Australasian Vascular Public Audit Report – 2021

Contents

Foreword

The ANZSVS is proud to present the 2021 report of the Australasian Vascular Audit (AVA). This is the 12th annual report since it commenced on January 1, 2010.

Individual annual reports have been regularly published since the inception of the AVA. Since the inclusion of peripheral endovascular interventions as a mandatory index procedure for data entry purposes commencing in 2020, the AVA should provide useful data on the contemporary practice of vascular surgery in Australia and New Zealand. Challenges remain in ensuring data from the private sector is accurately and efficiently captured and the AVA – like all similar audits – rely on technical, diligent and true compliance of all our participating surgeons and the support and vigilance of the hospitals where participation of the AVA is a required element in credentialling.

While no audit of activity, with short term outcome data (now an optional field in the AVA) can be considered a perfect instrument of peer review, the mindset of genuine (rather than perfunctory) compliance is a key element of perfecting the tool.

The ANZSVS continues to strive to encourage established and emerging vascular surgeons to continue to truly and accurately comply with the requirements of the certificate of participation in both public and private sector activity. The integrity of the AVA is set by the integrity of the individual contributing to the data entry.

The impact of the Omicron variant early this year will likely provide an interesting comparison in *next* years AVA report but urgent aortic surgery and peripheral interventions for limb threatening ischemia are unlikely to have been particularly affected.

As vascular surgery evolves, the AVA, remains a proven methodology for standard setting, benchmarking and a reliable quality initiative tool of clinical performance improvement. As I mentioned in my foreword last year, the mandatory nature of the requirement of participation in the AVA for membership of the ANZSVS, should not – for most fair minded and objective thinkers – take away from its inherent value as a unique, robust and constantly improving bi-national, web-based audit of key vascular surgical procedures. This should always remain 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.

The ANZSVS continues to review options to enhance the AVA platform and to continue to build on the success of the AVA.

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

Peter Subramaniam

President ANZSVS

Introduction

The Australasian Vascular Audit (AVA) has just completed its 13th 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

There were 44,894 operations entered in 2021; 40,457 from Australia and 4,437 from New Zealand (Fig 1). Although the demographic data applies to all operations, the outcome analyses are based on the 44,637 discharged patients (99.4%).

Fig 1. Volume of vascular surgery by country 2021

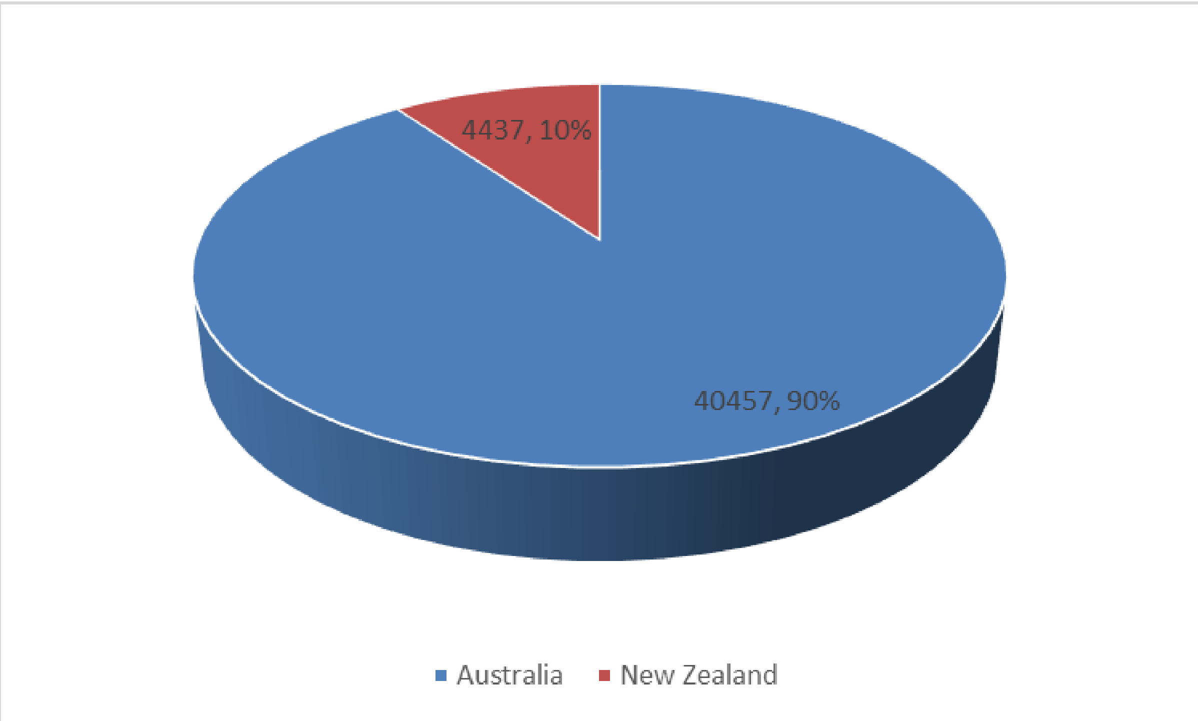
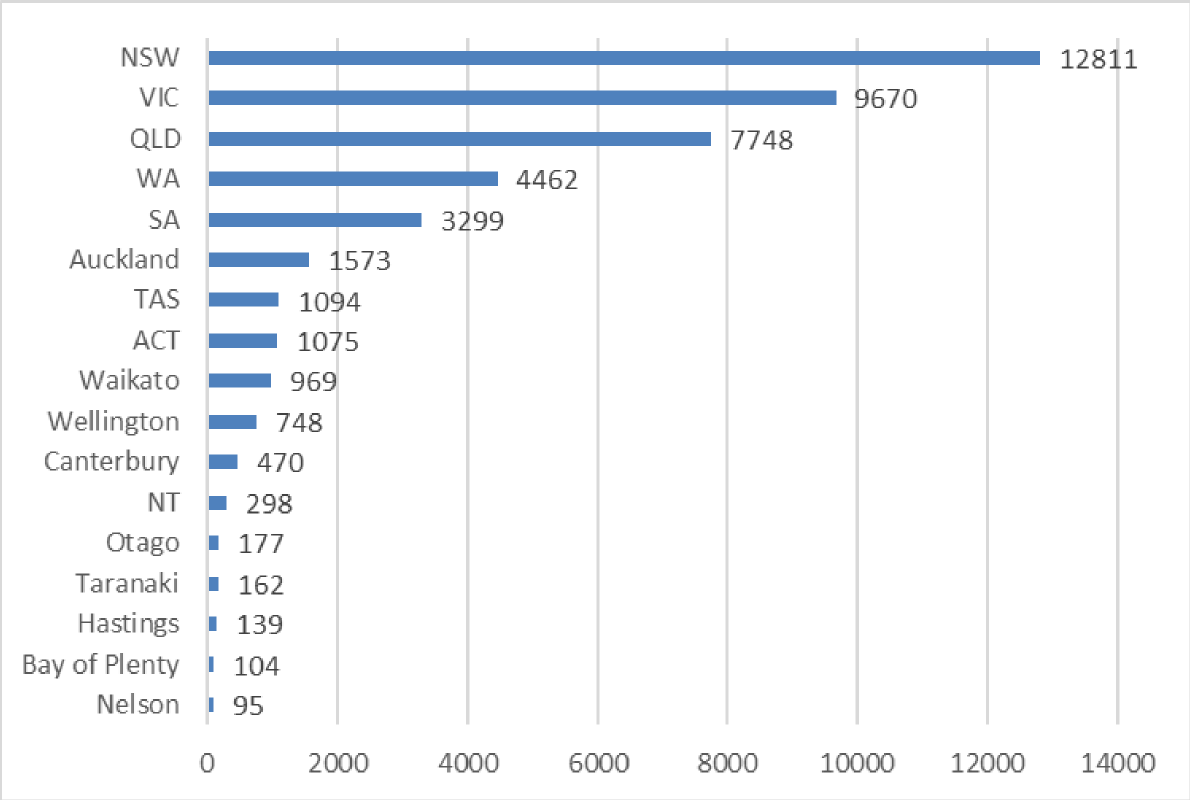


Fig 2. Operations by Australian State and New Zealand Region 2021



264 consultants entered data from 191 hospitals/clinics which are shown alphabetically in the following table. The mean number of operations was 170 with a range of 1-599.

Alfred Hospital-Melbourne
Armadale Kelmscott District Hospital-Armadale
Ashford Hospital-Ashford
Auburn District Hospital-Auburn
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
Blacktown Hospital-Blacktown
Blue Mountains Hospital-Katoomba
Box Hill Hospital-Box Hill
Brisbane Waters Private Hospital-Woy Woy
Buderim Private Hospital-Buderim

Cabrini Hospital-Malvern
Cairns Base Hospital-Cairns
Cairns Private Hospital-Cairns
Calvary Adelaide Hospital-Adelaide
Calvary Hospital-Lenah Valley
Calvary Hospital-Wagga Wagga
Calvary Private Hospital-Bruce
Calvary Public Hospital-Bruce
Canberra Hospital-Garran
Canterbury Charity Hospital-Christchurch
Christchurch Public Hospital-Addington
Coffs Harbour Health campus-Coffs Harbour
Concord Repatriation Hospital-Concord
Dandenong Hospital-Dandenong
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
Fiona Stanley Hospital-Murdoch
Flinders Medical Centre-Bedford Park
Flinders Private Hospital-Bedford Park
Frankston Hospital-Frankston
Fremantle Hospital-Fremantle
Friendly Society Private Hospital-Bundaberg West
Geelong Private Hospital-Geelong
Geelong Public Hospital-Geelong
Geraldton Regional Hospital-Geraldton
Gold Coast Private Hospital-Parklands
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
Hobart Private Hospital-Hobart
Hollywood Private Hospital-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
Knox Private Hospital-Wantirna
Lake Macquarie Private Hospital-Gateshead
Launceston General Hospital-Launceston
Lingard Private Hospital-Merewether
Lismore Base Hospital-Lismore
Liverpool Hospital-Liverpool
Lyell McEwin Hospital-Elizabeth Vale
Macquarie University Hospital-North Ryde
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
Memorial Hospital-North Adelaide
Mercy Hospital-Epsom
Miami Day Hospital-Miami
Middlemore Hospital-Otahuhu
Mitcham Private Hospital-Mitcham
Monash Medical Centre-Clayton
Mount Barker Hospital-Mt Barker
Mulgrave Private Hospital-Mulgrave
National Capital Private Hospital-Garran
Nelson Hospital-Nelson
New Bendigo Hospital-Bendigo
Newcastle Private Hospital-New Lambton Heights
North Gosford Private Hospital-North Gosford
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
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

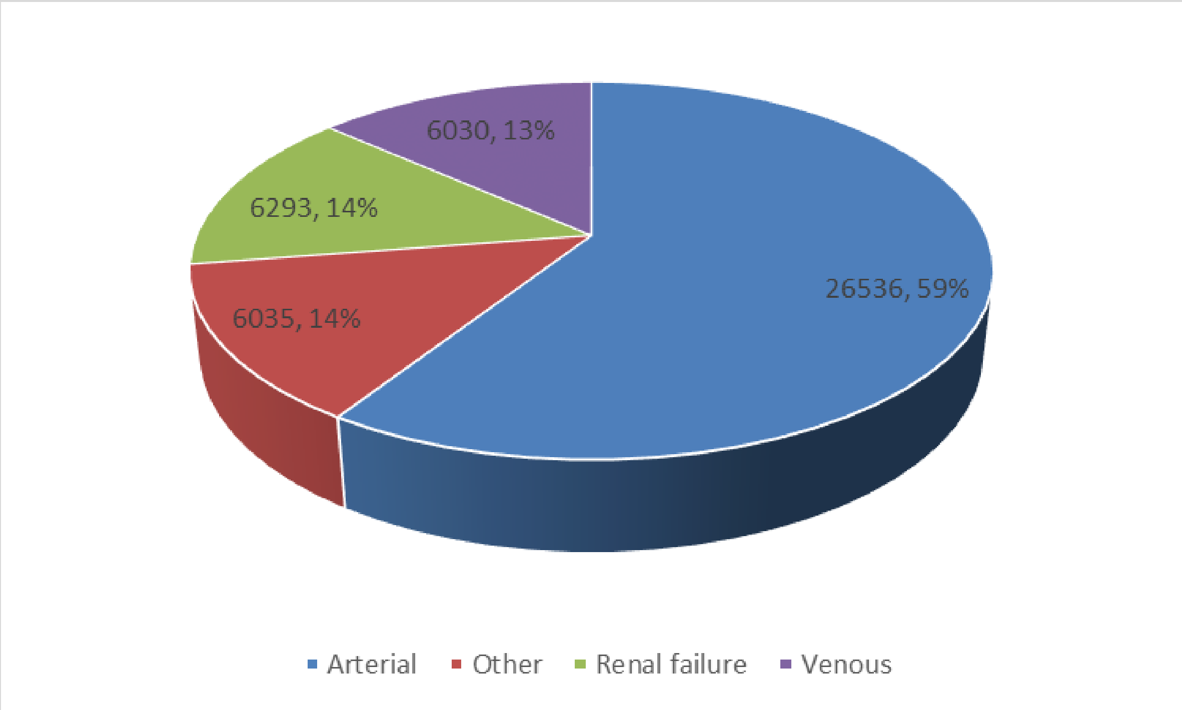
Princess Alexandra Hospital-Woolloongabba
Queen Elizabeth Hospital-Woodville West
Queensland Childrens Hospital-South Brisbane
Riverland Regional Hospital-Berri
Rosebud Hospital-Rosebud
Royal Adelaide Hospital-Adelaide
Royal Brisbane and Womens Hospital-Herston
Royal Childrens Hospital-Parkville
Royal Darwin Hospital-Casuarina
Royal Hobart Hospital-Hobart
Royal Melbourne Hospital-Parkville
Royal 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
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-Geelong
St JOG Hospital-Midland
St JOG Hospital-Murdoch
St JOG Hospital-North Ballarat
St JOG Hospital-Subiaco
St Vincents Private Hospital-Darlinghurst
St Vincents Private Hospital-East Lismore
St Vincents Private Hospital-Fitzroy
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 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 Tweed Hospital-Tweed Heads
The Vein Centre-Richmond
The Vein Centre-Toorak
The Wesley Hospital-Auchenflower
Toowoomba Base Hospital-Toowoomba
Townsville Hospital-Townsville
Vascular Solutions-Subiaco
VCCC (Peter Mac)-Parkville
Wagga Wagga Base 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 Hospital-Henley Beach
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 233 with a range of 1-1,392

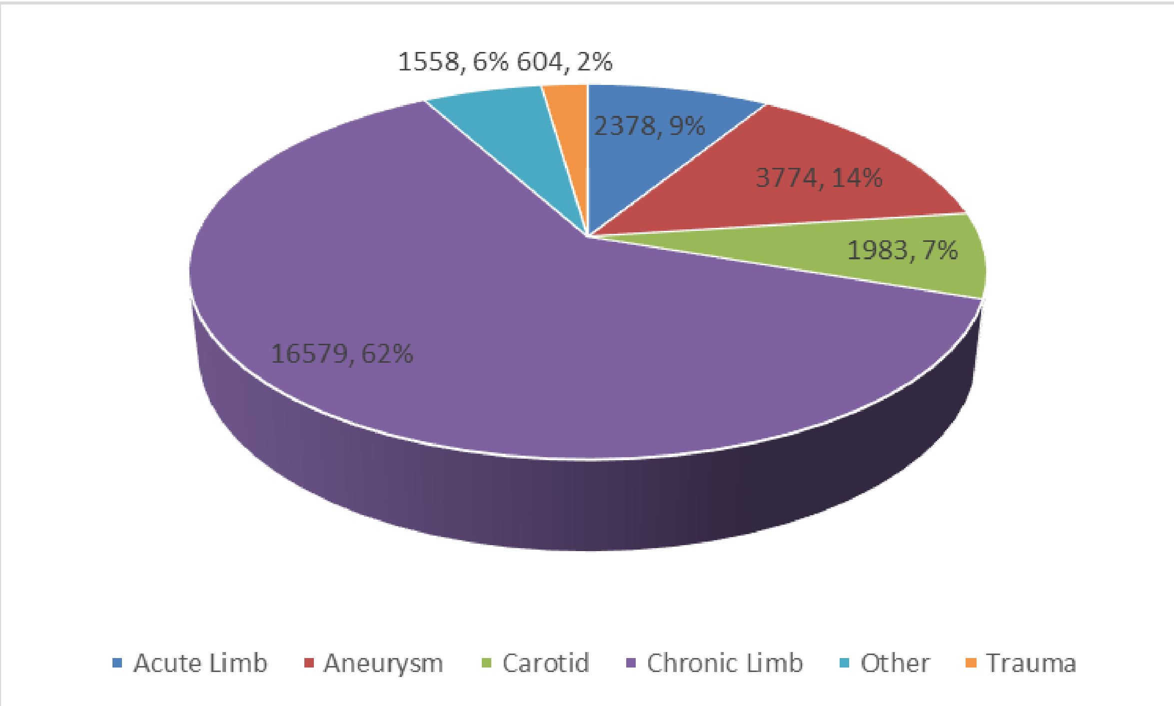
The distribution of procedures by patient type is shown in Fig. 3. The majority were arterial patients followed by venous disease then renal disease.

Fig 3. Patient type 2021



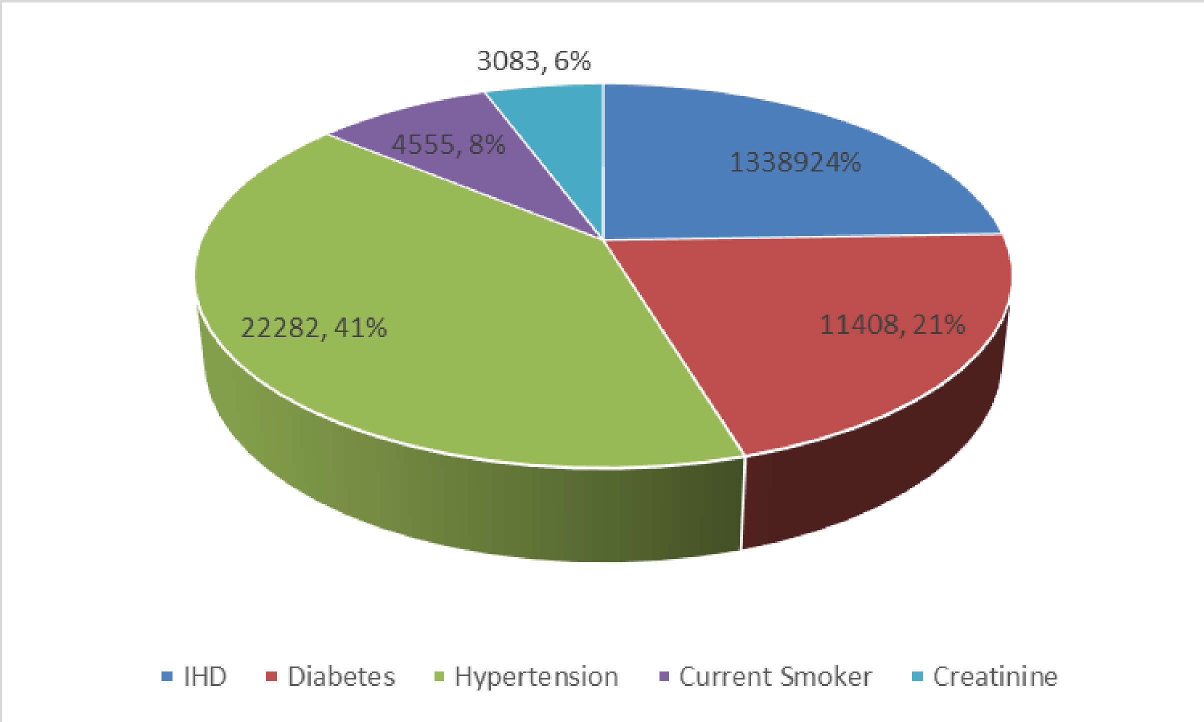
The distributions of procedures in the arterial category are shown in Fig. 4. The majority were for chronic limb operations (62%) followed by aneurysms (14%), acute limb (9%) then carotid procedures (7%).

Fig 4. Arterial categories 2021 (n=26,876)



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.

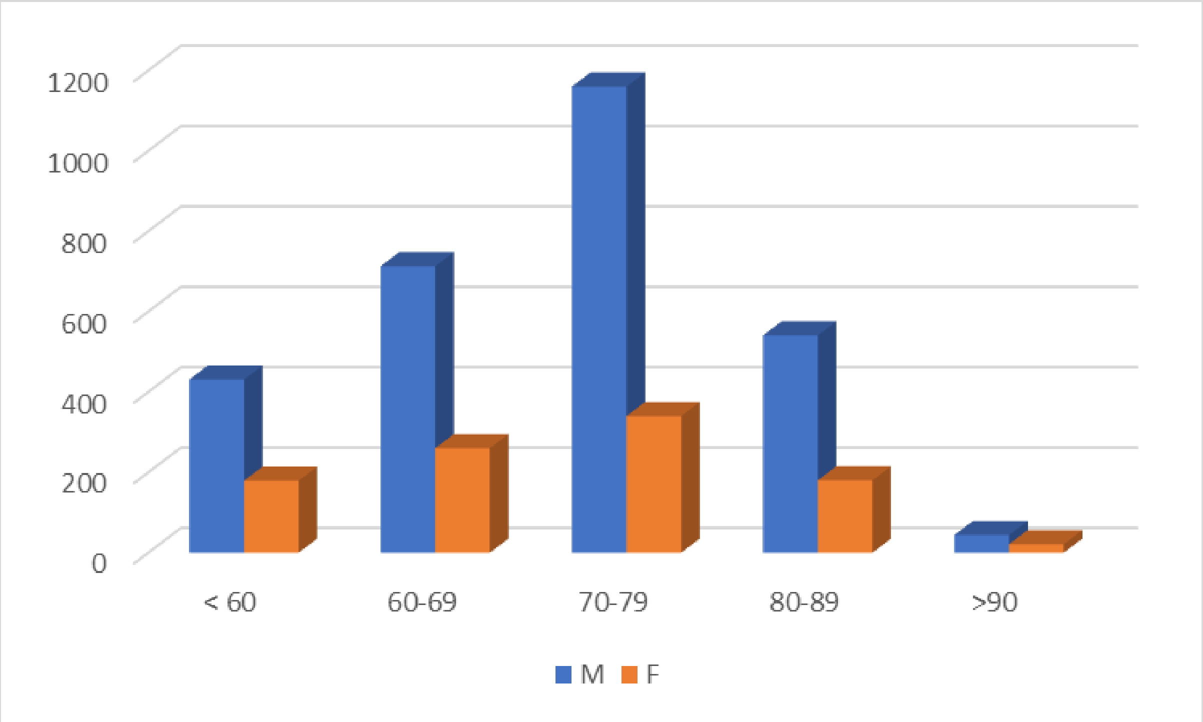
Fig 5. Risk factors in arterial operations 2021 (Creatinine = >150mMol/L, Smoking = current)



Aortic Surgery

There were 2,979 Aortic (discharged) procedures performed in 2021. This category includes aneurysmal disease (emergency and elective), open and endoluminal (ELG) procedures and aortic operations for non-aneurysmal disease.

Fig. 6. Age and Gender Aortic surgery 2021



The distribution of procedures and crude mortality is shown in Table 1.

Table 1. Aortic surgery raw data

Category	Total	Mortality (%)
All Aortic procedures	2979	4.3
Open Aortic surgery	915	10.7
Open AAA	579	10.4
Open AAA-elective	373	3.2
Open AAA-ruptured	118	38.1
AAA-EVAR-elective	1473	0.5
AAA-EVAR-ruptured	84	9.5
Non-aneurysm abdominal aortic surgery	315	10.8
Thoracic ELG	328	4.0
Open Thoracoabdominal	7	14.3
Endo Thoracoabdominal	75	1.3

i) Open aortic surgery

This includes all aneurysm and non-aneurysm surgery. 195 surgeons performed an average of 5 procedures with a range 1-24. The indications for the 314 non-AAA procedures are shown in Table 2.

Table 2. Non-aneurysm open aortic surgery

Indication	Total	Died
Claudication	75	1
Mesenteric ischemia	70	19
Acute ischemia	53	8
Rest pain	48	0
Ulcer/gangrene(arterial)	25	2
Neoplasm-malignant	11	0
Bypass / Stent graft / Patch sepsis	6	1
Aortoenteric fistula-secondary	5	1
Infection	5	1
Renal a stenosis/refractory hypertension-atheromatous	3	0
Trauma(iatrogenic)-haemorrhage	3	0
Neoplasm-benign	2	0
Retrieval device/FB	2	0
Trauma(non iatrogenic)-haemorrhage	2	1
Dissection	1	0
Entrapment	1	0
Renal a stenosis/refractory hypertension-FMD	1	0
Trauma(iatrogenic)-occlusion	1	0

Outcomes for Open Aortic Surgery

This data was risk-adjusted using predictive models obtained by logistic regression analysis (see **Appendix 2**-statistical methods). A multilevel model was not significant so standard binary logistic regression analysis was used.

The open aortic surgery model displayed excellent calibration (a measure of the ability to predict mortality across the spectrum of low and high-risk patients), determined by “goodness of fit” tests that do not show a difference, as well as good discrimination (the ability of the model to predict mortality in any particular patient) as determined by the area under the ROC, with a value of this C-statistic of > 0.7 signifying good discrimination.

The ROC graph for the model for open aortic surgery is shown in Fig. 7 with a C-statistic of 0.87.

Fig 7. ROC for mortality after open aortic surgery model.

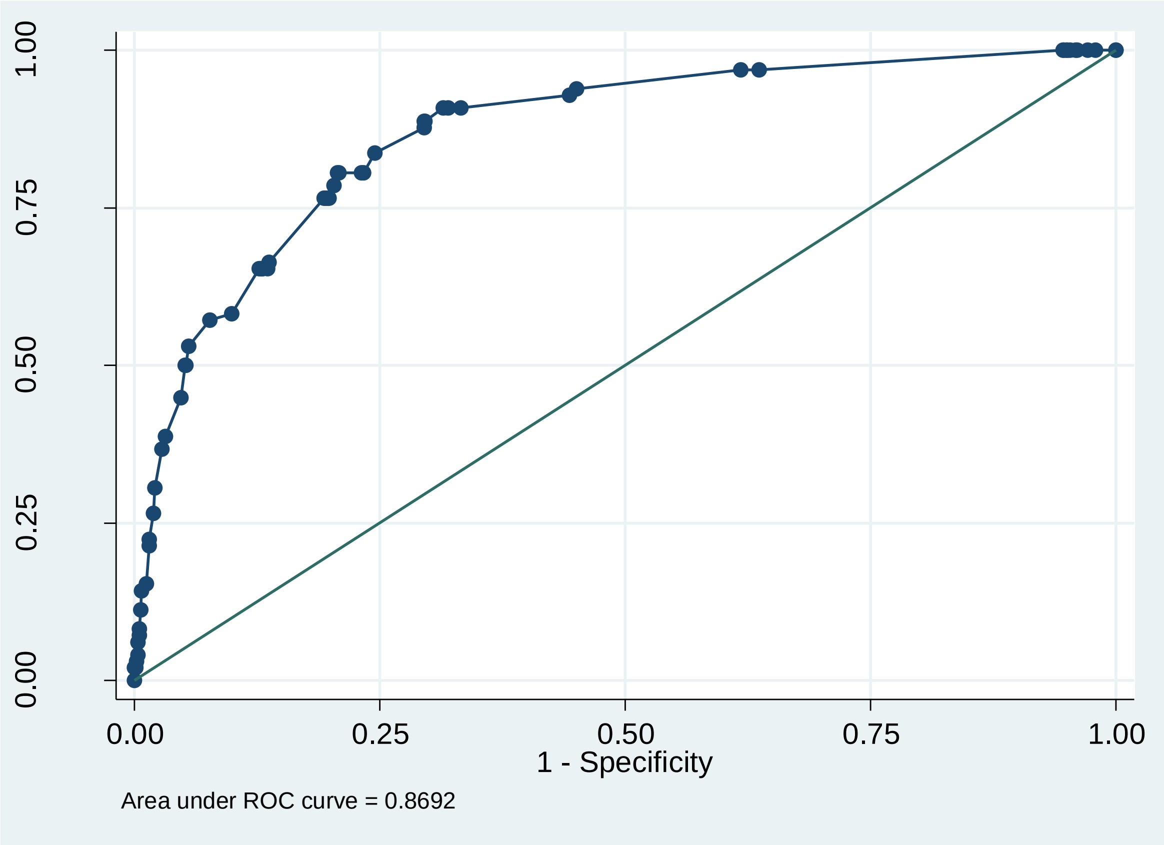


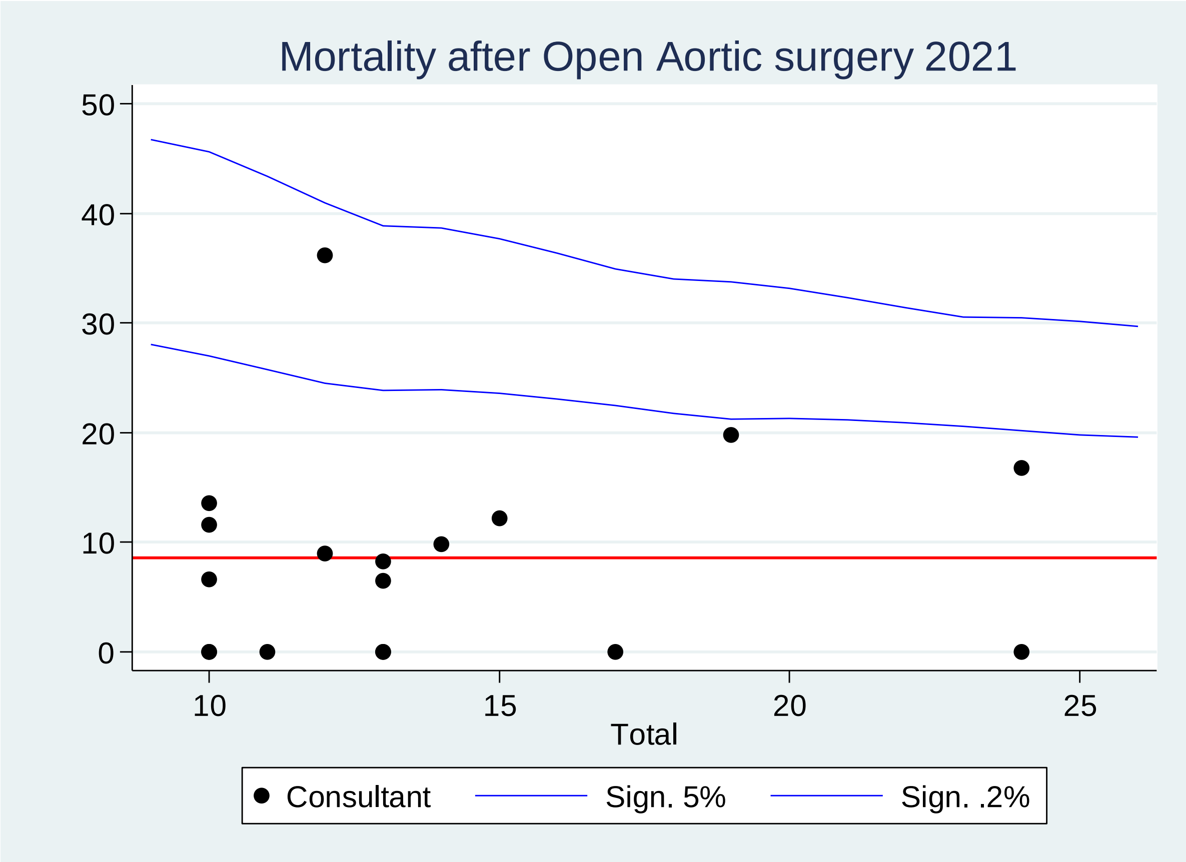
Table 3 shows the significant variables used in the model for all open aortic surgery 2021.

Parameter	Odds Ratio	95% Conf. Int.	P (>|Z|)
Emergency	8.741843	(5.018857 to 15.226539)	P < 0.0001
RuptnoBypass	6.340446	(2.324587 to 17.293931)	P = 0.0003
AnPain	0.139577	(0.031983 to 0.609131)	P = 0.0088
ASA4	2.476115	(1.419293 to 4.31986)	P = 0.0014
IHD	1.686195	(1.023611 to 2.777669)	P = 0.0402
Age80	2.874759	(1.513348 to 5.460898)	P = 0.0013
Female	2.193258	(1.301147 to 3.697033)	P = 0.0032

Once a predictive model is obtained, probabilities of mortality are obtained from the model and used to display risk-adjusted mortality based upon an expected mortality rate for each patient.

Funnel plots have been constructed and were plotted by including 18 consultants where 10 or more cases were performed during 2021. 177 surgeons performed <10 cases in this period (mean= 4, range 1-9). This plot shows the adjusted standardized mortality rate on the Y-axis against total cases done on the X-axis. 95% and 99% Poisson confidence intervals of the expected mortality for each surgeon are superimposed. This produces an easy-to-read graph showing any outliers. The mortality rate was 8.4% for open aortic surgery in the cohort of patients where the surgeons had performed 10 or more cases, compared to a mortality of 10.7% for the entire group of patients.

Fig 8. Risk-adjusted funnel plot for open aortic surgery for consultants with 10 or more cases (131)



Outliers

No outliers were identified.

Open AAA

168 surgeons operated upon 579 patients with a mean of 3 and a range from 1-17 cases. This dataset was restricted to patients with abdominal aneurysm repair, excluding thoraco-abdominal aneurysms. This allowed comparison of postoperative complications between 461 intact (elective, mycotic, painful, occluded) aneurysms and 118 ruptured AAA (Table 4). Mean aneurysm diameter was 66mm. Crude mortality was 10.4%.

Table 4. Complications after intact and ruptured AAA repair

Complication	Intact AAA (461)	Ruptured AAA (118)
AMI	6(1.3%)	5(4.2%)
Gut ischaemia	11(2.4%)	13(11.1%)
Renal failure/impairment	28(6.1%)	21(17.8%)
Ureteric injury	2(0.4%)	1(0.8%)
Died	15(3.3%)	45(38.1%)

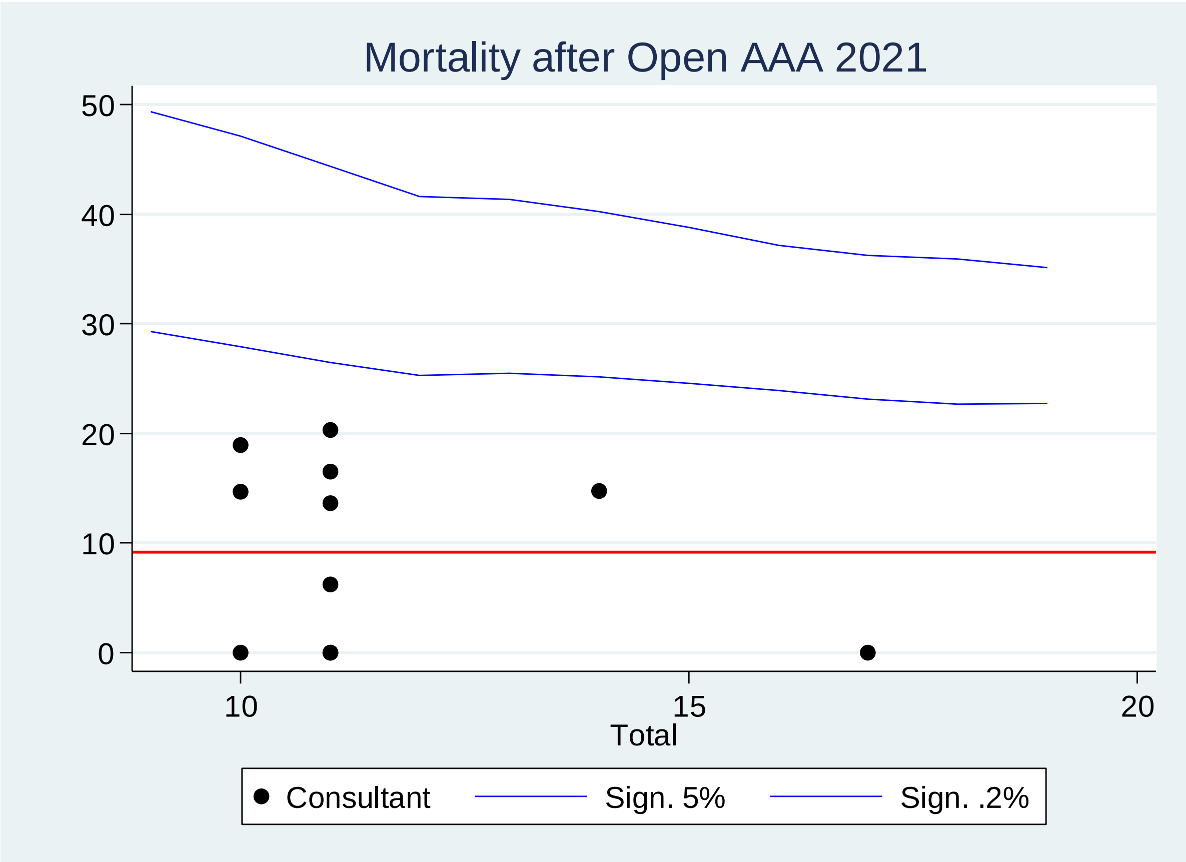
Outcomes

Predictive variables for the model are shown in table 5. Excellent discrimination was obtained with a c-statistic of 0.89. A multilevel model was not used as it was not significantly different from the binary logistic regression model.

Table 5. Significant variables in the Open AAA model 2021.

Parameter	Odds Ratio	95% Conf. Int.	P (>|Z|)
4L	6.291454	(2.820703 to 14.032811)	P < 0.0001
Suprarenal Clamp	2.541036	(1.302637 to 4.956765)	P = 0.0062
Rupt	11.468003	(5.670904 to 23.191206)	P < 0.0001
Age80	4.323459	(1.881869 to 9.932841)	P = 0.0006
Female	2.88137	(1.297689 to 6.397753)	P = 0.0093

Fig 9. Risk-adjusted funnel plot for open AAA repair where surgeons performed 10 or more cases (11)



Outliers: There were no outliers for open AAA surgery. Raw mortality was 10.4%. 157 surgeons performed < 10 cases in 2021 (Mean= 3, range 1-9).

iii) Endoluminal abdominal aortic surgery

Abdominal aortic aneurysm

212 surgeons inserted 1,719 non-thoracic ELG during 2021, with a range of 1-39 and a mean of 8. 88% patients had percutaneous access with closure device. Mean aneurysm diameter was 58mm. There were 29 type 1, 23 type 2 and 6 type 3 endoleaks. There were 8 occluded limbs and 0 conversions to an open repair. There were 7 cases with device failure/malposition. GA was used in 95%. Mortality was 0.9%.

The indication for EVAR was not confined to AAA as shown in Table 6.

Table 6. Indications for EVAR 2021

Indication	Total
Aneurysm-elective	1474
Aneurysm-pain	112
Aneurysm-ruptured	84
Aneurysm-mycotic	18
Endoleak	8
Claudication	6
Aneurysm-occluded	4
Dissection	3
Penetrating aortic ulcer	3
Aortoenteric fistula-primary	2
Aneurysm-false(iatrogenic trauma)	1
Aneurysm-false(non iatrogenic trauma)	1
Aortoenteric fistula-secondary	1
Rest pain	1
Trauma(iatrogenic)-occlusion	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 7. Complications after intraabdominal ELG (n = 1,719)

Complication	Intact Aorta (1,635)	Ruptured AAA (84)
AMI	12(0.7%)	4(4.8%)
Gut ischaemia	2(0.1%)	1(0.1%)
Renal failure/impairment	16(1.0%)	6(7.1%)
Endoleak type 1	26(0.1%)	3(3.6%)
Endoleak type 2	23(1.4%)	0
Endoleak type 3	6(0.4%)	0
Died	8(0.5%)	8(9.5%)

The type of device used for ELG is shown in table 8.

Device	Total
Endurant	598
Excluder	324
Zenith Alpha	205
Cook low profile	168
Zenith Fenestrated	147
Cook low profile with spiral limb(s)	84
Zenith branched-Iliac	46
Cook with side branches	43
Other hybrid combination	22
Zenith Flex(non-fenestrated)	22
Zenith limb only	11
Cordis Incraft	9
Zenith T Branch	9
Endologix	8
Excluder conformable	5
Anaconda(non-fenestrated)	4
Talent body with Endurant limb(s)	3
Zenith body with Anaconda limb(s)	3
Jotec E-nside	1
Jotec E-xtra	1
Trivascular Ovation (Prime)	1
Zenith body with Endurant limb(s)	1
Zenith body with Gore limb(s)	1
Zenith branched-Iliac;Zenith Fenestrated	1
Zenith Fenestrated;Cook with side branches	1
Zenith Flex(non-fenestrated);Cook low profile with spiral 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; 162 (9.4 %) were fenestrated with a zero-mortality vs non-fenestrated mortality of 16/1,557 (1%). Endoleaks occurred in 4.3% of fenestrated vs 3.3% in non-fenestrated ELG (ns).

Table 9. Configuration of ELG 2021

Configuration	Total
Bifurcated	1336
Fenestrated Renal(s)-SMA-Coeliac	80
Tube	57
Fenestrated Renal(s)-SMA	48
BREVAR Renal(s)-SMA-Coeliac	33
Branched endograft R Iliac	29
Branched endograft L Iliac	28
Aorto-uni-iliac-no x-over	23
Bifurcated-bifurcated(+/- IBD)	22
Aorto-uni-Iliac and Fem fem bypass	19
Fenestrated both Renals	19
Fenestrated + Branched endograft	10
BREVAR both Renals	2
BREVAR Coeliac	2
BREVAR R Renal	2
Fenestrated L Renal	2
Fenestrated Renal(s)-Coeliac	2
Branched endograft R Iliac;Fenestrated Renal(s)-SMA-Coeliac	1
BREVAR Renal(s)-SMA	1
BREVAR-SMA	1
Fenestrated Renal(s)-SMA-Coeliac;Fenestrated Renal(s)-SMA	1
Scalloped	1

Outcomes

Mean mortality for all EVAR (for AAA only) was 0.9%. The c-statistic was 0.8. Significant variables in the model were gender, Creatinine > 150mMol/L, IHD and ruptured AAA.

Table 10. Significant variables for mortality after EVAR for AAA 2021

Parameter	Odds Ratio	95% Conf. Int.	P (>|Z|)
Rupt	19.789297	(6.954356 to 56.31237)	P < 0.0001
CreatinclDial	3.547896	(1.014554 to 12.406994)	P = 0.0474
IHD	3.130007	(1.02627 to 9.546169)	P = 0.0449
Female	4.522798	(1.563139 to 13.086304)	P = 0.0054

iv) Thoracic and thoraco-abdominal procedures

Endoluminal. Pathology in thoracic and thoracoabdominal TEVAR (n=328) is shown in Table 11.

Table 11. Pathology for TEVAR 2021

Pathology	Total
Aneurysm(non-dissecting)	93
Dissection-acute	66
Aneurysm(dissecting)	44
Dissection-chronic	41
Penetrating ulcer	41
Traumatic tear	39
Fistula	3
Infected TEVAR	1

There were 13 deaths (4%). 124 surgeons inserted a mean of 3 ELG with a range from 1-29. 86 surgeons had performed < 3 cases in 2021. Configuration is shown in Table 12.

Configuration	Total
Overlapping Stent grafts	156
Single Stent graft	140
Stent graft(s) with distal bare stent	14
Fenestrated/branched-Brachioceph	6
Stent graft(s) with intra-abd fenestration(s)	6
Fenestrated/branched-Brachioceph & CCA	4
Fenestrated/branched-CCA	2

The following devices were inserted in patients having stent grafts in the thoracic aorta (Table 13).

Device	Total
Gore C-TAG	**157**
Zenith Alpha	78
Zenith TX2	39
Medtronic	28
Custom Cook (fenestrated/branched)	12
Gore C-TAG with Zenith Alpha extension	6
Jotec E-nside Thoracoabdominal	4
Excluder	2
Endospan Nexus	1
Jotec E-vita Thoracic 3G	1

There were 6 patients with paraplegia (1.8%) and 4 strokes (1.2%) following TEVAR. 5 patients had renal failure or impairment and none developed intestinal infarction. There were 4 type 1, 1 type 2 and 1 type 3 endoleaks. No patients required conversion to open. Breakdown of complications by aetiology is shown in Table 14.

Table 14. Complications according to the main pathology types

Pathology	Total	Mortality	Stroke	Paraplegia
Aneurysm(non-dissecting)	93	3	1	1
Dissection-acute	66	2	1	3
Aneurysm(dissecting)	44	3		1
Dissection-chronic	41	1		
Penetrating ulcer	41	1	2	1
Traumatic tear	39	3	1	

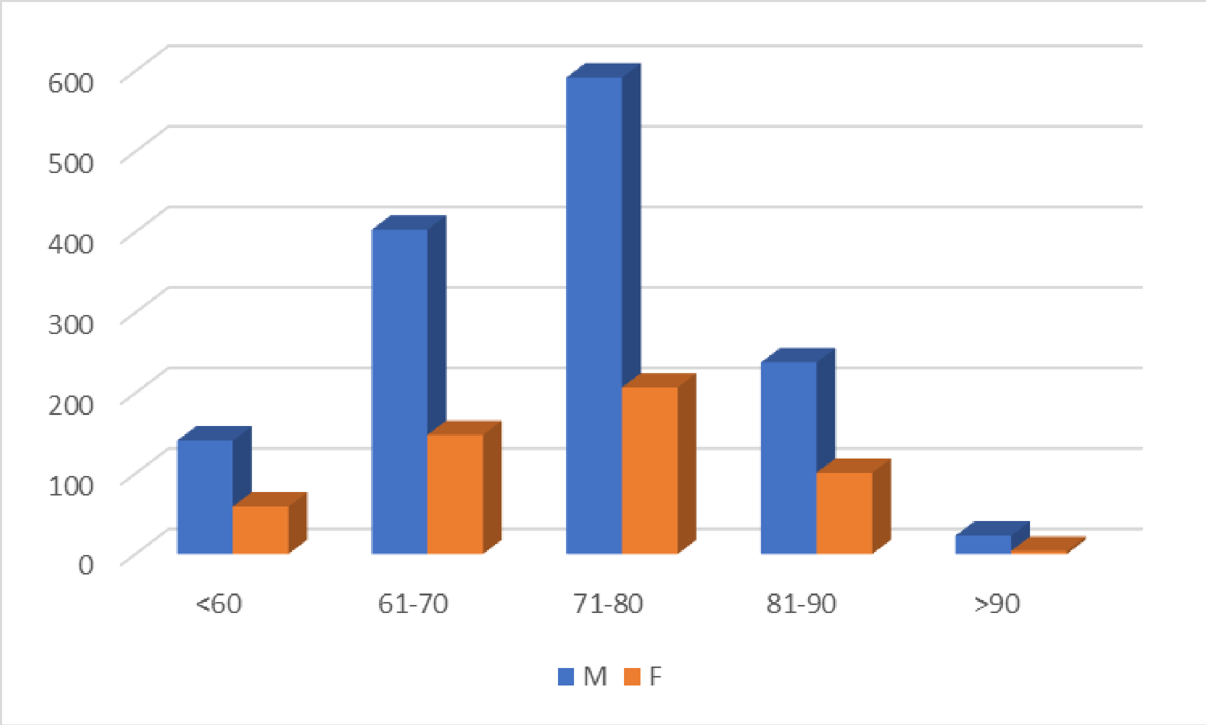
Outcomes

No predictive model was produced.

Open. There were 7 open thoracoabdominal procedures with 1 death They were performed by 6 surgeons and only one surgeon had performed > 1 procedure (2 cases). This surgeon had no mortality in either patient. There were 0 strokes and 2 paraplegias, one of whom died. There was a single rupture and this patient survived. Length of stay in this cohort was 31 days. Mean diameter of the aneurysms was 67mm.

Carotid Surgery

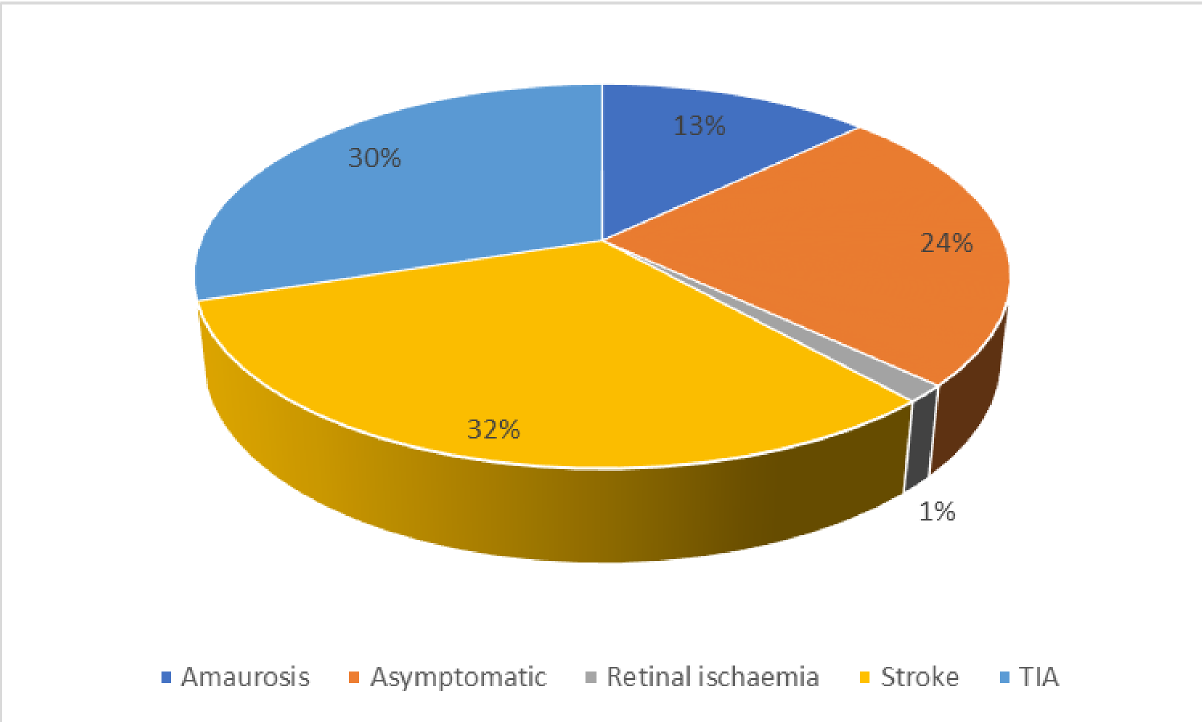
There were 1,919 carotid interventions, 1,801 carotid endarterectomies (CEA) and 118 carotid stents (CAS) in 2021. Age and gender are shown in Figure 10.



i) Carotid Endarterectomy

221 surgeons performed an average of 8 CEA with a range from 1-37. The indications for CEA are shown in Fig.11 with 24% having no symptoms. In the 2010 report 31% were asymptomatic.

Fig 11. Indication for CEA



The time from onset of symptoms to surgery in symptomatic patients was < 48 hours in 1%, < 2 weeks in 62%, 2-4 weeks in 17% and > 4 weeks in 20%. 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 78% of the patients.

Eversion endarterectomy was performed in 12.6% of patients and 43% were shunted. Patches were used in 88% of CEA (Table 15).

Table 15. Patches after CEA.

Patch	Total
Pericardium	836
Polyurethane	521
PTFE	72
Prosthetic (Other)	67
Dacron	50
GSV-reversed	22
Omniflow	7
Peritoneum	6
Vein (Other)	4
Ext carotid	2

Complications after CEA are shown in table 16.

Table 16. Complications after CEA (n= 1,801)

Complication	Percent
Haemorrhage requiring exploration	2.4
Cranial nerve trauma	1
Myocardial infarction	0.5
Major/minor stroke	1.2
TIA	0.4
Hyperperfusion	0.1
Death	0.2
Stroke or death	1.3

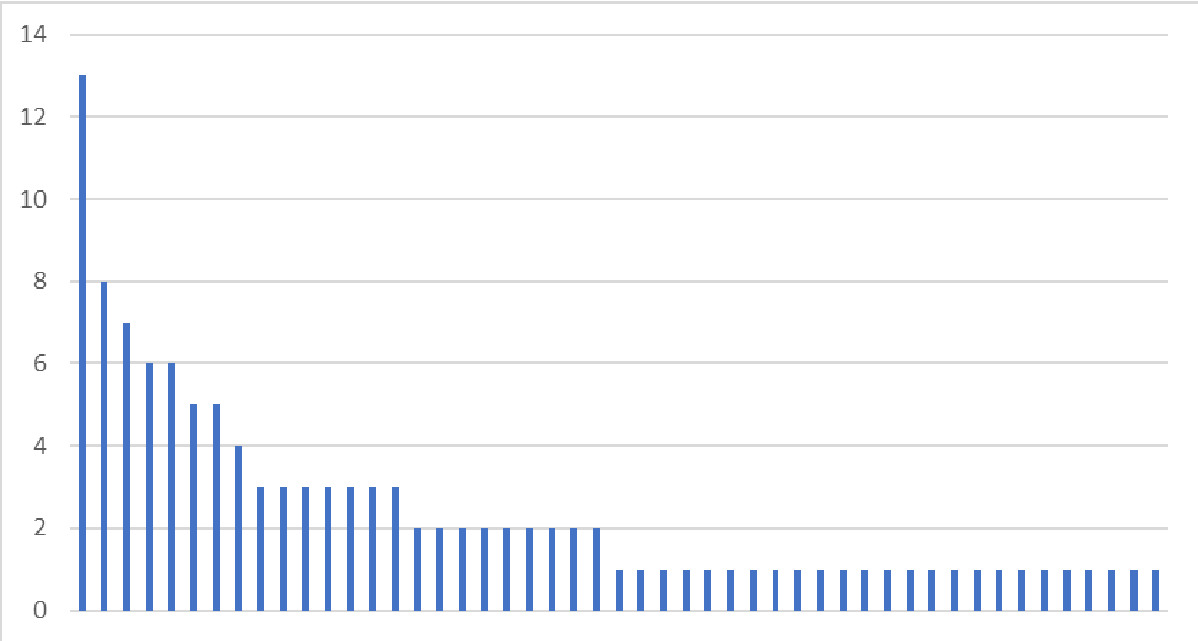
Outcomes

No predictive model for Stroke and/or death after CEA was possible in 2021

Only those surgeons (76) who performed 10 or more CEA were assessed by a non-risk adjusted funnel plot. The mean stroke/death(S/D) rate was 1.3% Symptomatic S/D rate was 1.7% and Asymptomatic S/D was 0.2%. Postop S/D rate for stroke as the indication for operation was 2.3%.

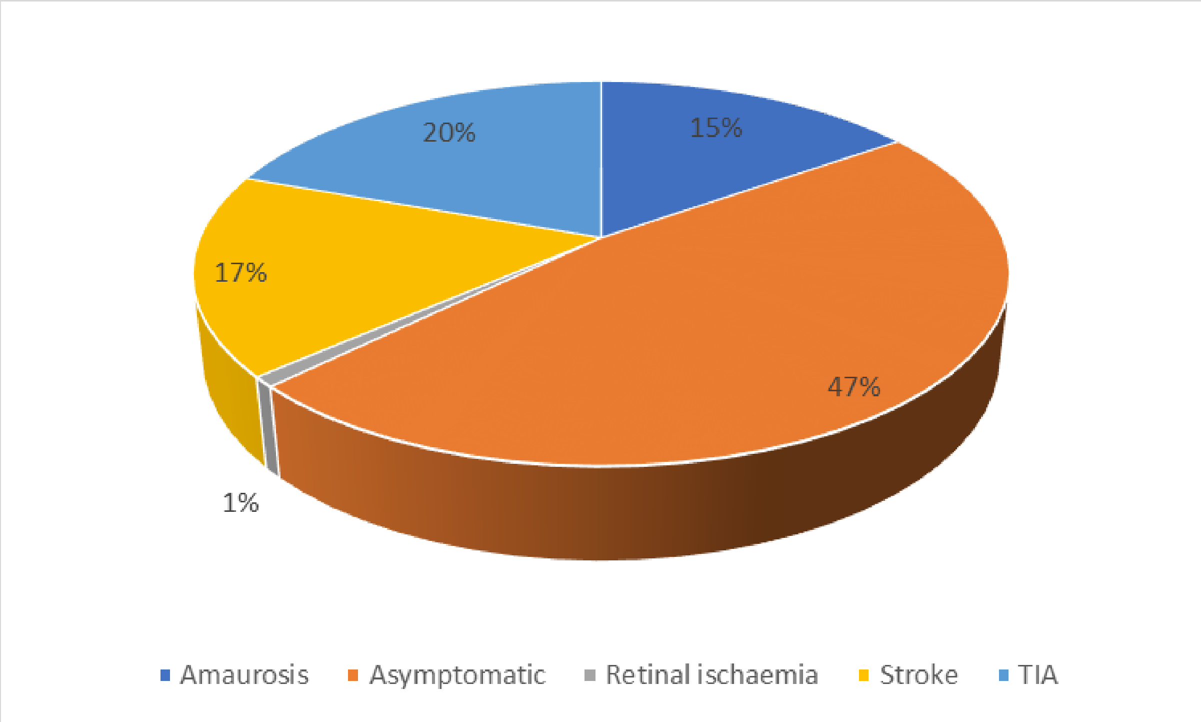
ii) Carotid Stents

49 surgeons placed 118 carotid stents in 2021, with a mean of 2 and a range from 1 – 13. Fig 12 shows the number of CAS per consultant.



Indications for CAS are shown in Fig 13, with the most frequent being asymptomatic, then TIA.

Figure 13. Indications for CAS 2021.



Technical details. n=118

Access was via a long sheath in 87 and via a short sheath with guiding catheter in 31. There was a type 1 arch in 73, type 2 in 44 and type 3 in 1 patient.

Cerebral protection devices used are shown in table 17. No protection device was employed in 9 patients. Post-dilatation was used in 97.

Filter	Total
Emboshield	49
Nav 6	34
Angioguard	16
None	9
SpiderFX	8
Filterwire EX	2

Stent types are shown in table 18.

Stent	Total
Xact	63
CGuard	17
Precise	16
Casper	6
Covered stent	4
ProtegeRX	4
Tapered	4
Wallstent	2
ADAPT(Boston)	1
Angioplasty only	1

Outcomes

There was 1 post op stroke and no deaths with a stroke and death rate of 1/118 (0.8%). This patient was 1 of 3 patients operated upon by this surgeon during 2021 and the indication was for stroke. There were no AMIs or renal impairment in this cohort.

Infrainguinal bypass

212 surgeons performed 1,491 Infrainguinal bypasses (IIB) in 2021. The range was 1-26 with a mean of 7. The average age of patients was 68 with the M: F ratio of 3.3:1. General anaesthetic was used in 97%.

Indications for surgery are shown in Fig 14 with tissue loss being the most frequent.

Fig. 14 Indications for infrainguinal bypass 2021

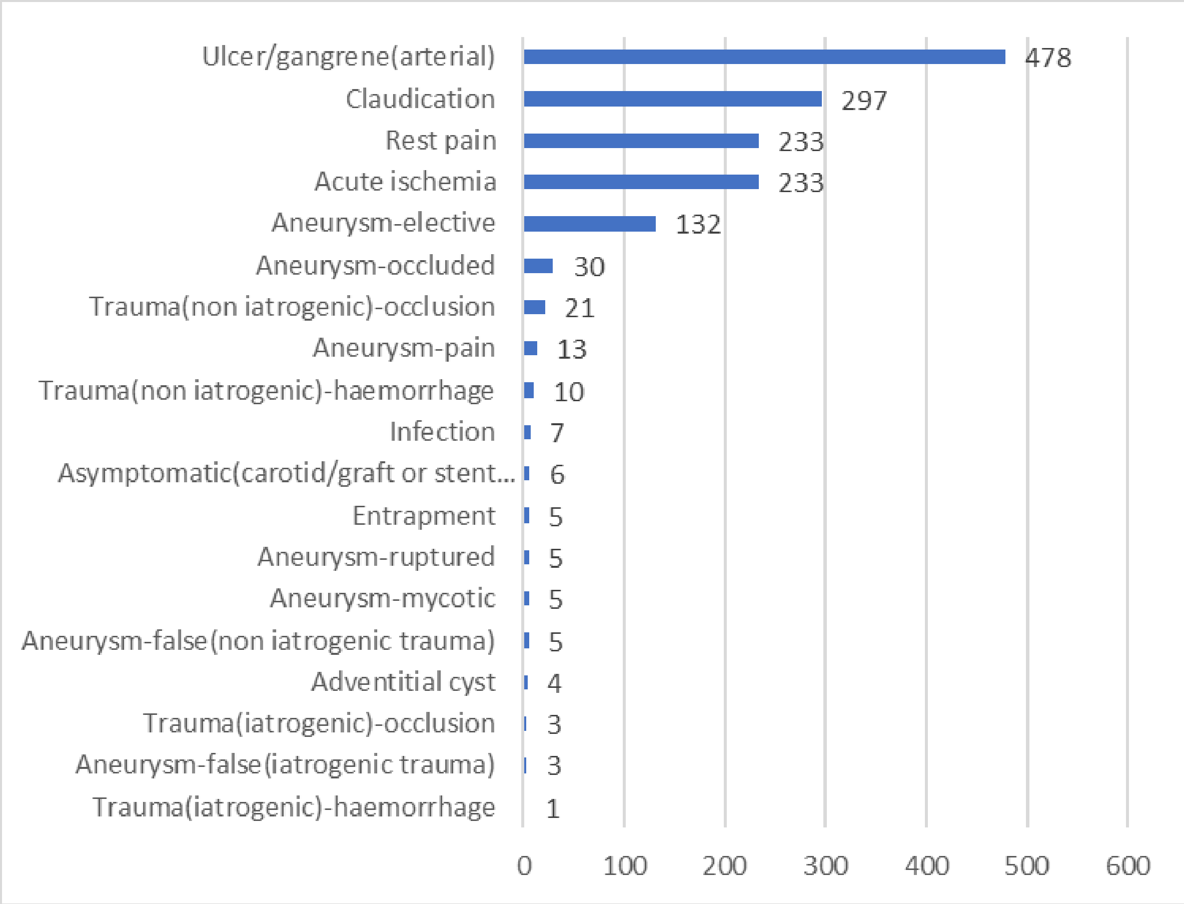
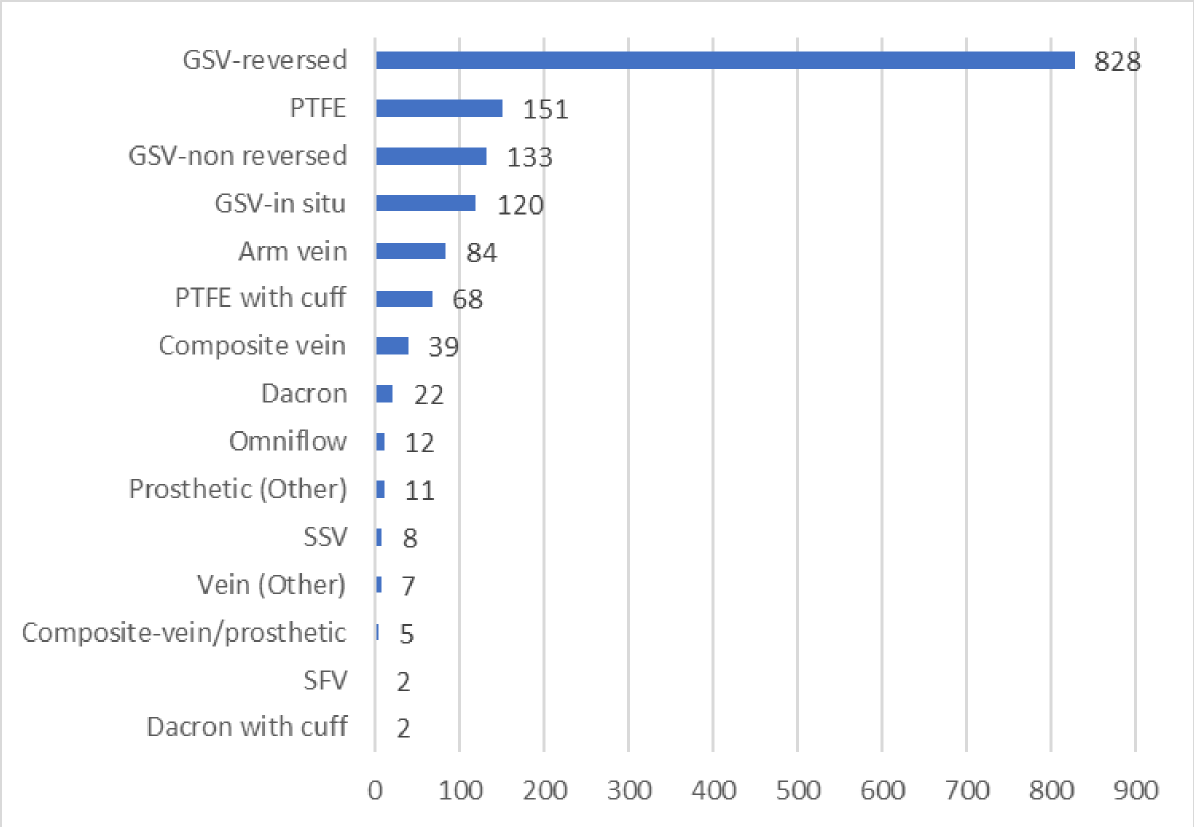
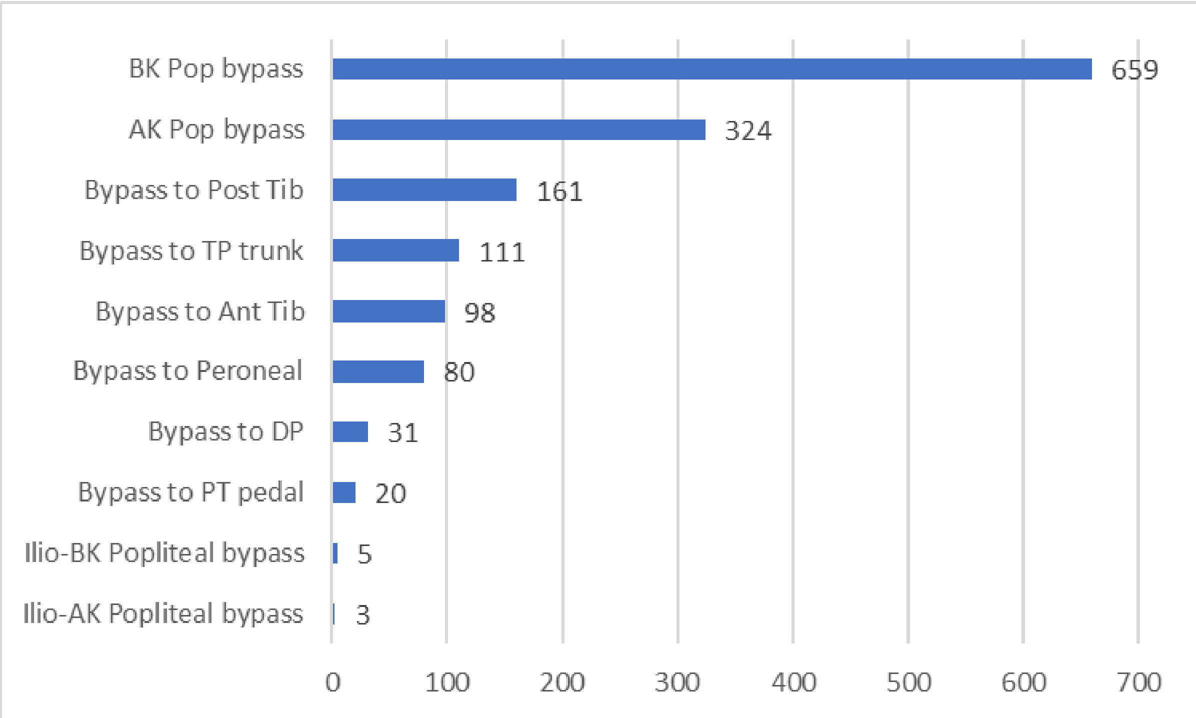


Fig. 15 Conduits for infrainguinal bypass 2021.



Bypass configuration is shown in Fig 16.



Post-operative complications are shown in table 19 (n = 1,491)

Complication	Percent
Myocardial infarction	0.9
Stroke	0.1
Renal impairment/ failure	0.6
Wound complications	3.4
Haemorrhage requiring reoperation	1.7
Graft occlusion	4.6
Amputation	1.1
Death	1.1

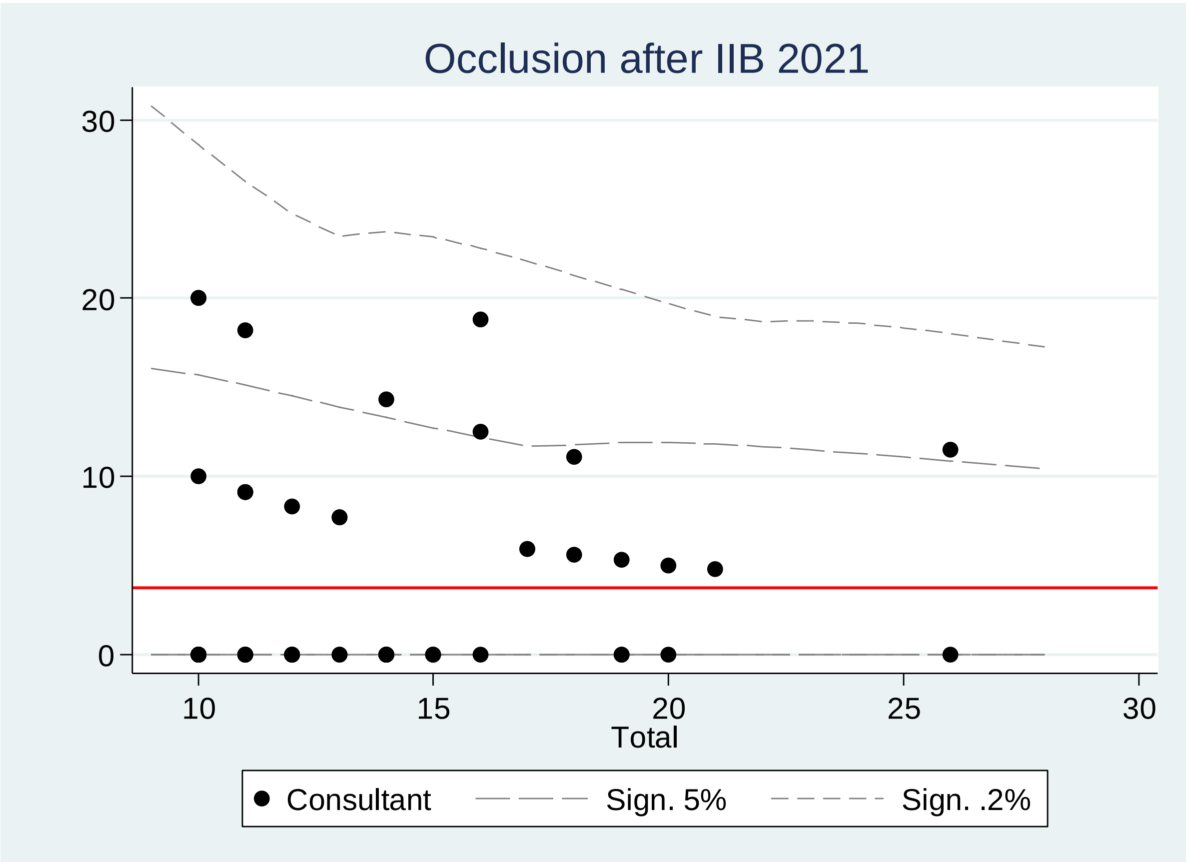
Outcomes

i) Occlusion

A logistic regression model for occlusion after IIB was not obtained due to poor discrimination.

Occlusion rates were assessed using a non-risk adjusted funnel plot for those 59 consultants that performed 10 or more bypasses (Fig 19). No outliers were detected for 2021. The mean occlusion rate was 4.6% and mortality was 1.1%.

Fig 17. Non-risk adjusted funnel plot for occlusion after IIB 2021 (10 or more cases) n=59



Popliteal Aneurysm: There were 152 bypasses for aneurysm (elective, occluded, pain or rupture). There were no occlusions or limb loss. In non-aneurysm patients the graft occlusion rate was 4.6% and the amputation rate was 1.4%. 69 patients had an endovascular stent graft placed as the primary treatment for popliteal aneurysm.

Claudicants *vs* tissue loss: In the 297 claudicants, the occlusion rate was 2.0.% and there were no amputations. In 478 patients with tissue loss the occlusion rate was 3.6% and the amputation rate was 1.0%.

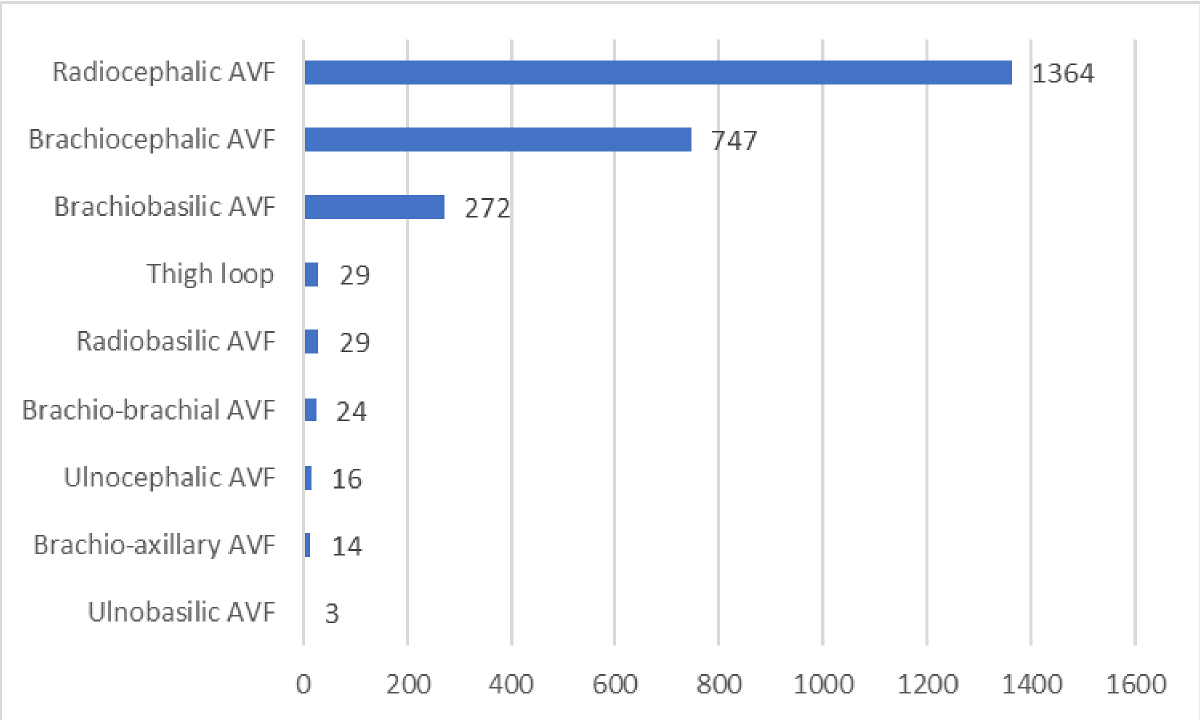
ii) Amputation

The limb salvage rate was 98.9%. 17 limbs were amputated and 5 of these occurred with a patent graft; 2 patients in this subgroup were diabetic.

Arteriovenous Fistulae

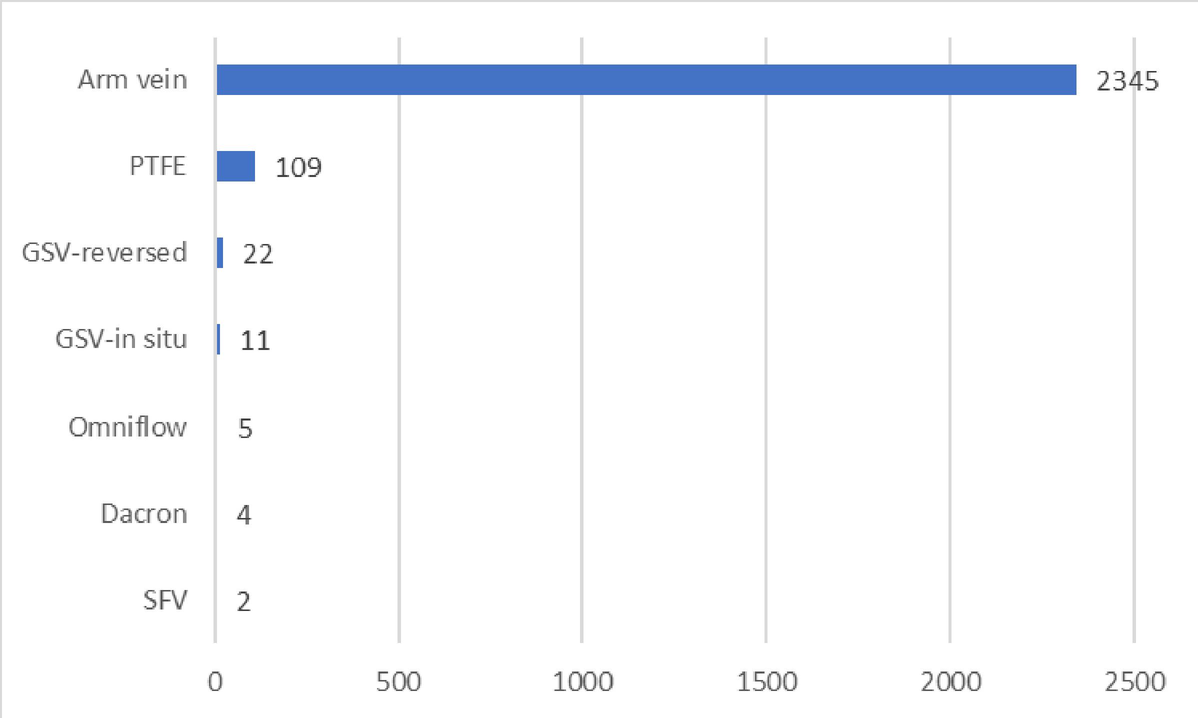
2,496 patients had an arteriovenous fistula (AVF) placed in 2021. 189 surgeons performed a range from 1-68 with a mean of 13. The locations of AVF are shown in Fig 18.

Fig 18. AVF configuration



The majority of AVF were autogenous (95.3%). The conduits used are shown in Fig 19.

Fig 19. Conduits used



Outcomes

There were 44 occlusions (1.8%). Autogenous fistulae occluded in 38/2379 (1.6%) and prosthetic fistulae occluded in 6/119 (5%). 4 patients had a steal syndrome, 3 of whom were in a brachial level fistula.

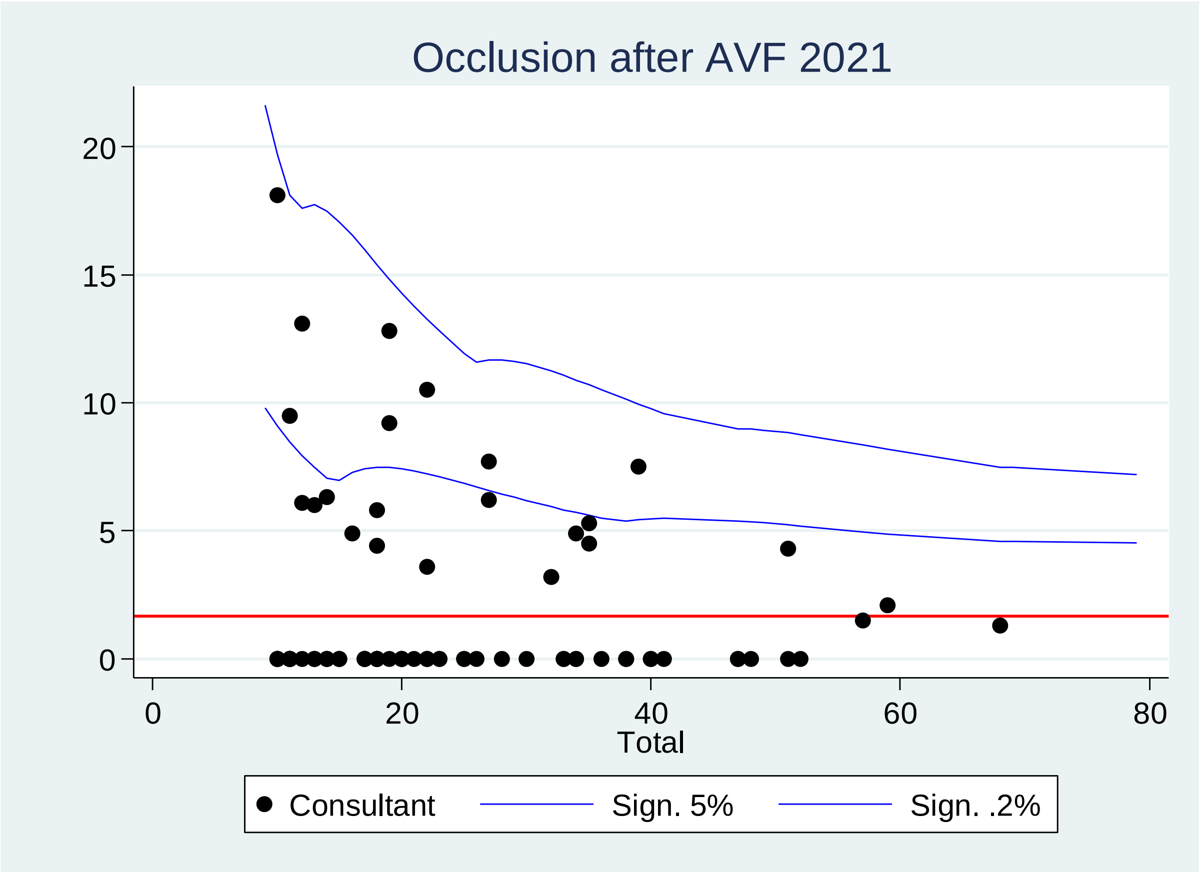
A model was obtained for occlusion after AV Fistula with a c-statistic of 0.7. Significant variables are shown in Table 20. Note that Diabetes was protective for occlusion

Table 20. Significant variables for Occlusion after AVF construction 2021

Parameter	Odds Ratio	95% Conf. Int.	P (>|Z|)
ASA Status(4)	2.220311	(1.103065 to 4.469167)	P = 0.0254
Diabetes	0.281014	(0.14923 to 0.529176)	P < 0.0001
Female	1.935814	(1.055487 to 3.550374)	P = 0.0328

A risk adjusted funnel plot for in-hospital occlusions is shown in Fig 20.

Fig. 20. Funnel plot Occlusion after AVF 2021 for surgeons performing 10 or more AVF (88)



No outliers were identified.

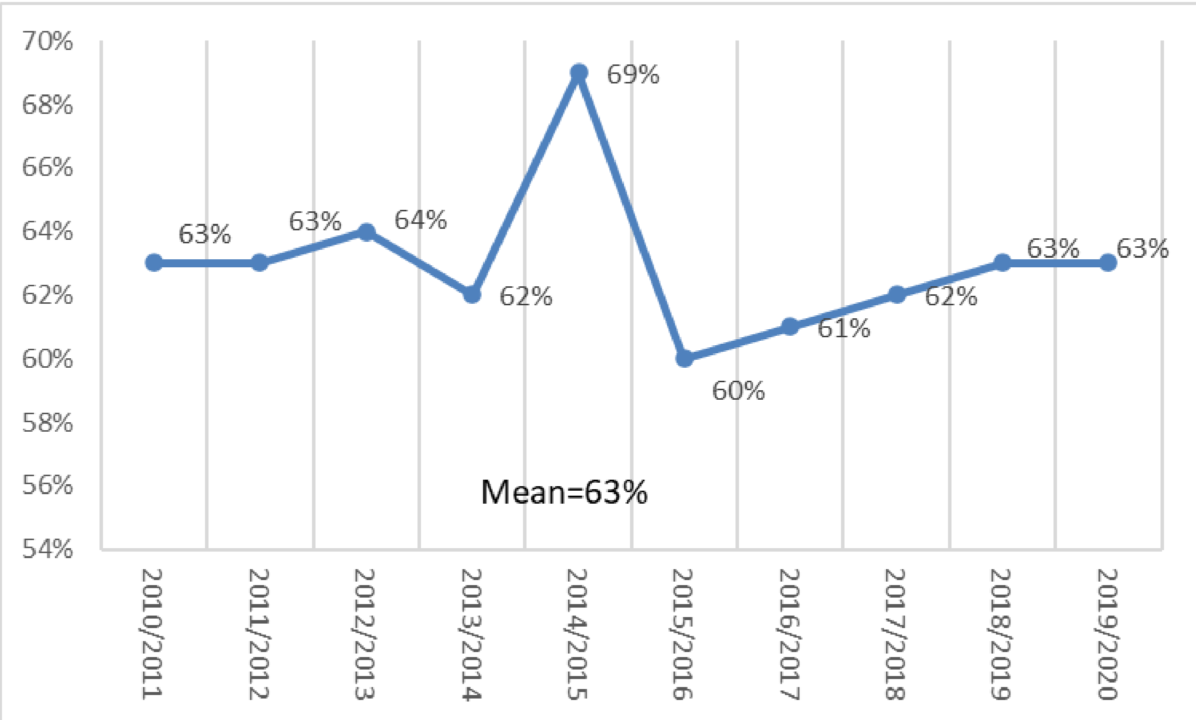
Endovascular treatment for PAD

Since 2020 this category has been added to the index procedures. There were 10,180 interventions performed by 220 surgeons, with a mean of 46 and a range from 1-294. Hybrid open + endovascular procedures, aneurysmal disease and procedures performed by radiologists were excluded from this analysis. There were 6,310 PTA and 3,870 stents. 71 patients died (0.7%) and there were only 4 amputations. Combined complications, amputation and death was 5.6% 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 2019/20 financial year (Fig 21).

Fig 21. AVA capture compared with AIHW data



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 2010-2021 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

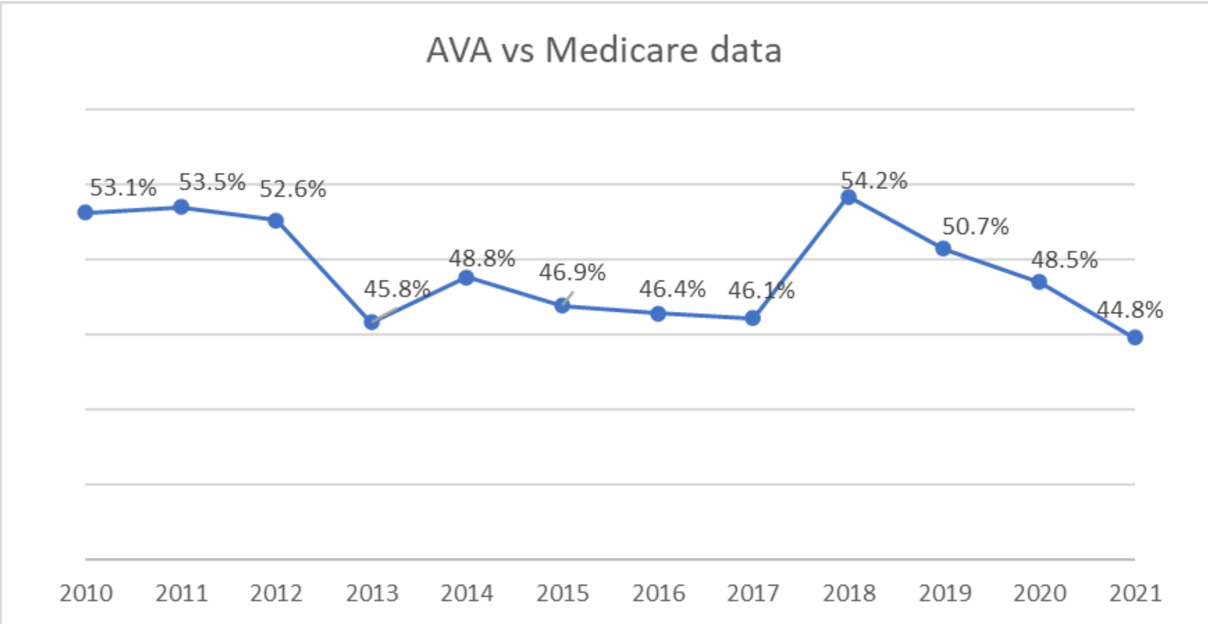
Item numbers 32739, 32742, 32745, 32748, 32751, 32754, 32757, 32763, 33050, 33055

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, and is below 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, and half of the workload in this sector is not being subjected to AVA methodology.

Fig 22. Private practice participation in the AVA for Australia 2010-2021

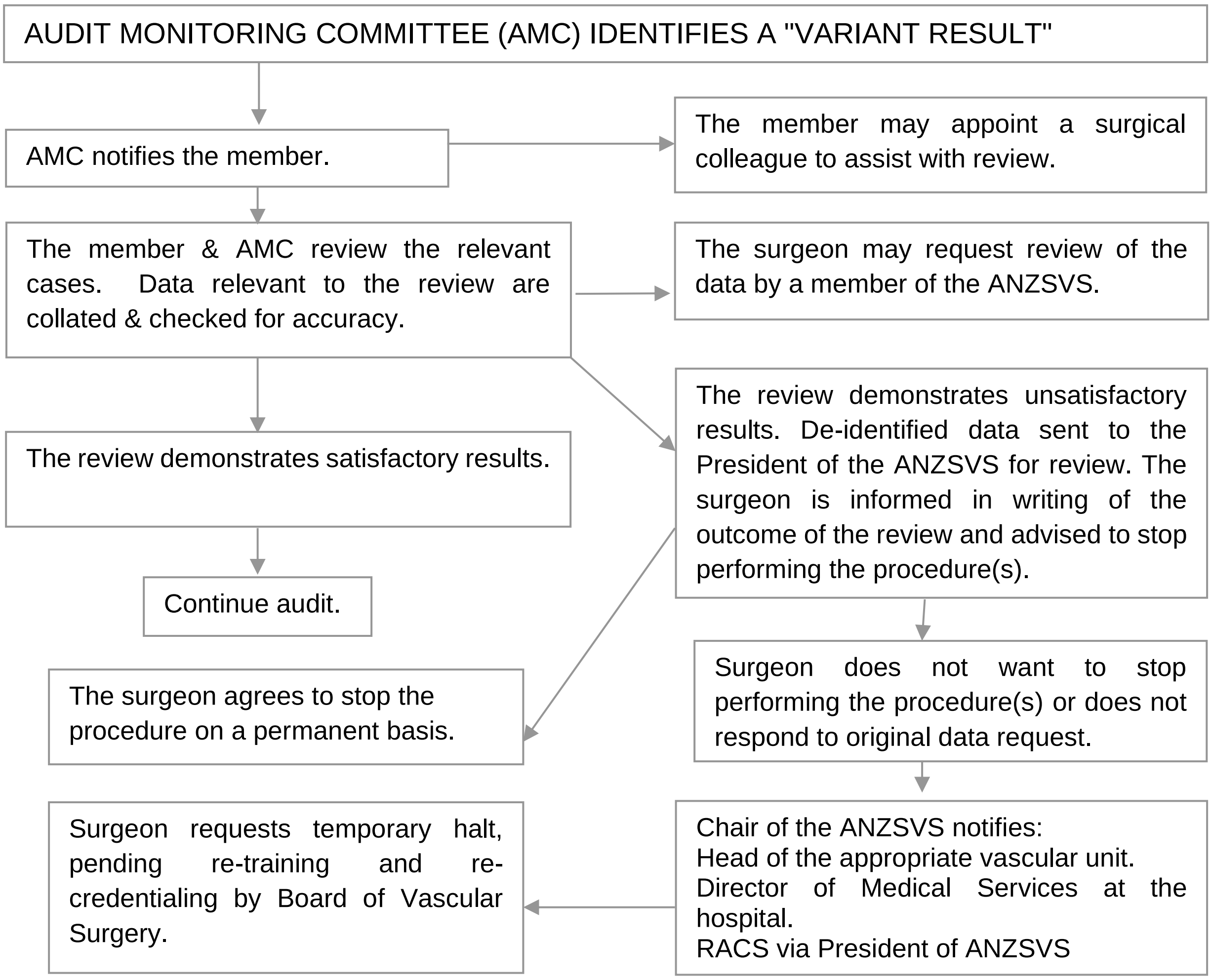


Internal validation was performed in 2020 comparing a 5% sample of patients with the actual case notes by nominated members at each hospital. This showed that data entry was of high quality with only 2.7% having incorrect field data entered out of a total of 4,216 fields studied. In particular, it is noteworthy that no outcome fields were incorrect. 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, occlusion after AVF creation and complications after endovascular treatment of PAD. 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 that remains a statistical outlier after data accuracy bis confirmed is 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. Members of the ANZSVS have the ability to view all reports, and there is the ability to view the user's outcomes in the 5 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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