Australasian Vascular Audit Public Report – 2021-2023

Contents

Foreword

It gives me great pleasure to endorse and facilitate this annual report of the AVA in its 14th Year. It has been the pillar of the society and in its standing in the international forum of vascular surgeons.

It has not been without its challenges, particularly recently in view of changes in the Ministry. We were lucky in renewing the QP for this audit which still remains one of the few that has remedial mechanisms inbuilt in the system. However, the renewal of QP has come with its own challenges. One of the changes made was the addition of fields and procedures. As members embrace new technology, we do have to incorporate these into the audit and the introduction of new venous procedures is the start of this process.

Alongside of this, the executive of the society has actively been trying to increase the membership outside the sphere of vascular surgeons, once again due to the pressure of ongoing recognition with regaining QP. Approaches have been made to the venous societies and the Interventional radiologists as the skill sets are similar and the need to collaborate rather than being isolationists.

The challenges are the need for radical changes to the audit system and the need to align with privacy and security of data collected. This is a discussion in progress and I reassure you that the membership will be well informed as to the future of the audit system.

Thodur Vasudevan

President ANZSVS

Introduction

The Australasian Vascular Audit (AVA) has just completed its 14th 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)

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, 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 report covers the 3-year period 2021-2023. Every 3 years a cumulative audit is conducted in order to capture the workload of low-volume surgeons. There were 139,110 operations entered in 2021-2023; 124,909 from Australia and 14,201 from New Zealand (Fig 1). Although the demographic data applies to all operations, the outcome analyses are based on the 137,877 discharged patients (99.1%).

Fig 1. Volume of vascular surgery by country 2021-2023

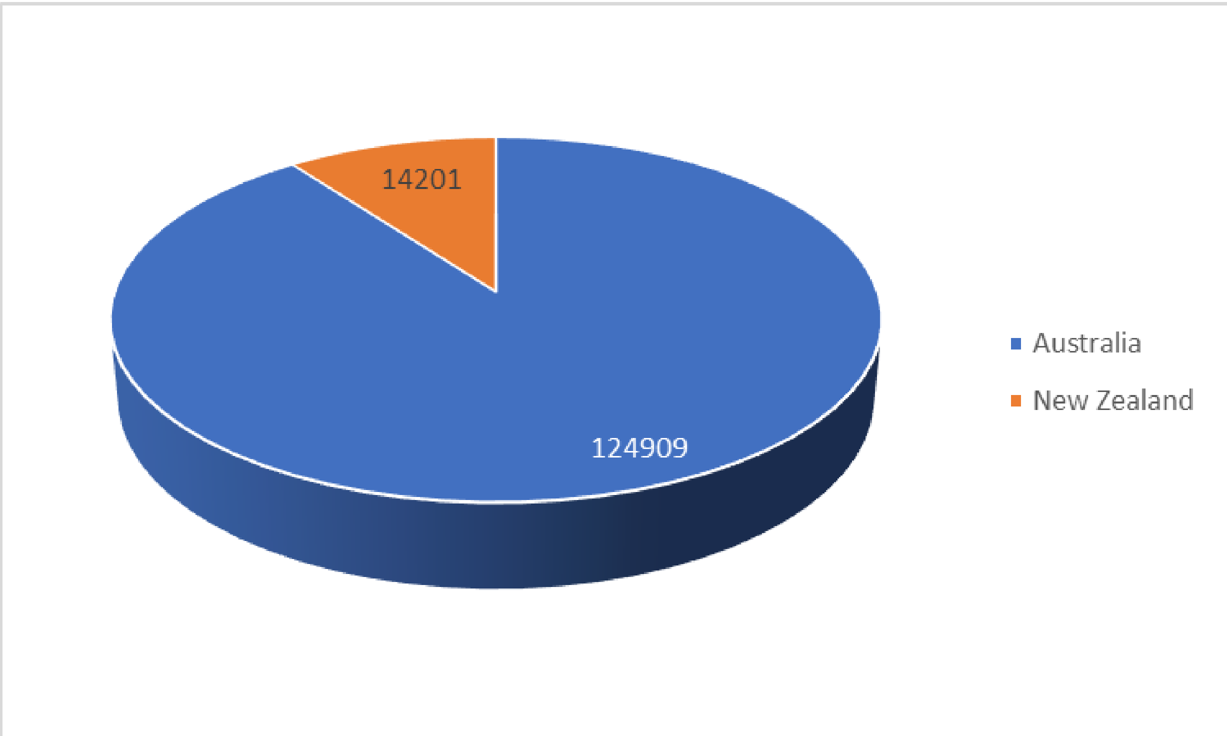
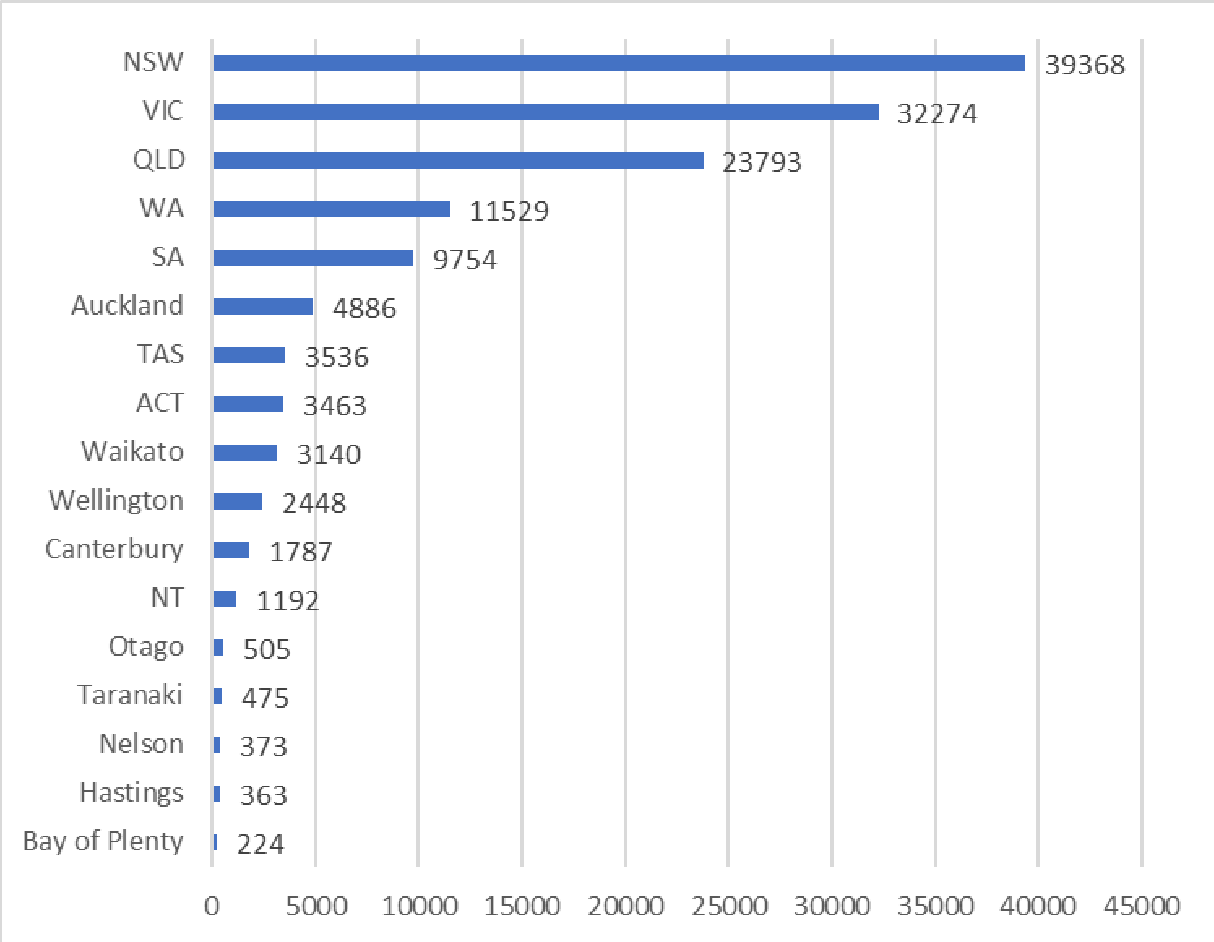


Fig 2. Operations by Australian State and New Zealand Region 2021-2023



302 consultants entered data from 218 hospitals/clinics which are shown alphabetically in the following table. The mean number of operations was 460 with a range of 1-1,729.

Alfred Hospital-Melbourne
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
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-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
Camden Surgical Hospital-Elderslie
Canberra Hospital-Garran
Canterbury Charity Hospital-Christchurch
Casey Hospital-Berwick
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
Freemasons Hospital-East Melbourne
Fremantle Hospital-Fremantle
Friendly Society Private Hospital-Bundaberg West
Geelong Private Hospital-Geelong
Geraldton Regional Hospital-Geraldton
Gold Coast Hospital Robina-Robina
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-Joondalup
Joondalup Health Campus-Joondelup
Kareena Private Hospital-Caringbah
Knox Private Hospital-Wantirna
Kununurra Hospital-Kununurra
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
Mater Private Hospital-South Brisbane
xxx rooms-Geelong
Melbourne Private Hospital-Parkville
Memorial Hospital-North Adelaide
Mercy Hospital-Epsom
Mercy Private Hospital-East Melbourne
Miami Day Hospital-Miami
Middlemore Hospital-Otahuhu
Mildura Base Hospital-Mildura
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 General 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
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
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 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

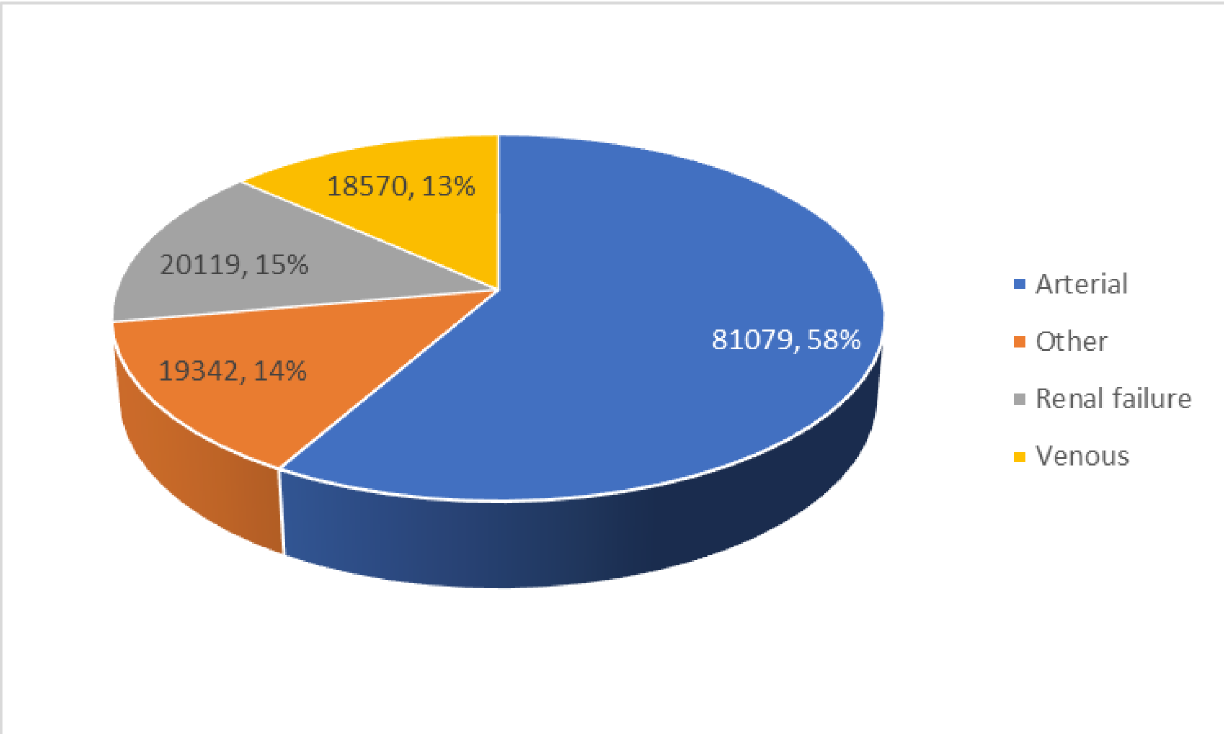
St JOG Hospital-Bendigo
St JOG Hospital-Berwick
St JOG Hospital-Bunbury
St JOG Hospital-Geelong
St JOG Hospital-Midland
St JOG Hospital-Murdoch
St JOG Hospital-North Ballarat
St JOG Hospital-Subiaco
St Lukes Hospital-Potts Point
St Vincents Private Hospital-Darlinghurst
St Vincents Private Hospital-East Lismore
St Vincents Private Hospital-Fitzroy
St Vincents Private Hospital-Launceston
St Vincents Private Hospital-Northside
St Vincents Private Hospital-Toowoomba
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-Kingswood
The Nepean Private Hospital-Kingswood
The Prince Charles Hospital-Chermside
The Tweed Hospital-Tweed Heads
The Vein Centre-Hawthorn
The Vein Centre-Richmond
The Vein Centre-Toorak
The Wesley Hospital-Auchenflower
Toowoomba Base Hospital-Toowoomba
Townsville Hospital-Douglas
University Hospital-Geelong
xxx rooms-QLD
Vascular Solutions-Subiaco

VCCC (Peter Mac)-Parkville
Wagga Wagga Base Hospital-Wagga Wagga
Wagner rooms-Melbourne
Waikato Hospital-Hamilton
Warringal Private Hospital-Heidelberg
Wauchope District Hospital-Wauchope
Waverly Private Hospital-Mt Waverly
Wellington Hospital-Wellington
Werribee Mercy Hospital-Werribee
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 635 with a range of 1-4,698

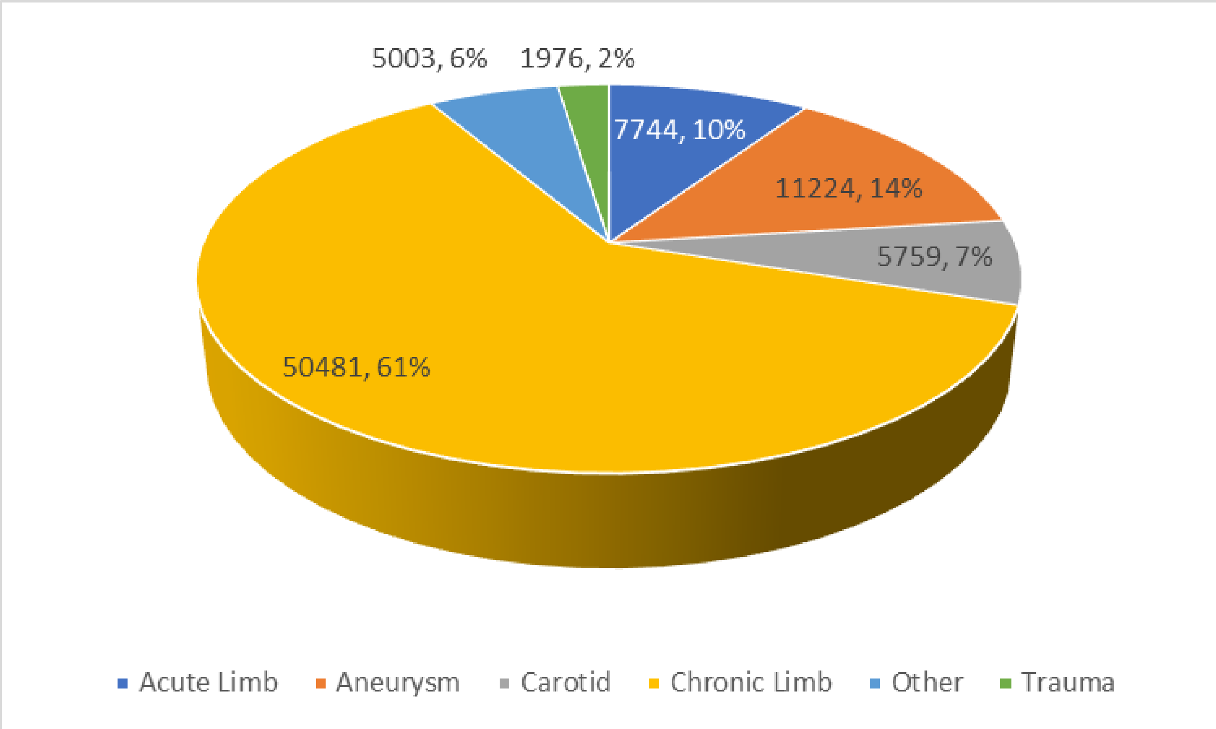
The distribution of procedures by patient type is shown in Fig. 3. The majority were arterial patients followed by renal.

Fig 3. Patient type 2021-2023



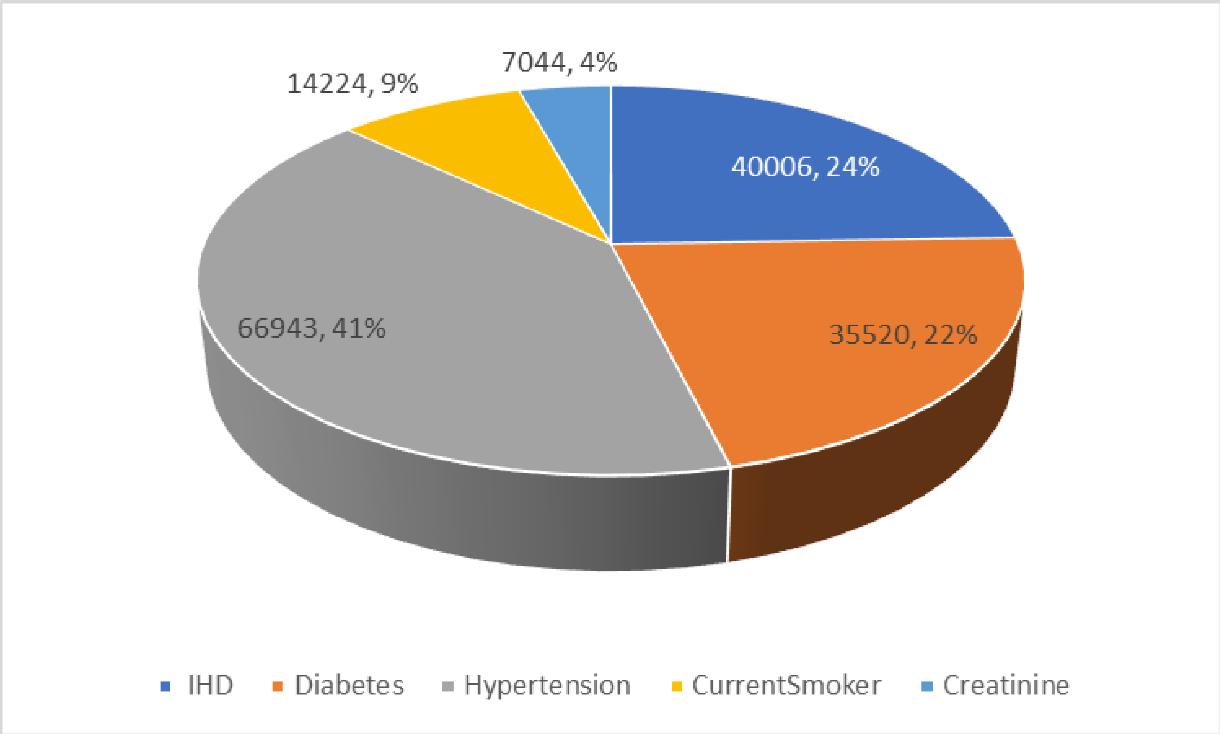
The distributions of procedures in the arterial category are shown in Fig. 4. The majority were for chronic limb operations (61%) followed by aneurysms (14%), acute limb (10%) then carotid procedures (7%).

Fig 4. Arterial categories 2021-2023 (n=82,107)



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.

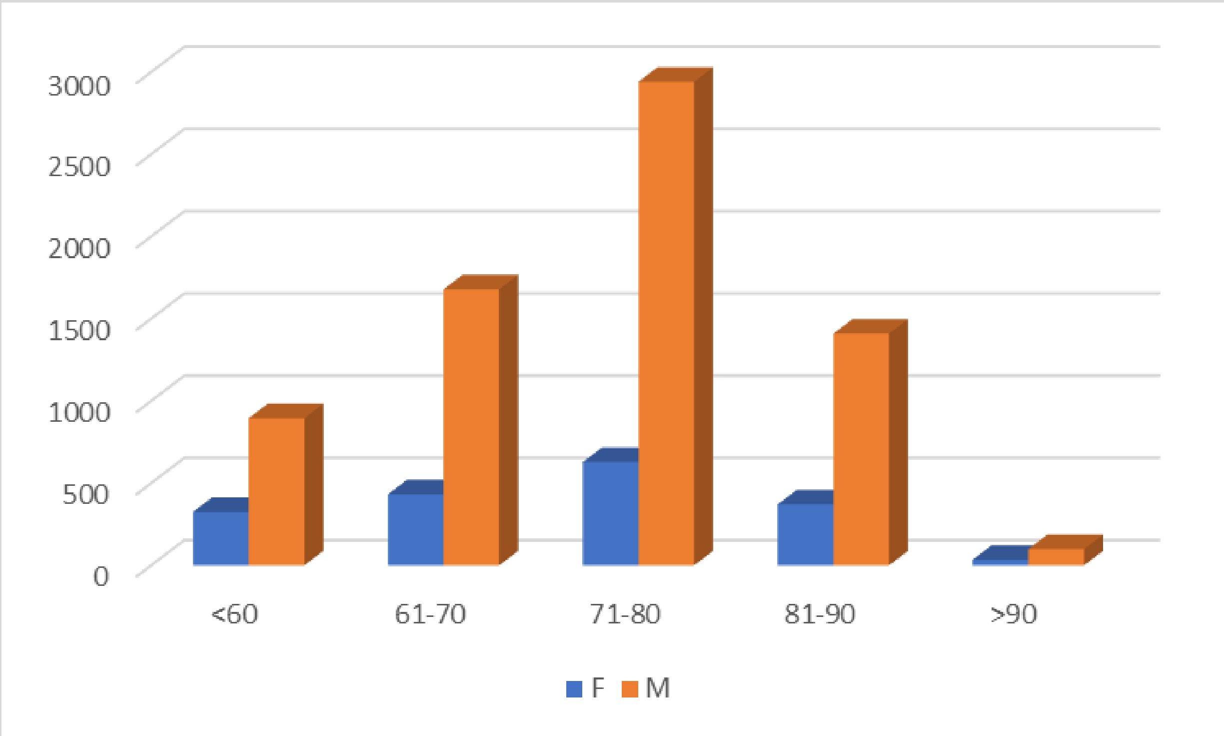
Fig 5. Risk factors in arterial operations 2021-2023 (Creatinine = >150mMol/L)



Aortic Surgery

There were 8,818 Aortic (discharged) procedures performed in 2021-2023. 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 2021-2023



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

Table 1. Aortic surgery raw data

Category	Total	Mortality (%)
All Aortic procedures	8818	4.3
Open Aortic surgery	1083	9.3
Open AAA	1620	9.9
Open AAA-elective	1027	3.2
Open AAA-ruptured	338	34.3
AAA-EVAR-elective	4137	0.6
AAA-EVAR-ruptured	258	17.1
Non-aneurysm abdominal aortic surgery	924	7.5
Thoracic ELG	1083	5.9
Open Thoracoabdominal	32	25
Endo Thoracoabdominal	242	6.2

i) Open aortic surgery

This includes all aneurysm and non-aneurysm surgery. 190 surgeons performed an average of 5 procedures with a range 1-22. The indications for the 345 non-AAA procedures are shown in Table 2.

Table 2. Non-aneurysm open aortic surgery

Indication	Total	Died
Claudication	245	4
Acute ischemia	172	25
Rest pain	161	5
Mesenteric ischemia	115	14
Ulcer/gangrene(arterial)	93	3
Dissection	19	3
Endoleak	18	1
Trauma(iatrogenic)-haemorrhage	18	3
Entrapment	12	0
Aortoenteric fistula-secondary	11	3
Bypass / Stent graft / Patch sepsis	8	1
Trauma(non iatrogenic)-haemorrhage	8	2
Aneurysm-false(non iatrogenic trauma)	7	1
Neoplasm-malignant	7	0
Aortoenteric fistula-primary	5	1
Infection	5	2
Renal a stenosis/refractory hypertension-atheroma	5	0
Trauma(iatrogenic)-occlusion	4	1
Aneurysm-false(iatrogenic trauma)	3	0
Retrieval device/FB	3	0
Renal a stenosis/refractory hypertension-FMD	2	0
Arteritis/collagenosis	1	0
Coarctation	1	0
Trauma(non 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 C-statistic for the model for mortality after open aortic surgery was 0.85.

Table 3 shows the significant variables used in the model for all open aortic surgery 2021-2023.

Parameter	Odds Ratio	95% Conf. Int.	Z Value	P (>|Z|)
Emergency	4.604484	(3.130223 to 6.773087)	7.755172	P < 0.0001
Thoracoabdominal(open)	8.340838	(3.307646 to 21.032957)	4.494846	P < 0.0001
AAA rupture no bypass	3.638827	(2.049846 to 6.459539)	4.411263	P < 0.0001
Aorta + Ax-bifem	2.772456	(1.315928 to 5.841136)	2.68205	P = 0.0073
ASA4	2.847682	(1.944932 to 4.169448)	5.379569	P < 0.0001
ASA5	4.322545	(2.665524 to 7.009653)	5.934676	P < 0.0001
Creatinine	2.491962	(1.485375 to 4.180677)	3.458783	P = 0.0005
IHD	1.527959	(1.11709 to 2.089946)	2.652868	P = 0.008
Age71-80	2.088583	(1.497245 to 2.91347)	4.33663	P < 0.0001
Age81-90	2.505817	(1.581306 to 3.970844)	3.910932	P < 0.0001
Female	1.721772	(1.23077 to 2.408654)	3.172205	P = 0.0015

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 104 consultants where 10 or more cases were performed during 2021-2023. 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 9%

Open AAA

218 surgeons operated upon 1620 patients with a mean of 7 and a range from 1-32 cases. This dataset was restricted to patients with abdominal aneurysm repair, excluding thoraco-abdominal aneurysms. This allowed comparison of postoperative complications between 1282 intact (elective, mycotic, painful, occluded) aneurysms and 338 ruptured AAA (Table 4). Mean aneurysm diameter was 66mm. Crude mortality was 9.9%.

Table 4. Complications after intact and ruptured AAA repair

Complication	Intact AAA (1282)	Ruptured AAA (338)
AMI	16(0.9%)	12(3.6%)
Gut ischaemia	36(2.2%)	30(8.9%)
Renal failure/impairment	65(4%)	61(18%)
Died	44(3.4%)	116(34.3%)

Outcomes

Predictive variables for the model are shown in table 5. Excellent discrimination was obtained with a c-statistic of 0.89.

Table 5. Significant variables in the Open AAA model 2021-2023.

Parameter	Odds Ratio	95% Conf. Int.	Z Value	P (>|Z|)
Blood loss 3-4L	3.532705	(1.88726 to 6.612762)	3.945528	P < 0.0001
Blood loss > 4L	6.55018	(4.014353 to 10.687862)	7.523724	P < 0.0001
Suprarenal Clamp	2.021734	(1.344494 to 3.040108)	3.382203	P = 0.0007
Rupture no bypass	2.459741	(1.275387 to 4.743914)	2.68584	P = 0.0072
Ruptured AAA	4.508261	(2.634007 to 7.716156)	5.492194	P < 0.0001
ASA4	1.758545	(1.014942 to 3.046952)	2.012851	P = 0.0441
ASA5	2.115752	(1.126776 to 3.972758)	2.331271	P = 0.0197
Hypertension	2.421082	(1.360496 to 4.308458)	3.006824	P = 0.0026
Age71-80	1.835118	(1.165356 to 2.889813)	2.620474	P = 0.0088
Age81-90	2.704428	(1.490724 to 4.906292)	3.273769	P = 0.0011
Female	2.140093	(1.311253 to 3.492844)	3.04417	P = 0.0023

iii) Endoluminal abdominal aortic surgery

Abdominal aortic aneurysm

251 surgeons inserted 4,844 ELG for AAA repair during 2021-2023, with a range of 1-81 and a mean of 19. 90% patients had percutaneous access with closure device. Mean aneurysm diameter was 58mm. There were 92 type 1, 69 type 2 and 16 type 3 endoleaks. There were 25 occluded limbs and 2 conversions to an open repair. There were 20 cases with device failure/malposition. GA was used in 94%. Mortality was 1.5%.

Table 6. Indications for EVAR 2021-2023

Indication	Total
Aneurysm-elective	4137
Aneurysm-pain	358
Aneurysm-ruptured	258
Aneurysm-mycotic	64
Aneurysm-occluded	12
Aneurysm-false(non iatrogenic trauma)	7
Aortoenteric fistula-primary	5
Aneurysm-false(iatrogenic trauma)	3

Comparison of complications between intact and ruptured ELG insertion is shown in Table 7.

Table 7. Complications after intraabdominal ELG (n = 4,844)

Complication	Intact Aorta (4,581)	Non-intact (263)
AMI	17(0.4%)	7(2.7%)
Gut ischaemia	8(0.2%)	4(1.5%)
Renal failure/impairment	36(0.8%)	18(6.8%)
Endoleak type 1	86(1.9%)	6(2.3%)
Endoleak type 2	66(1.4%)	3(1.1%)
Endoleak type 3	14(0.3%)	2(0.8%)
Died	30(0.7%)	45(17.1%)

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

Device	Total
Endurant	1503
Excluder	955
Zenith Alpha	527
Cook low profile	475
Zenith Fenestrated	414
Excluder conformable	203
Cook low profile with spiral limb(s)	166
Cook with side branches	150
Zenith branched-Iliac	134
Zenith Flex(non-fenestrated)	92
Other hybrid combination	66
Zenith t-Branch	25
Zenith limb only	22
Cordis Incraft	19
Jotec E-nside	19
Jotec E-tegra	14
Endologix	8
Zenith body with Endurant limb(s)	6
Anaconda(non-fenestrated)	5
Jotec E-xtra	5
Zenith body with Anaconda limb(s)	4
Zenith body with Gore limb(s)	4
Endurant;Endurant	3
Talent body with Endurant limb(s)	3
Anaconda(fenestrated)	2
Cook low profile;Zenith Alpha	2
Talent	2
Zenith branched-Iliac;Zenith Fenestrated	2
Aorfix	1
Cook low profile with spiral limb(s);Zenith Alpha	1
Cook with side branches;Zenith Fenestrated	1

Endurant;Excluder	1
Jotec E-iliac	1
Jotec E-iliac;Jotec E-nside	1
Trivascular Ovation (Prime)	1
Zenith Alpha;Endurant	1
Zenith Alpha;Zenith Alpha	1
Zenith body with Gore limb(s);Zenith Fenestrated	1
Zenith branched-Iliac;Cook low profile	1
Zenith branched-Iliac;Zenith Flex(non-fenestrated)	1
Zenith Flex(non-fenestrated);Cook low profile with spiral limb(s)	1
Zenith Flex(non-fenestrated);Other hybrid combination	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; 621/4844 (12.9 %) were fenestrated/BREVAR with 14 deaths (2.3%) vs non-fenestrated/BREVAR mortality of 60/4,178 (1.4%). Endoleaks occurred in 4.4% of fenestrated vs 3.5% in non-fenestrated ELG (p=0.01).

Table 9. Configuration of ELG 2021-2023

Configuration	Total
Bifurcated	**3705**
Fenestrated Renal(s)-SMA-Coeliac	250
Tube	191
Fenestrated Renal(s)-SMA	158
BREVAR Renal(s)-SMA-Coeliac	87
Branched endograft R Iliac	85
Aorto-uni-iliac-no x-over	84
Branched endograft L Iliac	68
Fenestrated both Renals	56
Bifurcated-bifurcated(+/- IBD)	45
Aorto-uni-Iliac and Fem fem bypass	38
Fenestrated + Branched endograft	31
BREVAR Renal(s)-SMA	11
Scalloped	5
Fenestrated R Renal	4
BREVAR both Renals	3
Fenestrated L Renal	3
Fenestrated Renal(s)-Coeliac	3
Fenestrated SMA-Coeliac	3
BREVAR Coeliac	2
BREVAR R Renal	2
BREVAR SMA-Coeliac	2
Bifurcated;BREVAR Renal(s)-SMA-Coeliac	1

Bifurcated;Fenestrated Renal(s)-SMA	1
Branched endograft L Iliac;Bifurcated	1
Branched endograft L Iliac;Bifurcated-bifurcated(+/- IBD)	1
Branched endograft L Iliac;Fenestrated Renal(s)-SMA	1
Branched endograft L Iliac;Fenestrated Renal(s)-SMA-Coeliac	1
BREVAR-SMA	1
Fenestrated + Branched endograft;Fenestrated Renal(s)-SMA-Coeliac	1

Outcomes

Mean mortality for EVAR (for AAA) was 1.5% (75/4,844). Significant variables in the model are shown in Table 10. The c-statistic was 0.83.

Table 10. Significant variables for mortality after EVAR for AAA 2021-2023

Parameter	Odds Ratio	95% Conf. Int.	Z Value	P (>|Z|)
Fenestrated	4.175734	(2.103234 to 8.290448)	4.084719	P < 0.0001
Emergency	5.726986	(2.26487 to 14.481342)	3.687197	P = 0.0002
Ruptured	8.549733	(3.511902 to 20.814343)	4.727085	P < 0.0001
IHD	2.245484	(1.359383 to 3.709183)	3.158969	P = 0.0016
Creatinine	2.176383	(1.102811 to 4.295064)	2.242115	P = 0.025

iv) Thoracic and thoraco-abdominal procedures

Endoluminal. Pathology in thoracic and thoracoabdominal TEVAR (n=1083) is shown in Table 11.

Table 11. Pathology for TEVAR 2021-2023

Pathology	Total
Aneurysm(non-dissecting)	322
Dissection-acute	230
Aneurysm(dissecting)	142
Penetrating ulcer	127
Dissection-chronic	121
Traumatic tear	118
Fistula	15
Infected TEVAR	8

There were 64 deaths (5.9%). 188 surgeons inserted a mean of 6 ELG with a range from 1-72. 120 surgeons had performed < 6 cases in 2021-2023. Configuration is shown in Table 12.

Table 12. TEVAR configuration

Configuration	Total
Single Stent graft	476
Overlapping Stent grafts	452
Stent graft(s) with distal bare stent	68
Fenestrated/branched-Brachioceph & CCA	23
Fenestrated/branched-CCA	21
Fenestrated/branched-Brachioceph	16
Stent graft(s) with intra-abd fenestration(s)	9

Table 13. TEVAR devices inserted.

Device	Total
Gore C-TAG	**546**
Zenith Alpha	250
Zenith TX2	100
Medtronic	67
Custom Cook (fenestrated/branched)	54
Gore C-TAG with Zenith Alpha extension	24
Gore TBE	18
Excluder	9
Endospan Nexus	4
Jotec E-vita Thoracic 3G	4
Jotec E-nside Thoracoabdominal	4
Bolton	2
Zenith TX2;Custom Cook (fenestrated/branched)	1

In the 1083 aneurysms and dissections, the proximal landing zones were; zone 0 in 71, zone 1 in 90, zone 2 in 302 and zone 3 in 620 patients. There were 22 patients with paraplegia (2%) and 15 strokes (1.4%) following TEVAR. 18 patients had renal failure or impairment and 2 developed intestinal infarction. There were 8 type 1, 2 type 2, and 4 type 3 endoleaks. No patients required conversion to open. Breakdown of complications by aetiology is shown in Table 14.

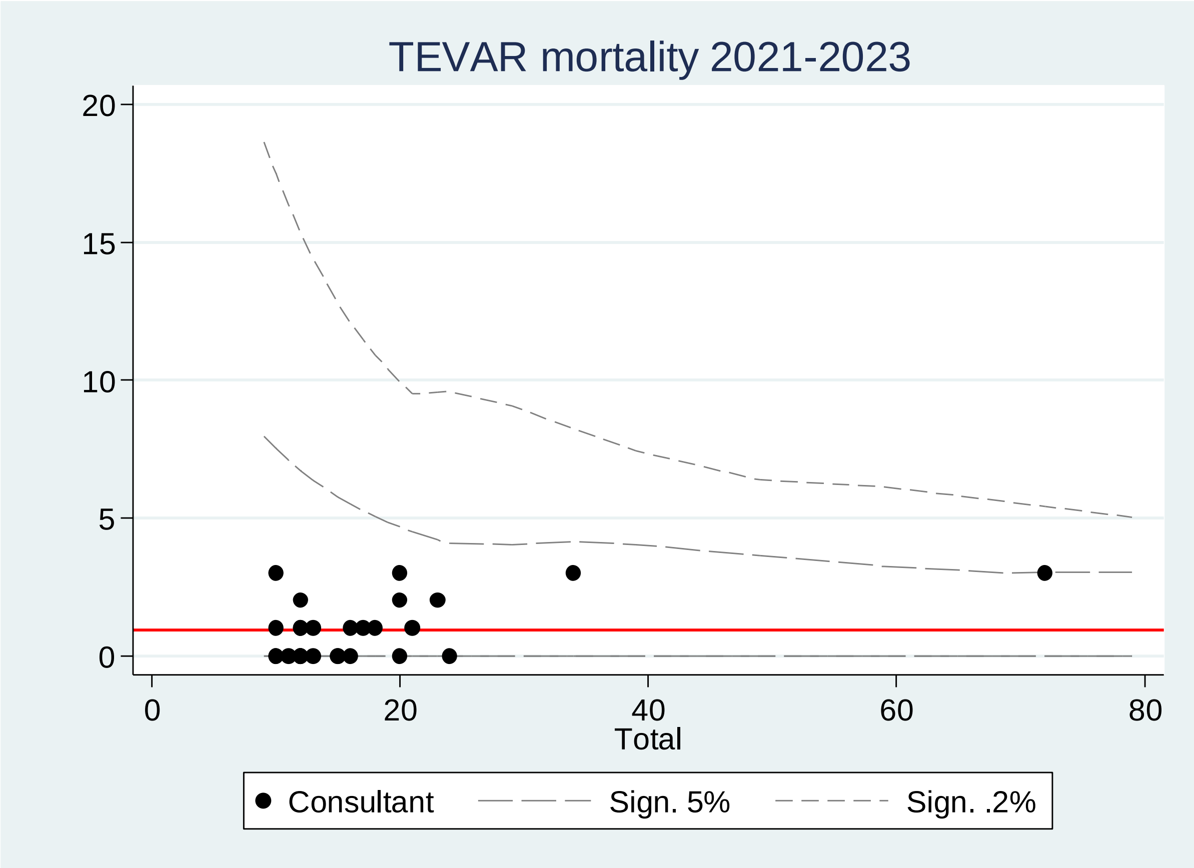
Table 14. Complications according to the main pathology types

Pathology	Total	Mortality	Stroke	Paraplegia
Aneurysm(non-dissecting)	322	19	8	3
Dissection-acute	230	19	3	15
Aneurysm(dissecting)	142	7	1	1
Penetrating ulcer	127	4	2	1
Dissection-chronic	121	4		2
Traumatic tear	118	8	1	
Fistula	15	2		
Infected TEVAR	8	1		

Outcomes

No predictive model was produced. 28 surgeons had performed 10 or more TEVAR in 2021-2023 and 119 had performed < 6 cases. Mortality in this group was 12.6%. Raw mortality for the total of cohort was 5.9%

The non-risk adjusted funnel plot showed no outliers for 2021-2023(Fig. 11)



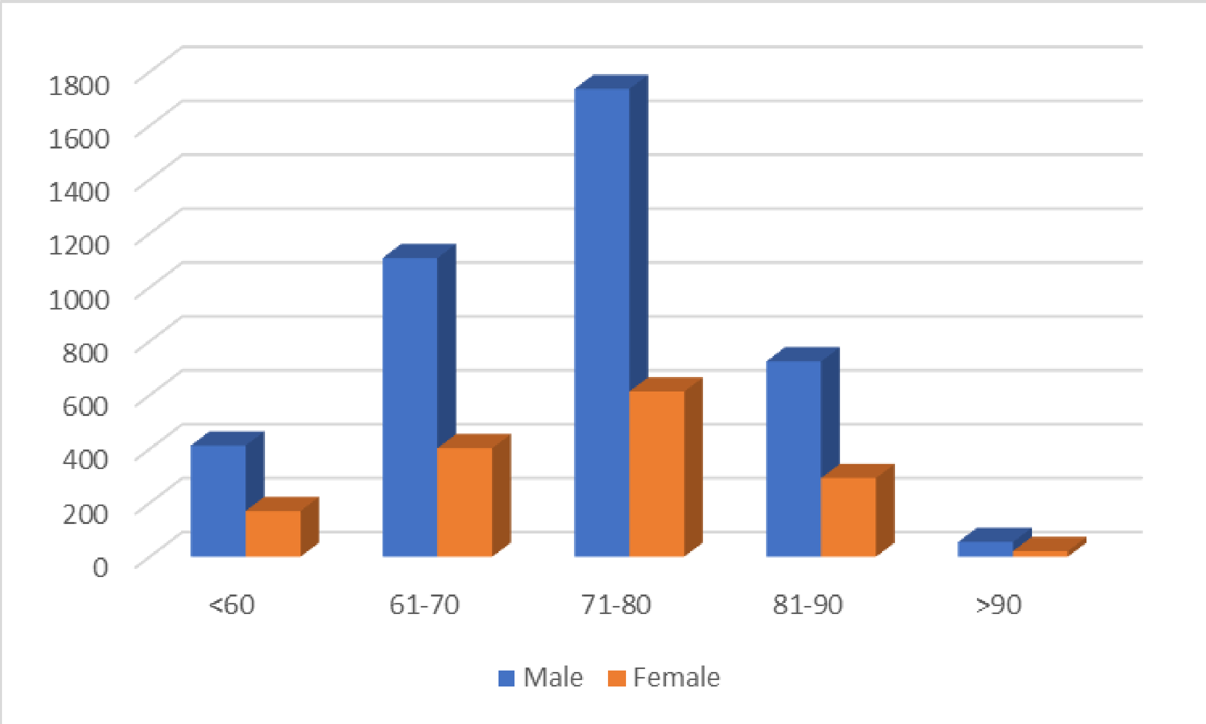
Open. There were 32 open thoracoabdominal procedures with 8 deaths They were performed by 19 surgeons and only 4 surgeons had performed > 1 procedure. 6 of the 8 mortalities occurred in the solitary cases. There were 0 strokes and 5 paraplegias, 2 of whom died. Length of stay in this cohort was 24 days. Mean diameter of the aneurysms was 66mm.

Table 15. Indications for open thoracoabdominal bypasses 2021-2023

Indication	Total
Aneurysm-elective	19
Dissection	4
Aneurysm-pain	4
Aneurysm-ruptured	2
Aneurysm-mycotic	1
Aneurysm-occluded	1
Coarctation	1

Carotid Surgery

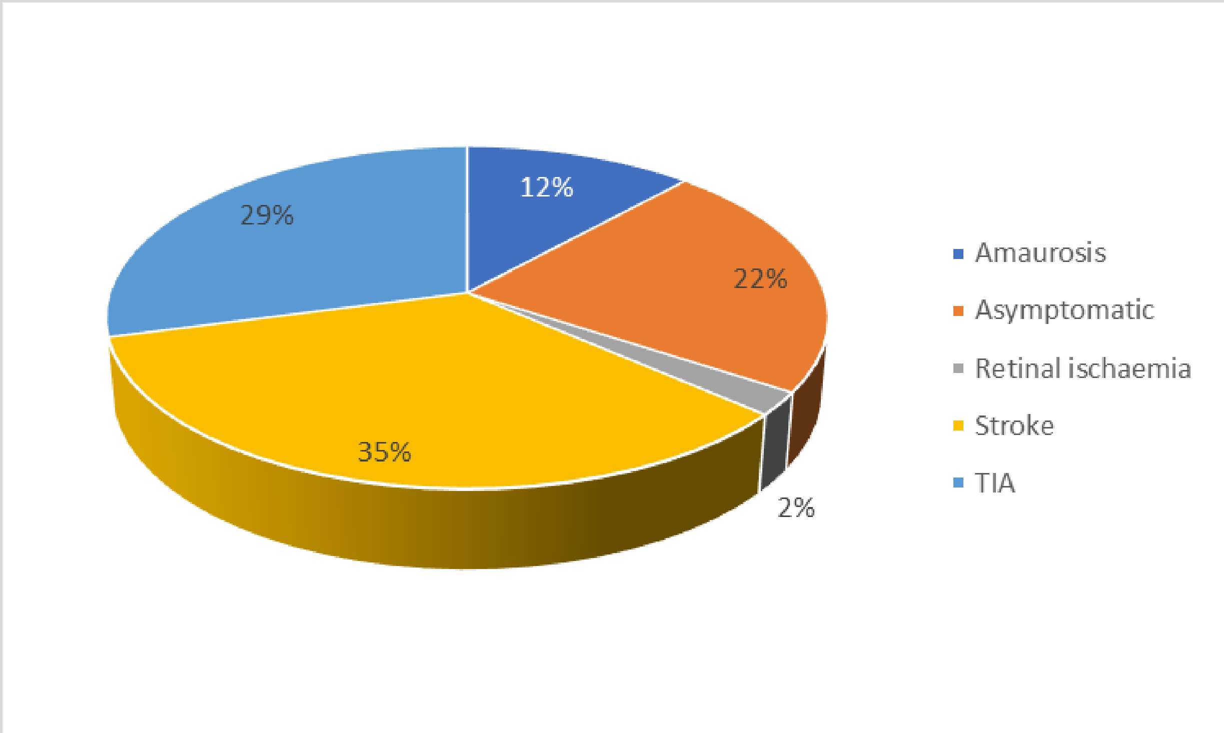
There were 5,542 carotid interventions, 5,134 carotid endarterectomies (CEA) and 408 carotid stents (CAS) in 2021-2023. Age and gender are shown in Figure 12.



i) Carotid Endarterectomy

261 surgeons performed an average of 19 CEA with a range from 1-97. The indications for CEA are shown in Fig.13 with 22% having no symptoms. In the 2010 report 31% were asymptomatic.

Fig 13. Indication for CEA



The time from onset of symptoms to surgery in symptomatic patients (n=1,346) was < 48 hours in 1%, < 2 weeks in 62%, 2-4 weeks in 18% and > 4 weeks in 18%. 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 14% of patients and 42% were shunted. Patches were used in 88% of CEA (Table 15).

Table 16. Patches after CEA.

Patch	Total
Pericardium	2644
Polyurethane	1360
(blank)	606
Prosthetic (Other)	145
PTFE	144
Dacron	118
GSV-reversed	58
Vein (Other)	22
Peritoneum	14
Neck vein	11
Omniflow	7
Ext carotid	4
SSV	1

Table 17. Complications after CEA (n= 5,134)

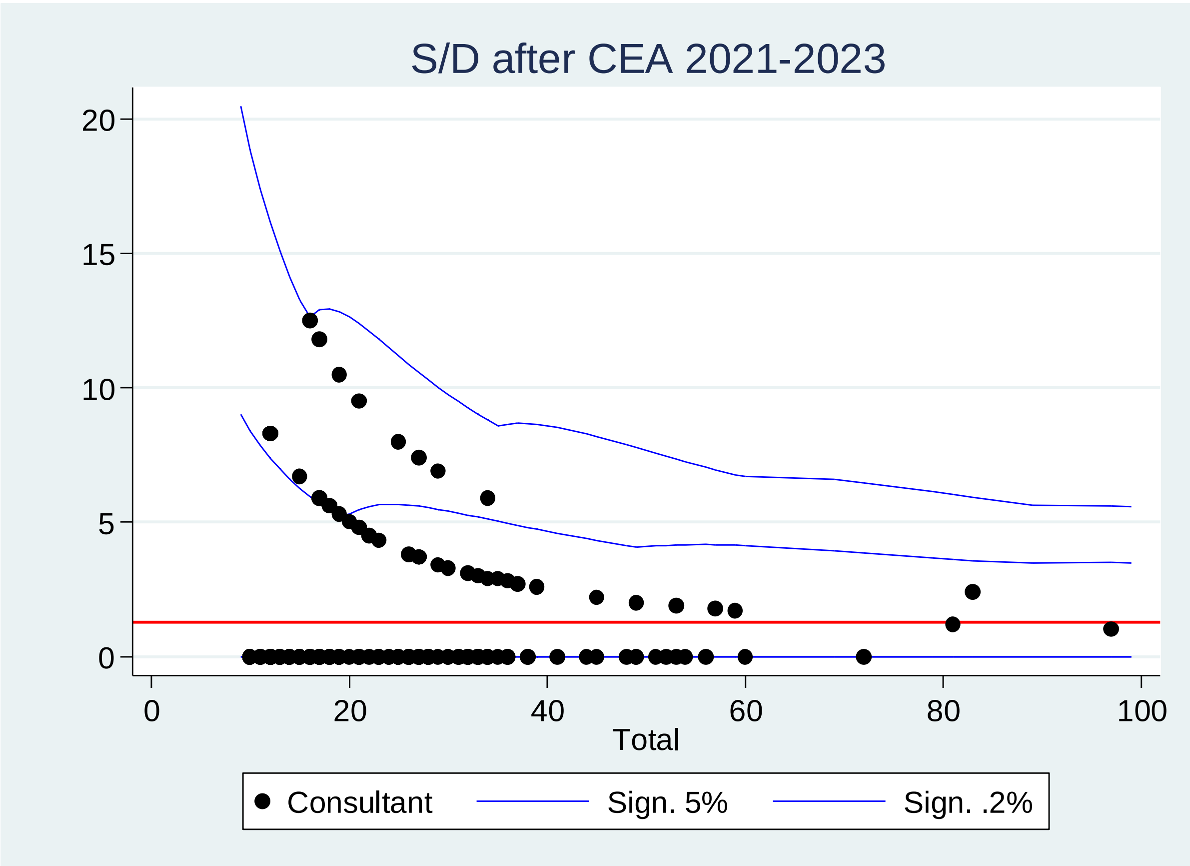
Complication	Percent
Haemorrhage requiring exploration	2.4
Cranial nerve trauma	0.7
Myocardial infarction	0.4
Major/minor stroke	0.8
TIA	0.3
Hyperperfusion	0.1
Death	0.4
Stroke or death	1.2

Outcomes

No predictive model was obtained.

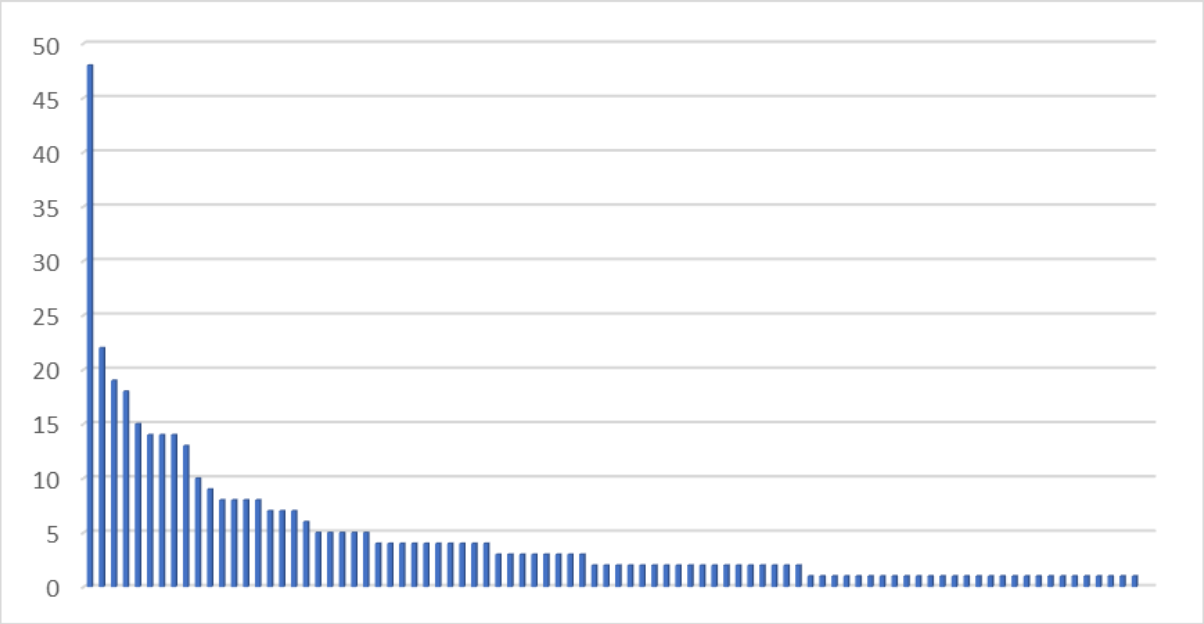
Only those surgeons (186) who performed 10 or more CEA were assessed by a non-risk adjusted funnel plot. The mean stroke/death (S/D) rate in this cohort was 1.3% and no outliers were detected as shown in Figure 14. Symptomatic S/D rate was 1.4% and Asymptomatic S/D was 0.5%. Postop S/D rate for stroke as the indication for operation was 1.6%.

Fig 14. Non-risk adjusted Funnel plot for stroke and death after CEA 2021-2023

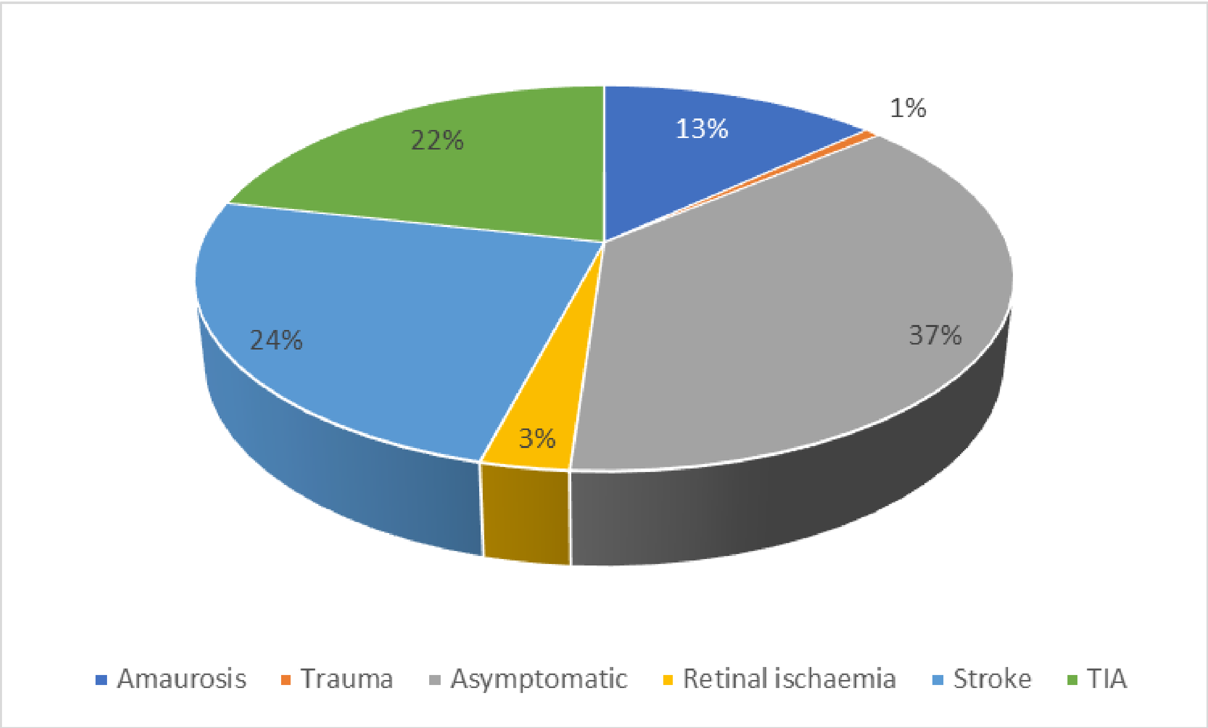


ii) Carotid Stents

88 surgeons placed 408 carotid stents in 2021-2023, with a mean of 5 and a range from 1 – 48. Fig 15 shows the number of CAS per consultant.



Indications for CAS are shown in Fig 16, with the most frequent being asymptomatic, then stroke.



Technical details. n=408

Access was via a long sheath in 295 and via a short sheath with guiding catheter in 113. There was a type 1 arch in 232, type 2 in 155 and type 3 in 21 patients.

Cerebral protection devices used are shown in table 18. No protection device was employed in 43 patients. Post-dilatation was used in 304.

Filter	Total
Emboshield	275
None	43
SpiderFX	40
Angioguard	29
Filterwire EX	19
Flow Reversal	2
Trap	1

Stent types are shown in table 19.

Stent	Total
Xact	229
CGuard	46
Precise	33
Covered stent	30
Casper	20
Wallstent	17
ProtegeRX	15
Tapered	7
Angioplasty only	6
Smart	2
ADAPT(Boston)	2
Acculink	1

Outcomes

There were 4 deaths and no strokes, with a stroke and death rate of 4/408 (1%). There were no AMIs or renal impairment in this cohort.

Infrainguinal bypass

261 surgeons performed 4,719 Infrainguinal bypasses (IIB) in 2021-2023. The range was 1-76 with a mean of 18. The average age of patients was 68 with the M: F ratio of 3.6:1. General anaesthetic was used in 98%.

Indications for surgery are shown in Fig 17 with tissue loss being the most frequent.

Fig. 17 Indications for infrainguinal bypass 2021-2023

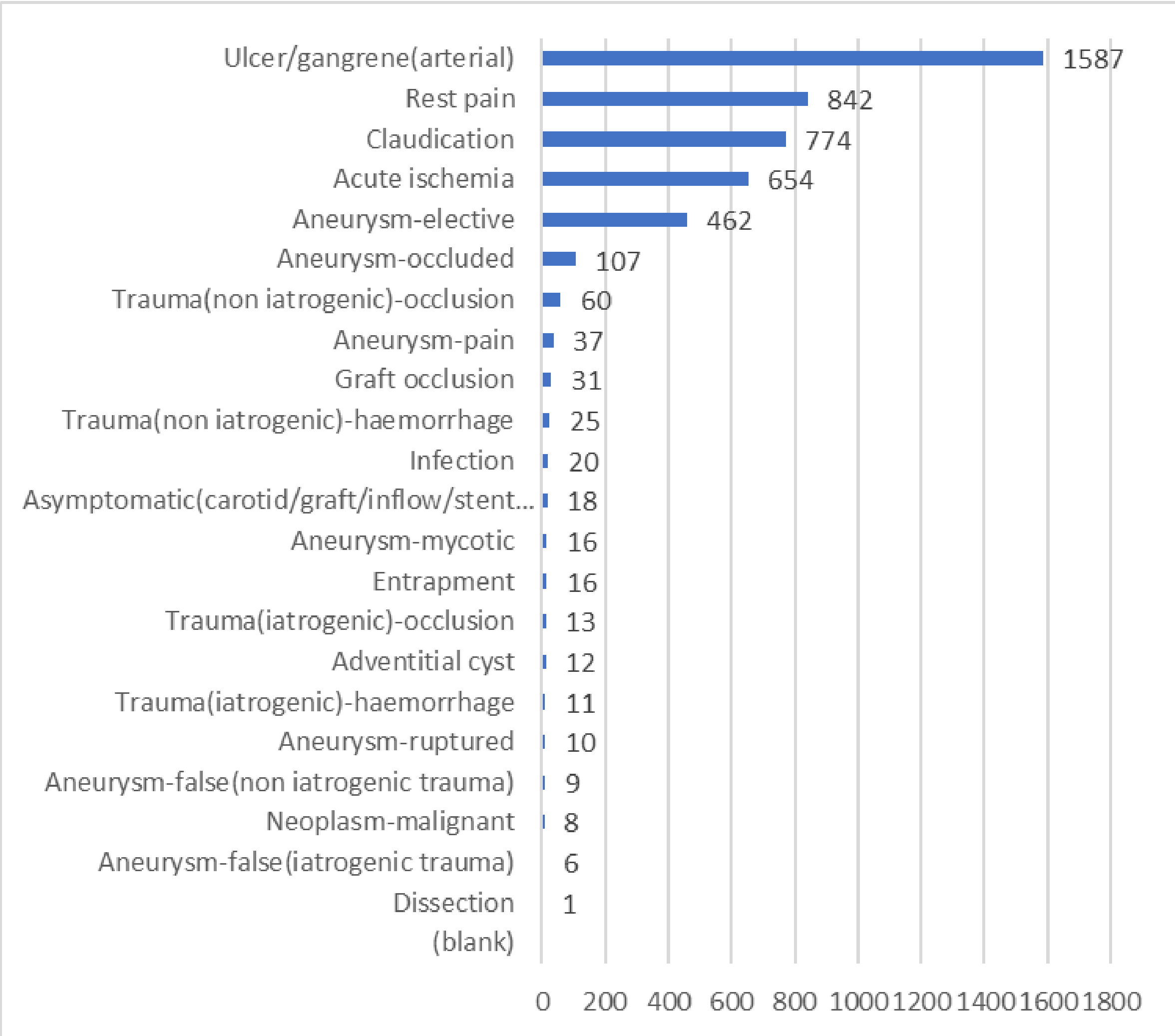
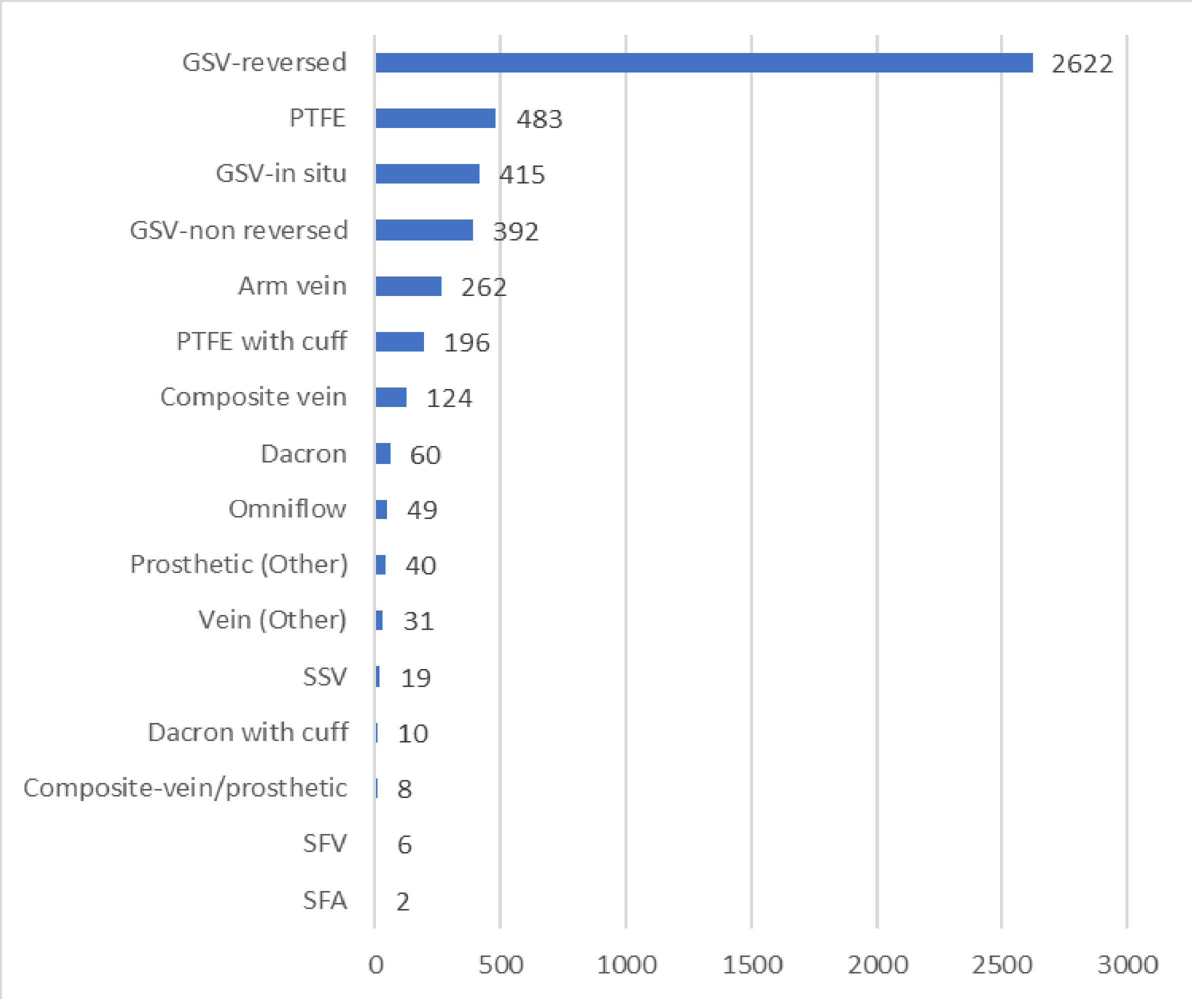
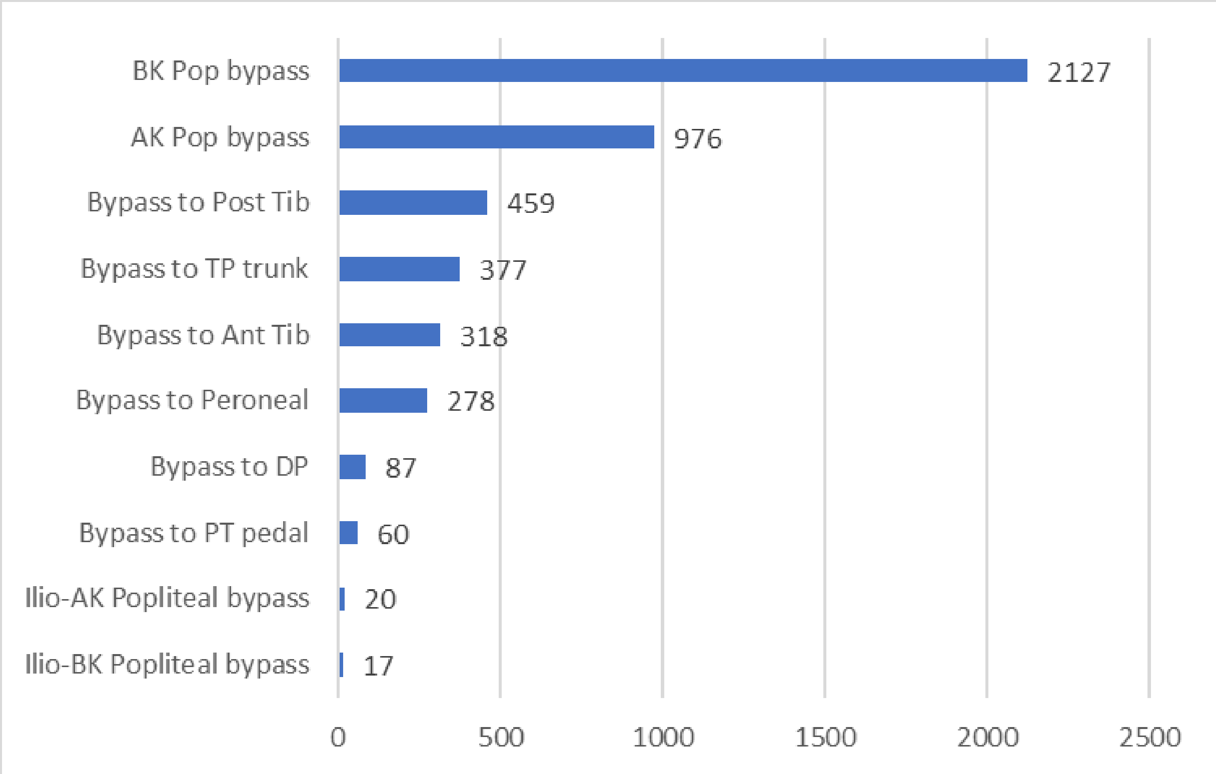


Fig. 18 Conduits for infrainguinal bypass 2021-2023



Bypass configuration is shown in Fig 19.



Post-operative complications are shown in table 20 (n = 4,719)

Complication	Percent
Myocardial infarction	1.0
Stroke	0.3
Renal impairment/ failure	0.6
Wound complications	3.1
Haemorrhage requiring reoperation	1.9
Graft occlusion	3.8
Amputation	0.1
Death	1.5

Outcomes

i) Occlusion

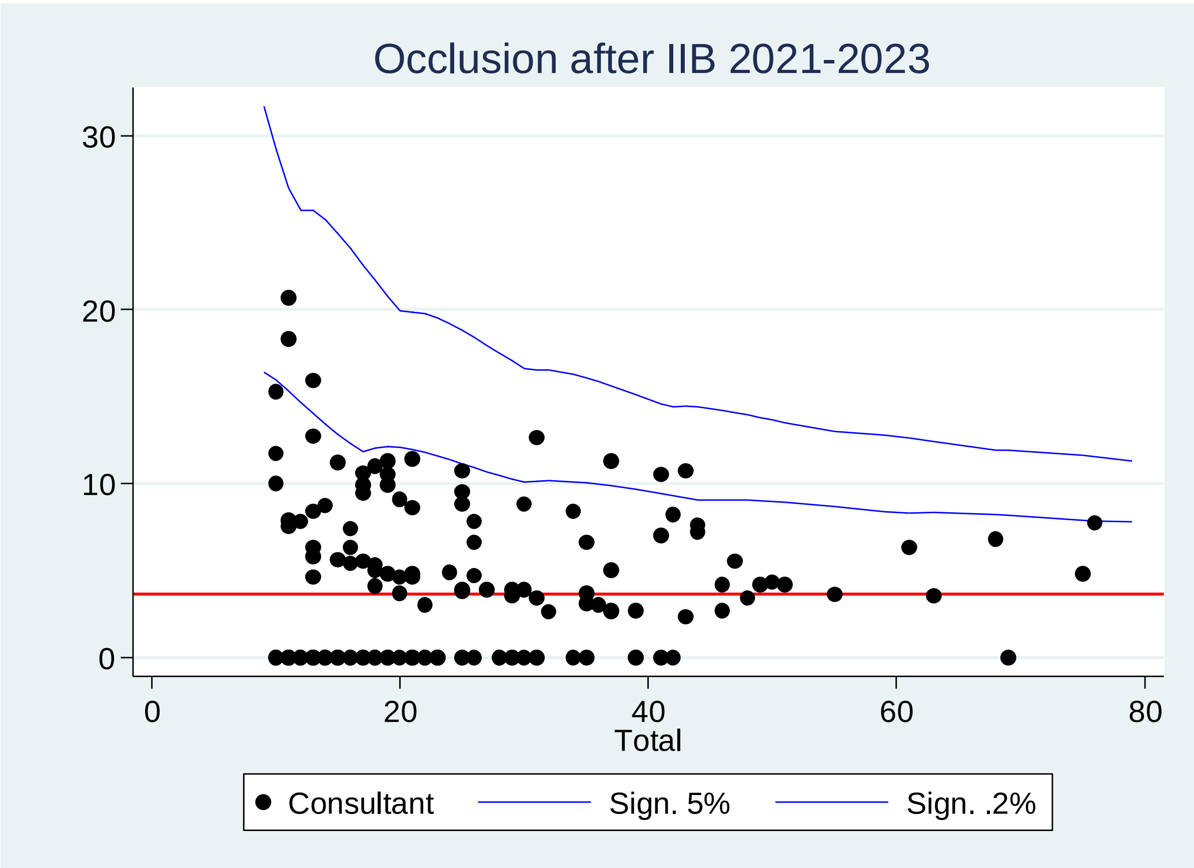
A logistic regression model for occlusion after IIB was obtained with a c-statistic of 0.7.

Significant variables are shown in Table 21

Parameter	Odds Ratio	95% Conf. Int.	Z Value	P (>|Z|)
1 vessel runoff	2.463024	(1.797451 to 3.37505)	5.608183	P < 0.0001
Dacron + cuff	6.612482	(1.325254 to 32.993623)	2.303344	P = 0.0213
PTFE	1.669922	(1.073477 to 2.597766)	2.274457	P = 0.0229
An elective	0.088692	(0.021743 to 0.361776)	-3.377428	P = 0.0007
Claudication	0.508803	(0.29892 to 0.866053)	-2.48989	P = 0.0128
Tissue loss	0.578932	(0.412989 to 0.811553)	-3.171609	P = 0.0015

Occlusion rates were assessed using a risk adjusted funnel plot for those 184 consultants that performed 10 or more bypasses (Fig 20). No outliers were detected for 2021-2023. The mean occlusion rate was 3.6% and mortality was 1.5%.

Fig 20. Risk adjusted funnel plot for occlusion after IIB 2021-2023 (10 or more cases) n=184



Popliteal Aneurysm: There were 633 bypasses for aneurysm (elective, occluded, pain, mycotic or rupture). There were 5 occlusions with a single limb loss for an occluded aneurysm. In non-aneurysm patients the graft occlusion rate was 4.2% and the amputation rate was 1.1%. 201 patients had an endovascular stent graft placed as the primary treatment for popliteal aneurysm.

Claudicants *vs* tissue loss: In the 774 claudicants, the occlusion rate was 2.2.% and there were no amputations. In 1,587 patients with tissue loss the occlusion rate was 3.4% and the amputation rate was 0.9%.

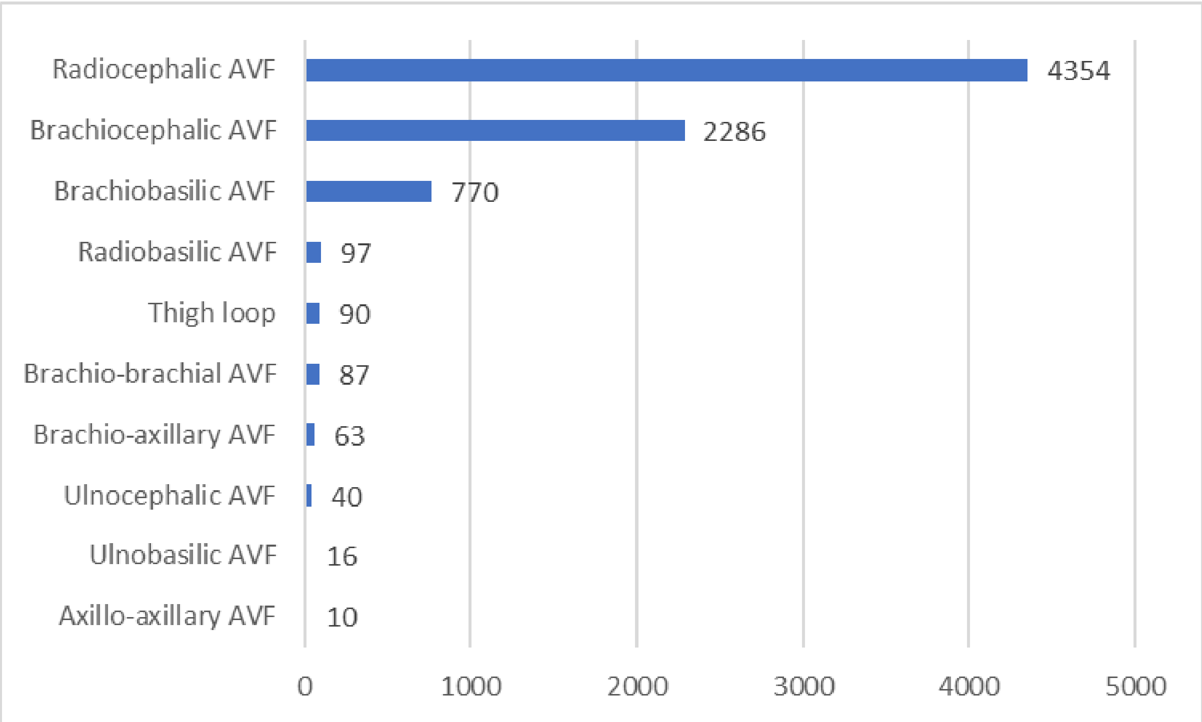
ii) Amputation

The limb salvage rate was 99%. 45 limbs were amputated and 9 of these occurred with a patent graft; 4 patients in this subgroup were diabetic.

Arteriovenous Fistulae

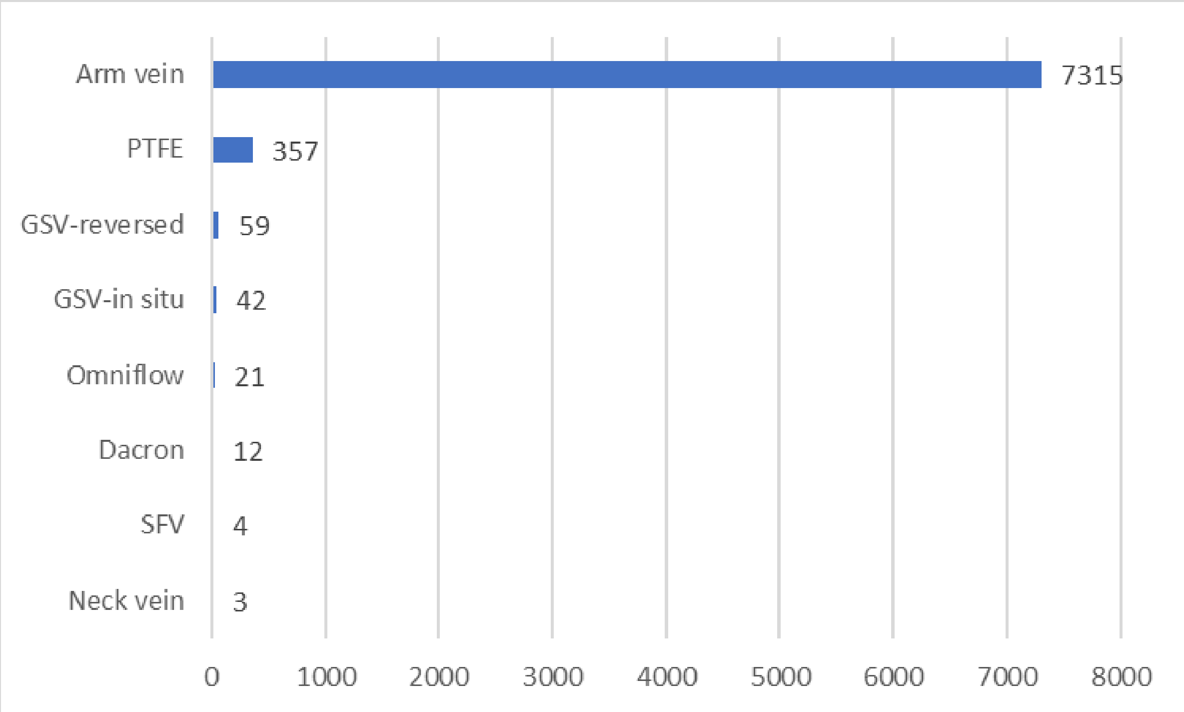
7,813 patients had an arteriovenous fistula (AVF) placed in 2021-2023. 231 surgeons performed a range from 1-264 with a mean of 34. The locations of AVF are shown in Fig 21.

Fig 21. AVF configuration



The majority of AVF were autogenous (95%). The conduits used are shown in Fig 22.

Fig 22. Conduits used



Outcomes

There were 121 occlusions (1.5%). Autogenous fistulae occluded in 100/7423 (1.3%) and prosthetic fistulae occluded in 21/390 (5.4%). 13 patients had a steal syndrome, 12 of whom were in a brachial level fistula and 1 thigh loop.

A model was obtained for occlusion after AV Fistula with a c-statistic of 0.72. Significant variables are shown in Table 22.

Table 22. Significant variables for occlusion after AVF construction 2021-2023

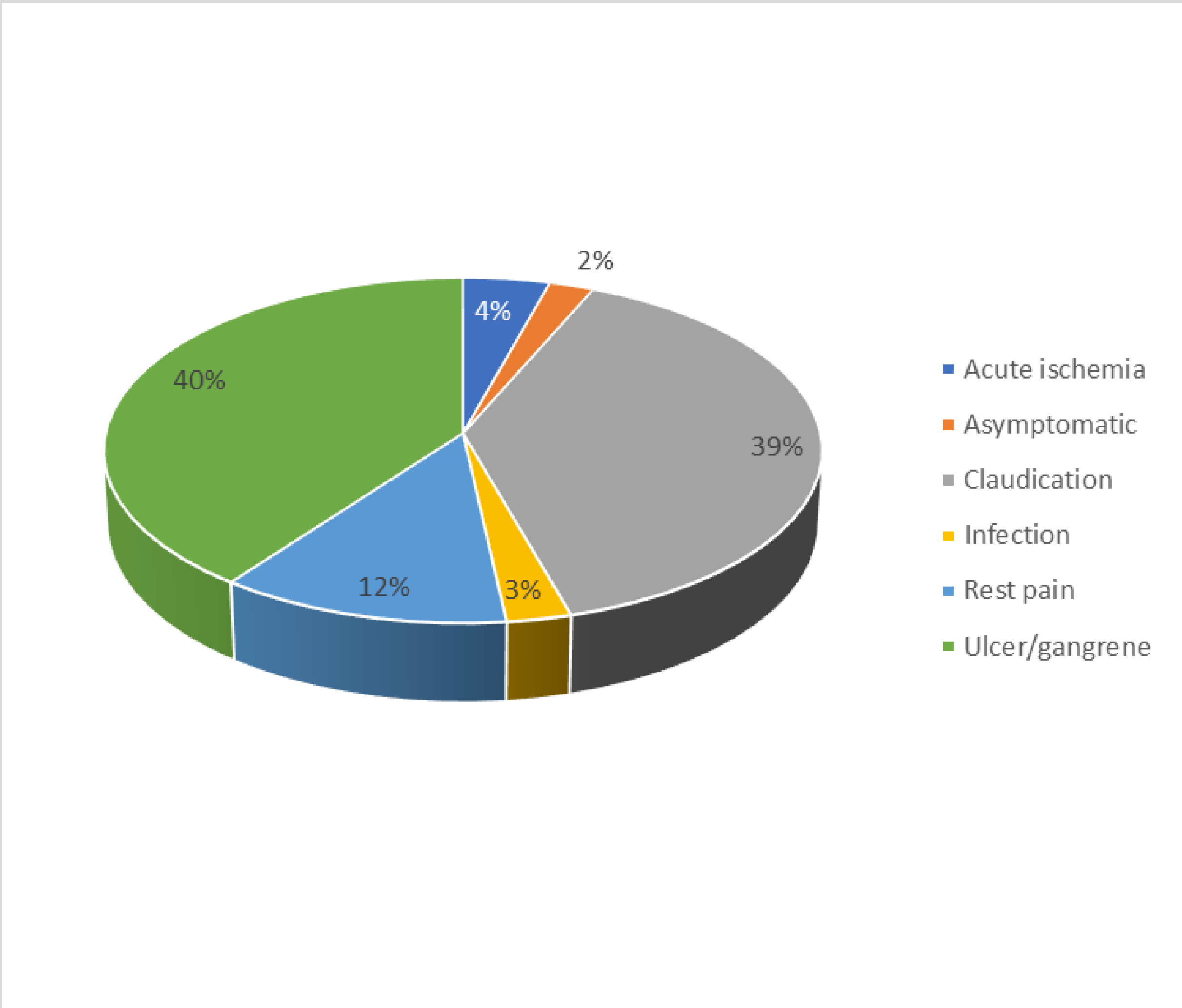
Parameter	Odds Ratio	95% Conf. Int.	Z Value	P (>|Z|)
Emergency	2.545437	(1.041502 to 6.221063)	2.049149	P = 0.0404
SFV	20.618816	(2.007022 to 211.824075)	2.546091	P = 0.0109
PTFE	2.730714	(1.567022 to 4.758579)	3.545115	P = 0.0004
Omniflow	10.560766	(2.872199 to 38.8308)	3.548141	P = 0.0004
ASA4	1.80854	(1.16499 to 2.807592)	2.640516	P = 0.0083
GA	2.002585	(1.365906 to 2.936036)	3.557238	P = 0.0004
Diabetes	0.445435	(0.306516 to 0.647317)	-4.240503	P < 0.0001
Age71-80	0.589992	(0.353094 to 0.985829)	-2.014454	P = 0.044
Female	1.483092	(1.027962 to 2.13973)	2.107428	P = 0.0351

Endovascular treatment for PAD lower limb

Since 2020 this category has been added to the index procedures. There were 29,823 interventions performed by 260 surgeons, with a mean of 115 and a range from 1-587. Trauma, Hybrid bypass + endovascular procedures, aneurysmal disease and procedures performed by radiologists were excluded from this analysis. This group included procedures from the abdominal aorta to the ankle. There were 17,495 PTA and 12,188 stents.

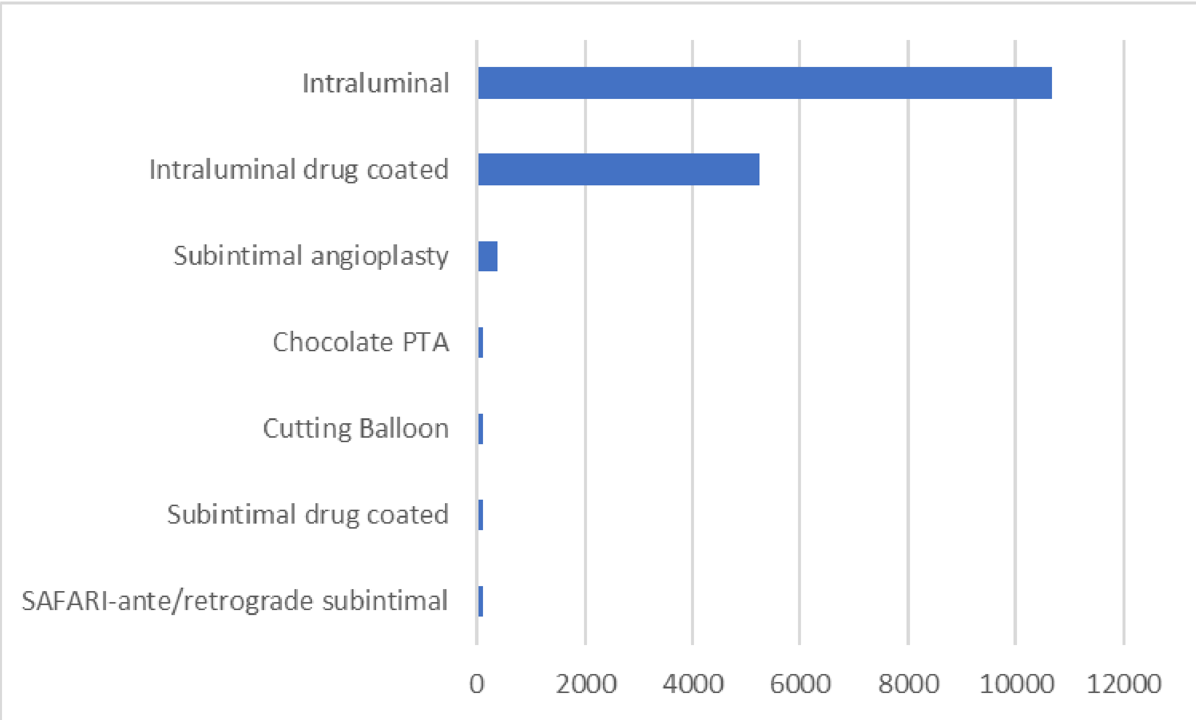
Indications for intervention are shown in Figure 24. Tissue loss was the most frequent, followed by claudication and rest pain.

Figure 24. Indications for endovascular treatment for PAD 2021-2023. (Asymptomatic=stenosis graft)

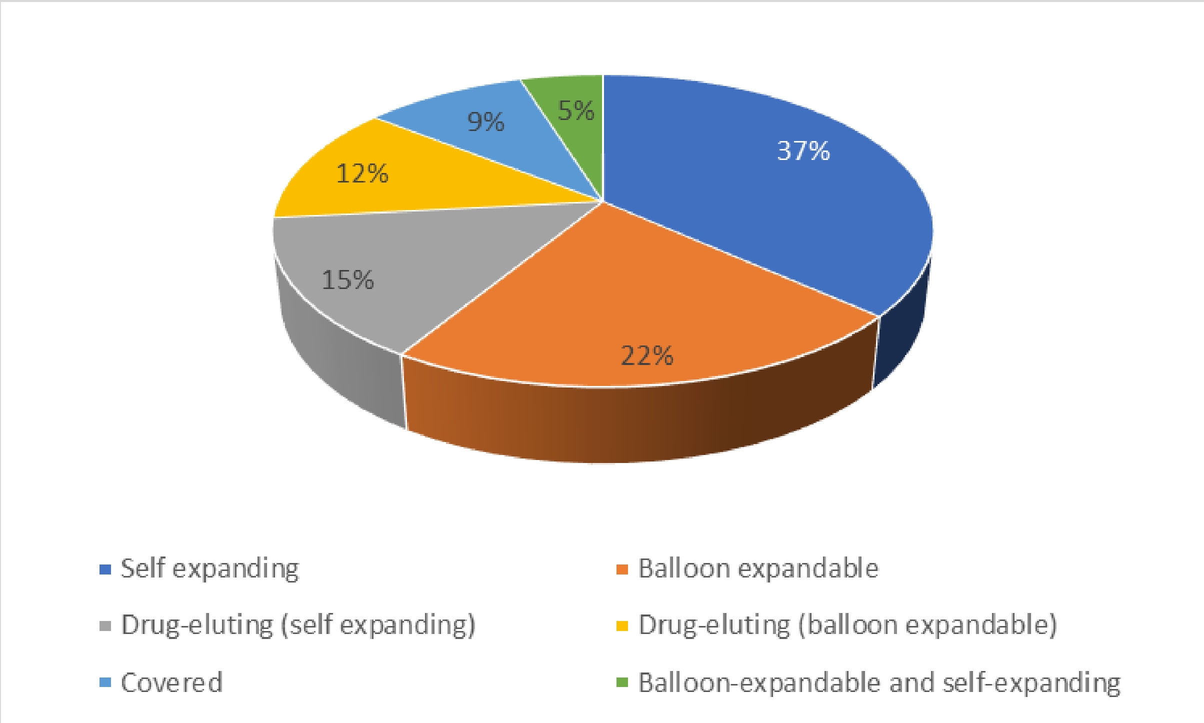


The type of PTA is shown in Figure 25. Most had an intraluminal angioplasty and 29% had an intraluminal drug coated balloon.

Figure 25. Type of angioplasty used in 2021-2023.



27% of stents were drug eluting and 9% were covered stents as shown in Fig 26.



Endovascular complications are shown in Table 23.

Table 23. Endovascular complications 2021-2023

Complication	Total
Dissection	219
Thromboembolism	179
Perforation	141
Occlusion	106
Pseudoaneurysm	76
Access failure	60
Haematoma	54
Haemorrhage	37
Device failure	33

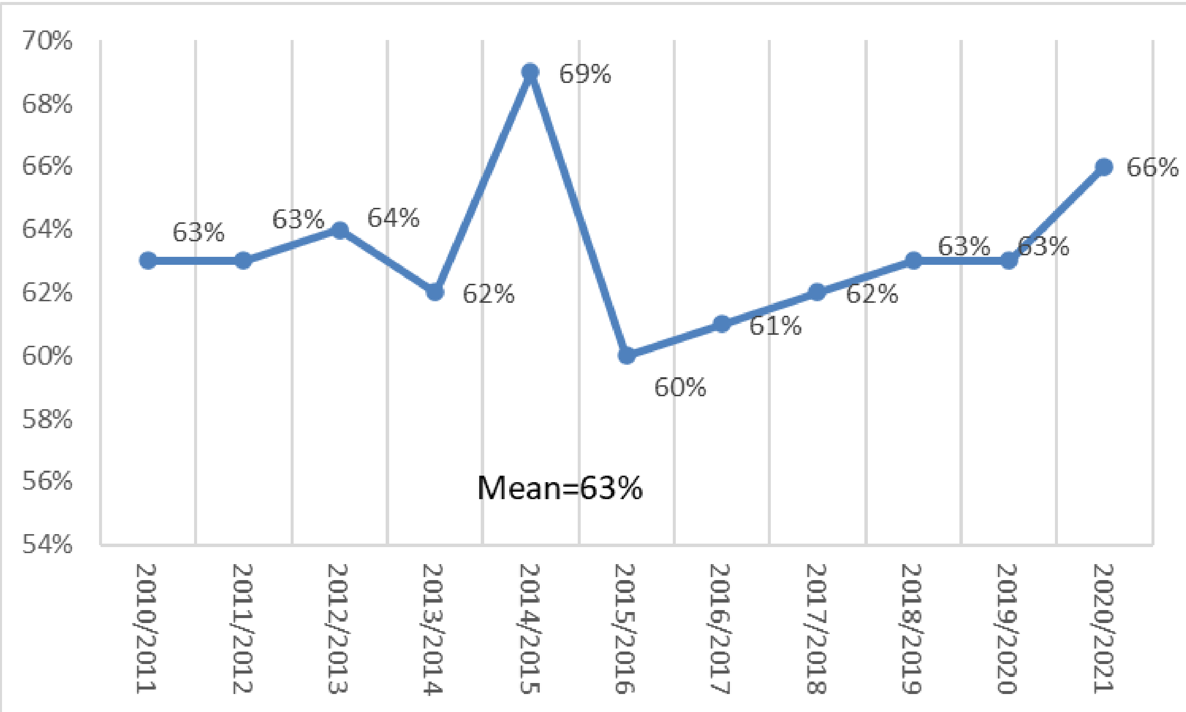
Outcomes

229 patients died (0.8%) and there were 7 amputations. Combined complications, amputation in claudicants and death was 3.2% and complications included both endovascular (*excluding* dissections without sequelae, perforations without sequelae, and access failure) and general (renal failure requiring dialysis, and re-exploration for haemorrhage) 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 2020/2021 financial year (Fig 28).

Fig 28. AVA capture compared with AIHW data



Data validation in the <u>private sector only</u> 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 2010-2022 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

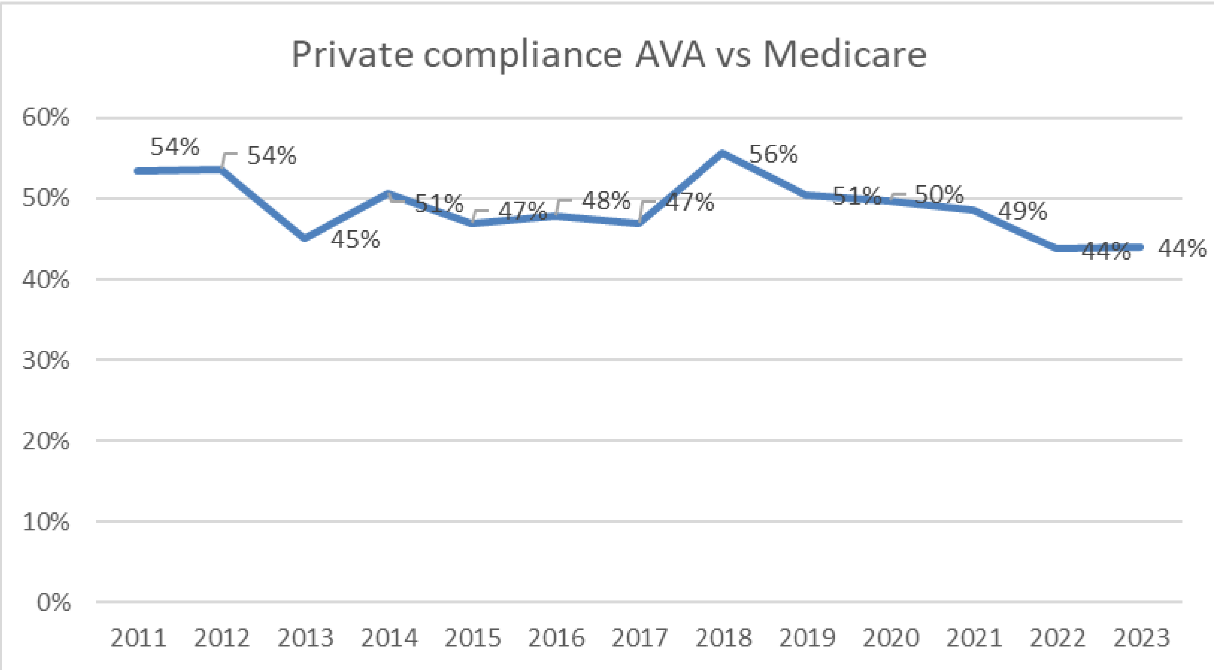
Item numbers 34503, 34509, 34512

EVAR/TEVAR

Item number 33119

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 at its lowest rate ever of 41%. 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 29. Private practice participation in the AVA for Australia 2010-2023

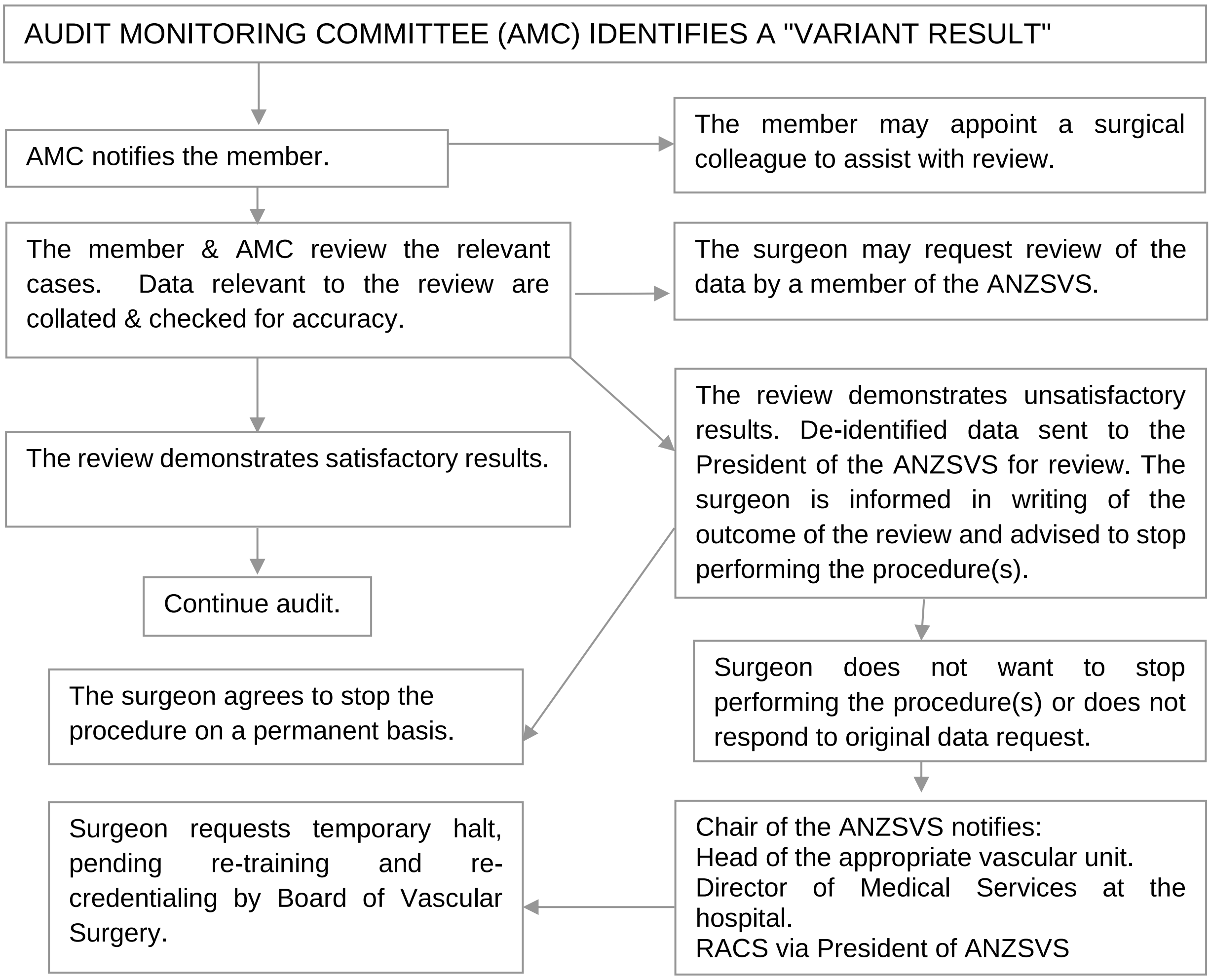


Internal validation was performed in 2023 comparing a 5% sample of patients with the actual case notes by nominated members at each hospital for 2022 data. This showed that data entry was of high quality with only 2.1% having incorrect field data entered out of a total of 2,894 fields studied. 2 outcome field 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 on the server. Confidentiality of patient details is thus assured. Ethics committee approval has been obtained for this activity by the RACS ethics committee until 2016, after which it was determined that this was not required to be renewed annually as it was deemed a "low risk" activity according to the new NHMRC guidelines. 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. In Australia in 2022, QP renewal was rejected but a new application is expected to be successful in 2023 for a 5-year period. 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 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.

References

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