainees extract data from the AVA to submit their logbooks to the Board of Vascular Surgery.

7. Benefits for the user:

The ability to compare real time outcomes by surgeon and /or hospital with the membership as a whole is very attractive. Also, there is the ability to conduct unit or personal audit using the reports specifically designed for this purpose. There is the ability to export data extracts, which represent a spreadsheet containing every field for each patient. This allows filtering to manipulate data in any form the user requires for any purpose. Logbook reports are also available for trainees and members. Participation in the AVA has been approved as a recognised audit activity by the Royal Australasian College of Surgeons for the purpose of re-accreditation. Participation also allows the user access to de-identified data for the purpose of research or in the event of an inquiry into one's performance by a hospital or medico legal proceeding. A certificate of participation is issued annually upon application. This certificate is mandatory for retention of membership of the Society since 2019.

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