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Editor's foreword

The *JVSGBI* has had an incredibly successful first three years. The journal is free, open-access, published online quarterly and represents the whole vascular community. One hundred and seventeen articles have been published and time to on-line publication is ten weeks.

It is pleasing that the most accessed *JVSGBI* resource over the last 12 months has been the fantastic free online text book '*All you need to know about Vascular Surgery*', superbly produced and edited by Mr Patrick Coughlin and Mr Lasantha Wijesinghe, which was recently included as a *JVSGBI* supplement. This beautifully illustrated and easy to read book aims to increase understanding and knowledge of vascular surgery and specifically targets medical students, early career stage doctors and allied healthcare professionals. The most accessed article over the last 3 years is the excellent '*Wi-Fi scoring: a reliable tool for risk stratification in the diabetic foot clinic*' by Williams *et al* (2022).

Although predominantly aimed at UK based vascular clinicians, the *JVSGBI* certainly appears to have a global appeal, with user access from over 80 countries.

This months issue includes a survey and editorial addressing the important issue of radiation protection for the vascular work force. It would appear there are significant deficiencies which require urgent attention. It is ethically and legally paramount that we ensure the safety of our workforce. A second survey assesses burnout in trainees and offers potential solutions. The important topic of cardiovascular risk management in patients with abdominal aortic aneurysms is analysed in a paper by Kwan *et al*.

It is pleasing to see papers from vascular nurses and vascular scientists included in this issue. Cooper addresses the somewhat divisive issue of nurse delivered endovenous ablation. The standard and safety of patient care is paramount, and must be equivalent to consultant practice. With appropriate training, clear scope of practice and governance this may contribute to improving waiting times but there must be no effect on training opportunities for vascular surgical trainees. Trochowski *et al* highlight the improvement and remaining variability in ultrasound grading of carotid artery stenosis in the UK & Ireland.

We include POVS 2024 as a supplement to this issue. POVS 2024 is somewhat different to previous iterations. It builds on POVS 2021, which remains the blueprint for high-quality vascular service, highlighting potential solutions in the most challenging 8 areas of vascular services.

Finally, the editorial board submitted *JVSGBI* Medline application which we recently were informed was unsuccessful. Detailed feedback was provided and a response and resubmission will be actioned as soon as *JVSGBI* is confident that all areas have been addressed. Medline have also encouraged resubmission.

As always I am hugely grateful to the editorial board and admin staff for their support and to reviewers and authors for their commitment to the *JVSGBI*.

Ian Chetter
Editor in Chief JVSGBI
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EDITORIAL

Improving radiation protection amongst the UK vascular surgery workforce

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Introduction

The use of ionising radiation in the UK is regulated nationally through legislation. The legal requirements for employers for the protection of radiation exposed workers are detailed in Ionising Radiation Regulations 2017 (IRR17),[1] Ionising Radiation (Medical Exposure) Regulations 2017 (IRMER17)[2] and Ionising Radiation (Medical Exposure) (Amendment) Regulations 2018,[3] with the ultimate responsibility for their enforcement sitting with the Health and Safety Executive (HSE), Britain's national regulator for workplace health and safety.

IRR17 stipulates that exposure to ionising radiation arising from work activities should be kept 'as low as reasonably practicable' (ALARP), also known as 'as low as reasonably achievable' (ALARA). Every employer therefore has a legal obligation to minimise the extent to which employees are exposed to ionising radiation by using a range of measures.[1] These include providing systems of work which restrict exposure to ionising radiation and provision of adequate and suitable personal protective equipment (PPE) to all those exposed to ionising radiation. IRR17 also requires employers to ensure that all practitioners and operators are adequately trained for their role and undertake continuous education and training, outlining the obligation of employers to monitor, record and maintain records relating to radiation exposure.[1]

The survey published in this issue of the *JVSGBI* highlights a worrying disconnect between legislation and practice across the UK. Whilst it demonstrates deficiencies in knowledge, access to personal radiation protection and failures to monitor individual exposure to ionising radiation affecting the UK vascular surgical workforce, this is by no means a problem isolated to this group. It affects all healthcare professionals working with ionising radiation, including interventional radiologists,[4] trauma and orthopaedic surgeons,[5] urologists[6] and cardiologists.[7] The solutions therefore require a cross-specialty approach with national standards and processes put into place. This will ensure that every specialty and the wider team, including anaesthetists, radiographers, nursing staff and surgical care practitioners, are afforded the same levels of workplace protection against ionising radiation. Despite the size of the task, protecting the workforce from preventable harm should be a priority for everyone. Moreover, the consequences of inaction are profound.

Education

The lack of awareness and knowledge of ALARA principles, a failure to consistently utilise these principles in practice, and a lack of awareness of local radiation policies seen in this survey, with one in four resident doctors in vascular training and one in 10 vascular consultants reporting not having undertaken any radiation safety training, highlight significant failures to successfully embed radiation protection education into vascular surgery training programmes, continuous professional development for consultants and clinical practice. National standards for training in radiation protection should be advocated. For consultants, this could form part of their trust mandatory training and, for resident doctors, evidence of training in radiation protection could be assessed at ARCP in the second Generic Professional Capability, the Professional Skills domain, whereby the safe use of medical devices and equipment must be demonstrated, and as a component of work-based assessments.

Although mandatory training gives organisations the assurance of completion of

Key words: radiation protection, patient safety, ALARP, ALARA, ionising radiation

training, courses do not necessarily translate into behavioural change. The various methods for effective delivery of radiation protection training should be considered. Face-to-face training used to form part of the national Annual Specialist Registrar Education (ASpiRE) programme for resident doctors in vascular surgery training programmes, but this has been replaced by national online teaching. An interactive online training course for the entire endovascular team has been shown to significantly improve radiation safety knowledge of the team,[8] and we know that team-based training can enhance patient safety behaviours in other areas of surgery.[9] However, the benefit of online versus face-to-face training methods and their translation into improved radiation safety behaviour requires greater evaluation. The intervals at which training should be delivered for optimal effect also requires attention, with IRR17 recommending training every 5 years, which is in contrast to the International Commission on Radiological Protection (ICRP) recommendation for training to be updated at least every 36 months.[10] The evidence base for these recommendations is unclear.

A concerted effort is required by all healthcare professionals, clinical leads, trust radiation protection advisors (RPAs) and NHS Trusts to ensure that the training received in radiation protection translates into ALARP practice in the workplace.

Improving access to personal protective equipment (PPE)

The survey highlights the alarming barriers resident doctors in vascular surgery and, to a lesser extent, consultants face in accessing the necessary PPE. Their trainee status and lack of permanency due to the rotational nature of surgical training appears to be the main reasons for lack of access to PPE. Resident doctors were also less likely to ask for PPE, with the survey providing an impression that trainees feel the need to prioritise their presence in an endovascular procedural environment over raising concerns about the availability of protective equipment, to fulfil procedural competencies.

For resident doctors and other staff who are new to an NHS Trust, induction would seem the most opportune time to be introduced to the RPA, be made aware of local policies and ensure that radiation protection training is up to date. It would also be the ideal time to be allocated personal dosimeters, or equivalent, and ensure provision of a minimum standard of PPE, to include appropriately fitted gender-specific gowns, thyroid collars and lead glasses, with additional protection with leg or tibial shields considered in high dose environments, as per the European Society for Vascular Surgery (ESVS) 2023 Clinical Practice Guidelines on Radiation Safety.[11]

Radiation passports

The development of a radiation passport documenting the radiation exposure throughout a career would provide a more robust mechanism and embed the requirement for an employer to give feedback on personal dosimeter readings, potentially improving clinician engagement and compliance with dosimeter usage. It would also overcome the problems of data being 'lost' as resident doctors rotate through placements.

The case for a national registry

The health-related effects of ionising radiation can be devastating, impacting on the mental and physical health of an individual and their families. One in four resident doctors in vascular surgery training and consultants experienced health conditions potentially related to working with ionising radiation. Whilst much is still unknown about the long-term effects of ionising radiation on health, establishing a register to document conditions which may be associated with working with ionising radiation would go a long way towards creating a culture of openness and transparency in the NHS surrounding radiation protection. We do not underestimate the challenges of who would hold or monitor the register; however, without such data collection we will remain in the dark about the excess risk of occupational exposure. A register would look for trends which could further increase our knowledge of the impact of working with ionising radiation on the workforce, allowing us to develop and/or refine current strategies to minimise their effect.

Whilst the focus of the survey and this editorial has been on improving radiation protection for healthcare professionals, it should be noted that this will undoubtedly translate into improvements in radiation protection for patients and patient safety.

Conclusions

This survey supports the need for urgent reform nationally with the development of clear robust education and training pathways in radiation protection, the development of appropriate standards of PPE and governance structures which will ensure annual and lifetime exposure to occupational radiation is accurately recorded. Protecting the workforce must be the priority and there are several workable solutions available. The responsibility for the safe use of radiation sits with the HSE and NHS trusts as employers. However, the bodies responsible for training and ensuring the well-being of the UK workforce need to take up the challenge of bringing about change. Moreover, for change to be successful, it is vital that all healthcare professionals engage in the process and provide the leadership creating awareness along with monitoring and recording safety for staff and patients.

Conflict of Interest: The authors declare that there are no conflicts of interest.

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ORIGINAL RESEARCH

The prevalence and solutions to burnout amongst surgical trainees

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Plain English Summary

Why we undertook the work: Burnout is characterised by the following three symptoms: (1) emotional exhaustion; (2) reduced sense of personal accomplishment; and (3) loss of sense of self. Burnout is increasingly affecting all healthcare workers in the UK. Surgical trainees, particularly female trainees, are dropping out at a higher rate. Burnout may be contributing to the surgical trainee drop-out rates. Unfortunately, there is not enough research on this topic. There is limited information on how to reduce burnout among surgical trainees. This review aims to report burnout rates among surgical trainees and find ways to reduce burnout and improve trainee well-being.

What we did: We systematically analysed the literature looking for papers which reported how common burnout is in surgical trainees, whether there was a difference in burnout between male and female trainees, and what interventions may reduce burnout.

What we found: We identified 22 relevant papers on burnout in surgical trainees, 11 of which focused on burnout rates among female and junior surgical trainees and the other 11 papers highlighted methods to help reduce burnout in surgical trainees and how to implement them. Trainees reporting prejudice, abuse or harassment are more likely to experience burnout, regardless of gender. There were conflicting results found on burnout prevalence and training level. Interventions identified to help combat burnout were mindfulness courses, mentorship programmes, stress resilience training and self-compassion training.

What this means: Female and junior trainees are more at risk of exposure to negative behaviours in the workplace. This contributes to higher levels of burnout. Mentorship, mindfulness and resilience training may reduce burnout and improve surgical trainee well-being, but more needs to be done to educate faculty and raise awareness amongst surgical peers.

Abstract

Background: Burnout is a syndrome of emotional exhaustion, reduced sense of personal accomplishment and loss of sense of self. Healthcare workers in the UK are known to suffer high psychological distress and burnout. Increasing attrition rates among surgical trainees have also been noted, particularly among female trainees. However, there are limited data on the factors contributing to burnout potentially leading to trainee attrition. Interventions to combat burnout and improve trainee well-being are still in their infancy. This review reports burnout prevalence and methods implemented to reduce burnout and improve surgical trainee well-being.

Objective: To report the prevalence and factors contributing to burnout and suggest evidence-based methods that reduce burnout and improve well-being within this cohort.

Methods: A literature search was conducted across five databases, identifying papers on burnout prevalence among surgical trainees and reported gender. Papers outlining interventions to reduce burnout were also included. Papers were screened against our inclusion and exclusion criteria. Quality was assessed using the modified Newcastle–Ottawa Scale and data were extracted and presented in this review.

Results: Following screening, 22 of 456 identified papers were included in the review; 11 papers were examined for burnout prevalence and the remaining 11 papers focused on interventions. Trainees reporting discrimination, abuse or harassment at least once a month were significantly more likely to experience burnout regardless of gender. Conflicting results were found on burnout prevalence and training level. Interventions identified included

mindfulness courses, mentorship programmes, Enhanced Stress Resilience Training (ESRT) and Self-Compassion for Healthcare Communities (SCHC) training. Dedicated faculty and wellness opportunities produced lower burnout rates (p=0.02). Two months of mindfulness training via the Headspace application also reduced burnout scores (p=0.01). ESRT reduced overall burnout by 38.9%. Similarly, increased self-compassion significantly predicted burnout reduction (p=0.018). No significant improvement was identified in residents at unionised programmes.

Conclusions: While there was no significant difference in burnout between genders, female and junior trainees are more at risk of exposure to negative behaviours in the workplace. This can directly contribute to higher levels of burnout. Interventions like mentorship and mindfulness and resilience training may reduce burnout and improve surgical trainee well-being. However, more needs to be done to educate faculty and raise awareness amongst surgical peers.

Key words: burnout, surgical training, wellbeing

Introduction

Following the COVID-19 pandemic, healthcare workers in the UK suffer high psychological distress.[1] Increasing attrition rates globally, especially among female surgical trainees, highlight the need for prioritising surgical trainee well-being.[2–4] However, there are limited data on the mental well-being and burnout experienced by surgeons and surgical trainees.

Burnout is a syndrome comprising emotional exhaustion, depersonalisation and reduced sense of personal accomplishment.[5] In 2021, 32% of UK surgeons reported burnout. Surgical trainees documented the highest average prevalence of 59% compared with 41% of consultants.[6] Surgical trainees also reported an 83% incidence of mild psychiatric illness, 83% disengagement and 87% exhaustion.[7] Poor mental well-being causes personal consequences such as higher levels of depression, anxiety, post-traumatic stress disorder (PTSD) and suicidal ideations, all affiliated with burnout. This leads to increased healthcare use and decreases functional status, debilitating trainees' ability to work.[8,9]

Despite limited research on patient outcomes, those reporting burnout have a higher self-reported risk of medical errors resulting in harm. The same was reported for near-misses not resulting in harm.[8,10] Similarly, surgical trainees reporting burnout were more likely to shout at their patients and make medical errors.[11–13]

Factors such as age, marital status, children, work-life balance and mental health are known to contribute to burnout.[14,15] In particular, female and junior surgical trainees have a higher risk of burnout.[15] However, previous reviews have not focused solely on surgical trainees, particularly those at a junior level and female.[16] Interventions for burnout and well-being are still in their infancy.[17] This review aims to report the prevalence and factors contributing to burnout and suggest evidence-based methods that may improve burnout and well-being within this cohort.

Research questions

- What is the prevalence of burnout among surgical trainees?
- Is prevalence affected by sex or training grade?
- What interventions are available to surgical trainees to combat burnout and improve well-being?
- What are the current gaps in research about improving burnout and well-being in surgical trainees?

Methods

The development of this scoping review was documented and conducted in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist.[18]

Inclusion and exclusion criteria

The inclusion and exclusion criteria are outlined in Table 1. Systematic reviews were excluded but separately examined to ensure all relevant studies were included. Studies included spanned the globe due to the lack of literature focusing on UK surgical training programmes. Well-being interventions were defined by the authors and were included if burnout outcomes were measured using the Maslach Burnout Inventory (MBI). Only studies recorded in the English language were included. No timeframe was specified in order to identify as many interventions as possible.

Outcome measures

The primary outcome measure was burnout using the MBI. MBI is the 'gold-standard' and most reliable measure for professionals working with others.[19] Despite the MBI receiving criticism for discounting burnout in informal work environments, it is an appropriate choice for assessing burnout in a healthcare workplace and was therefore used in this study.

Maslach Burnout Inventory (MBI)

Standard MBI is a 22-item burnout assessment tool widely adopted by healthcare workers. It measures three dimensions: nine measure emotional exhaustion (EE), five evaluate depersonalisation (DP) and eight measure personal accomplishment (PA). Individuals scoring highly on EE and DP and scoring low on PA were associated with a

Table 1 Selection criteria.

	Inclusion criteria	Exclusion criteria
Study type	Randomised controlled trials Observational studies Cross-sectional survey study	Purely qualitative studies Systematic reviews Articles
Population	Surgical trainees	Consultant surgeons, physicians and other healthcare professionals (HCPs)
Burnout score	Maslach Burnout Inventory	Oldenburg Burnout Inventory, Copenhagen Burnout Inventory, Stanford Professional Fulfilment Index, Mini Z-Survey, Perceived Stress Score
Outcomes	Prevalence of burnout: - Emotional exhaustion (EE) - Depersonalisation (DP) - Personal accomplishment (PA) Outline intervention(s) reducing burnout Burnout prevalence across genders and training levels Effect of Intervention methods on burnout/well-being	Not relating to prevalence of burnout and/or interventions to improve burnout or well-being
Language	English	Other than English
Access	Available through University of Warwick Institution access	Not subscribed to by the University of Warwick Institution

high risk of burnout.[19,20] Studies included in this review adopted variations of the MBI, including a two-item, nine-item and the full 22-item MBI.

Literature search strategy

Five databases (Medline, Embase, PsycInfo, Scopus and Web of Science) were electronically searched on 6 October 2023 for English language studies conducted prior to this date. Search strategies included text terms, MeSH terms and Boolean operators. Reference lists and citation searches were subsequently performed to identify sources not highlighted in these databases.

PROSPERO was also searched for existing and ongoing systematic reviews on burnout in surgical trainees. Two protocols were identified on surgeon burnout; however, their aims, inclusion and exclusion criteria differed from this review. One of the identified reviews focused on the effects of burnout on patient outcomes and surgical professionalism,[21] while the other explored trends in burnout prevalence across Canada and America over time.[22]

Screening

Two investigators (AN and YYY) independently screened titles, abstracts and full texts for inclusion with disagreements resolved through discussion. The same manual method was used for all screening (Figure 1).

Data extraction and synthesis

Data from the included studies were extracted as follows: author name, title, year of publication, during COVID-19 pandemic, location and type of study, sample size, number of male and female participants, diagnostic tool and burnout definition used, outcome measures, intervention performed, duration of data collection and results. Data were extracted independently on a spreadsheet by two investigators (AN and YYY) and any disparities were resolved through discussion.

Results

Search outcome

A systematic search produced 616 results from five databases, 160 of which were duplicates. Following duplicate removal, 362 of the remaining 456 studies were excluded following title and abstract suitability screening. Following full text screening of the remaining papers, 22 were considered eligible for inclusion in the analysis (Figure 2). Eleven papers were examined for burnout prevalence and the remaining 11 papers focused on interventions.

Figure 1 Flow diagram of title, abstract & full text screening

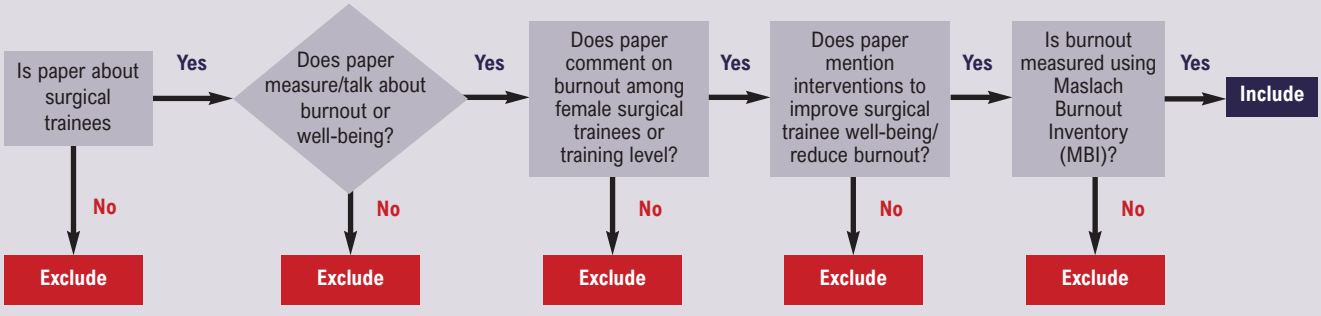
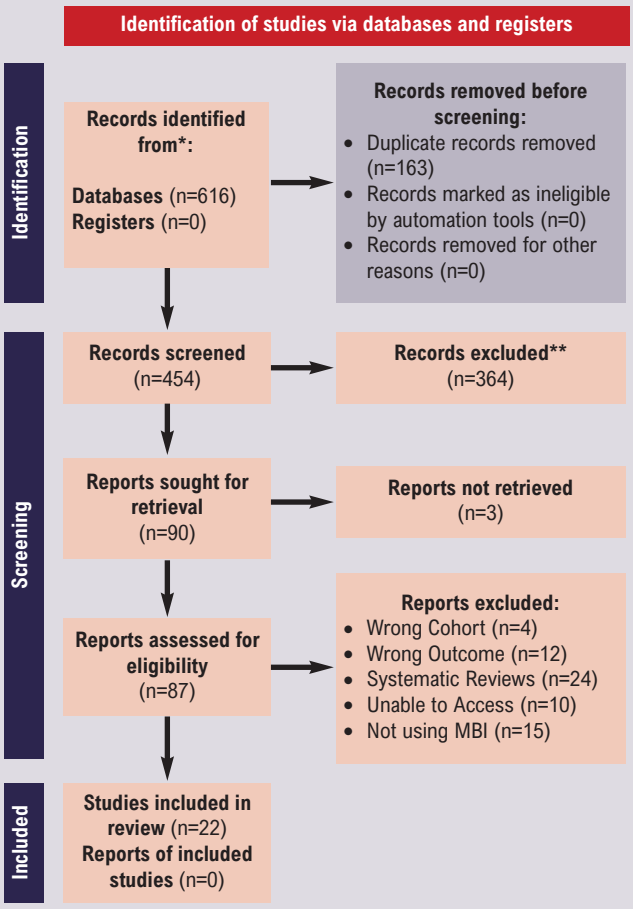


Figure 2 PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only[18]



* Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).
** If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Table 2 Quality assessment modified Newcastle–Ottawa Scale (mNOS) for studies on burnout prevalence

No.	Author and year	Quality assessment (mNOS)	Grade
1	Chow *et al*, 2021	5	Satisfactory
2	Daryanto *et al*, 2022	4	Unsatisfactory
3	Gleason and Baker, 2020	7	Good
4	Gleason and Malone, 2020	6	Satisfactory
5	Hu *et al*, 2019	8	Good
6	Kinslow *et al*, 2020	5	Satisfactory
7	Koo *et al*, 2021	5	Satisfactory
8	Lebares *et al*, 2018	7	Good
9	Lichstein *et al*, 2020	5	Satisfactory
10	Marchalik *et al*, 2019	7	Good
11	Salles *et al*, 2018	7	Good

Table 3 Quality assessment modified Newcastle–Ottawa Scale (mNOS) for studies on well-being and burnout interventions

No.	Author and year	Quality assessment (mNOS)	Grade
1	Boden, *et al*, 2023	5	Satisfactory
2	Brajcich *et al*, 2021	7	Good
3	Bui *et al*, 2020	6	Satisfactory
4	Burnet *et al*, 2023	7	Good
5	Kobritz *et al*, 2023	5	Satisfactory
6	Kratzke *et al*, 2023	5	Satisfactory
7	Letica-Kriegel *et al*, 2023	3	Unsatisfactory
8	Luton *et al*, 2021	5	Satisfactory
9	Pandit *et al*, 2022	4	Unsatisfactory
10	Shin *et al*, 2023	7	Good
11	Zhang *et al*, 2017	4	Unsatisfactory

Quality assessment

Quality was assessed by two independent reviewers (AN and YYY) using the modified Newcastle–Ottawa Scale (NOS) for cross-sectional studies. Discrepancies were resolved through discussion.[23] Although meta-analytical pooling was planned, variation in study designs, burnout ascertainment methods and statistical heterogeneity made quantitative pooling inappropriate. Therefore, studies were summarised descriptively and assessed qualitatively (Tables 2 & 3).

Description of included studies

Table 4 summarises the sample and design of the included studies reporting prevalence of burnout among surgical trainees. All studies (N=11) reported sample sizes, ranging from 34 to 7409, and specified the gender of participants. Most studies (N=9) had a higher number of male participants, which may be due to the higher number of men currently in the surgical field. Participants' training level ranged from 1 year post graduation to more senior levels at PGY level 4 and above.

Only one study on burnout prevalence included in this review was conducted in Indonesia,[24] the other 10 included studies originated in the USA.[25-34] Due to the differences in location, surgical training programmes differed greatly, even across training programmes in the USA, therefore factors contributing to burnout may not be generalisable to other surgical training programmes.

Three studies did not state study duration.[25,26,29] The other nine varied in timeframe, ranging from 19 days to 5 years.

Most studies (N=10) adopted a convenient sampling method. Only one used total sampling. Due to the volunteer-based participation, recruited participants were probably self-aware and motivated to engage, making it difficult to eliminate non-response and selection bias.

Table 4 Sample and design of studies on burnout prevalence

No.	Author and year	Sample size	Surgical specialty	Male vs female participants, n (%)	Study duration	Study type	Recruitment strategy
1	Chow *et al*, 2021	108	Cardiothoracic	M: 76 (70) F: 32 (30)	19 days	Cross-sectional survey	Convenient
2	Daryanto *et al*, 2022	120	Multiple	M: 109 (90.8) F: 11 (9.2)		Cross-sectional survey	Total Sampling
3	Gleason *et al*, 2020	236	General	M: 132 (56) F: 104 (44)	5 years	Cross-sectional survey	Convenient
4	Gleason *et al*, 2020	69	General	M: 29 (48.3) F: 31 (51.7)	3 months	Longitudinal survey	Convenient
5	Hu *et al*, 2019	7409	General	M: 4438 (59.9) F: 2935 (39.6)	Unspecified	Cross-sectional survey	Convenient
6	Kinslow *et al*, 2020	81	General	M: 41 (50.6) F: 39 (48.1)	3 months	Cross-sectional survey	Convenient
7	Koo *et al*, 2021	415	Urology	M: 293 (71) F: 122 (29)	5 months	Longitudinal survey	Convenient
8	Lebares *et al*, 2018	566	General	M: 276 (49.1) F: 286 (50.9)	Unspecified	Cross-sectional survey	Convenient
9	Lichstein *et al*, 2020	661	Orthopaedic	M: 551 (83) F: 101 (15)	Unspecified	Cross-sectional survey	Convenient
10	Marchalik *et al*, 2019	211	Urology	M: 145 (68.7) F: 66 (31.3)	2 months	Cross-sectional survey	Convenient
11	Salles *et al*, 2018	193	Multiple	M: 122 (63.2) F: 71 (36.8)	2 years	Cross-sectional survey	Convenient

Prevalence of burnout among surgical trainees and contributing factors

Burnout based on gender

Nine papers investigated the relationship between sex and prevalence of burnout (Table 5).[24-26,28-31,33,34] Of the nine studies, this was the primary outcome in six studies,[25,26,28,30,33,34] while the other three explored this association as a secondary outcome.[24,29,31] Female residents reportedly experience higher rates of burnout. However, this review found four papers highlighting workplace bullying and harassment as leading factors contributing to burnout, regardless of gender.[25,28,31,33]

Female surgical trainees were more likely to experience mistreatment in the workplace than their male colleagues (65.1% reported gender discrimination, 30.3% reported sexual harassment). Trainees reporting discrimination, abuse or harassment at least once a month experienced burnout symptoms significantly more (OR 2.94; 95% CI 2.58 to 3.36).[25]

Similarly, Kinslow *et al* found that female trainees reported burnout 2.7 times more than men.[30] Women also had more gender judgement concerns, which were significantly associated with higher burnout scores in all three MBI domains ($p<0.013$).[28]

In contrast, Lebares *et al* found higher DP among male residents.[26] However, in the same study female trainees had higher rates of alcohol misuse, also associated with higher DP scores as well as low anxiety. The alcohol misuse may provide a falsely low burnout score among women, and highlights a negative coping mechanism.[26] When accounting for burnout, depressive symptoms, quality of life (QOL) and work-life balance, female CTS trainees were significantly more likely to report negative balance/QOL outcomes ($p=0.013$). It was alluded that this may be due to the increased prevalence of mistreatment experienced by female trainees. However, their study did not identify any gender-related differences in burnout.[31]

Although women reported higher burnout rates in the other included studies, no significant difference was found in burnout prevalence between genders.[24,29,31–34]

Burnout based on training level

Seven studies reported burnout outcomes across surgical training levels (Table 6). Only two studies explored this relationship as a primary aim.

Conflicting results were observed. Four studies reported that junior residents experience more burnout,[24,27,32,34] while two reported that senior residents experience more burnout.[29,31] The remaining other study found no association between training level and burnout prevalence.[33]

72.9% of junior residents reported significantly higher DP scores than senior residents (60%) ($p=0.041$ and OR 1.27, 95% CI 1.12 to 1.41; $p<0.01$, respectively).[27,34] However, the training level did not remain statistically significant on multivariable

Table 5 Results and statistical analysis of studies on burnout prevalence and gender.

No.	Author and year	Results	Statistical analysis
1	Chow *et al*, 2021	Female trainees had poorer work-life balance and QOL as a composite measure of burnout, depressive symptoms, regrets and QOL	Chi-squared test performed. Female CTS trainees were significantly less likely to report positively on work-life balance/QOL than male colleagues ((0% vs 17% (p=0.013)
2	Daryanto *et al*, 2022	Overall 56.67% of trainees reported burnout. Male and female trainees reported similar levels of burnout	Chi-squared test performed. No significant difference in burnout rates was found between male or female trainees (p=0.625)
3	Gleason and Baker, 2020	Female trainees reported higher rates of burnout than their male colleagues (62% vs 55%)	Chi-squared test performed. Absolute higher rates of burnout amongst female trainees, but not statistically significant (p=0.33)
4	Gleason and Malone, 2020	Female residents reported higher rates of burnout (68% vs 48%) than male residents	Student *t*-test and Chi-squared test performed. Burnout rates between male and female residents were not statistically significant (p=0.1264), although higher in female residents
5	Hu *et al*, 2019	More women reported gender discrimination and sexual harassment than men (65.1% vs 10%). Exposure to mistreatment was associated with higher burnout scores	Multivariable logistic regression performed. No significant association was found between gender and aggregate mistreatment. Increasing frequency of exposure to mistreatment was associated with higher levels of burnout (OR 2.94, 95% CI 2.58 to 3.36). Women scored higher on EE, but both men and women had similar DP scores on MBI
6	Kinslow, 2020	Prevalence of burnout was higher in female trainees than in males	Chi-squared test and multivariable logistic regression performed. Women were four times more likely to report burnout (OR 4.108, 95% CI 0.438 to 38.495)
7	Lebares *et al*, 2018	Male trainees had higher DP scores. Women had higher rates of alcohol misuse. Those women reporting alcohol misuse had higher DP scores on MBI	Paired *t*-tests performed. High DP scores significantly more prevalent in men, whereas alcohol misuse was significantly higher in women (p<0.05). Alcohol misuse in women was significantly associated with higher DP scores (p=0.02)
8	Marchalik *et al*, 2019	More female residents reported burnout than male residents (72.7% vs 66.2%)	Mann–Whitney rank sum test performed. No statistical significance found between gender and burnout
9	Salles *et al*, 2018	Women had more gender concerns in the workplace than male colleagues. MBI scores in EE, DP and PA were similar between both genders	Paired *t*-tests performed. Gender concerns more prevalent among women (p<0.00001). Gender judgement was significantly associated with EE (p=0.03). No significant difference in all three MBI domains between men and women

DP, depersonalisation; EE, emotional exhaustion; MBI, Maslach Burnout Inventory; PA, personal accomplishment; QOL, quality of life.

Table 6 Results and statistical analysis of studies on burnout prevalence and training level.

No.	Author and year	Results	Statistical analysis
1	Chow *et al*, 2021	More senior trainees (in the last three years of training) had more negative balance/QOL ratings, when taking burnout, depressive symptoms, QOL and regrets into account	Chi-squared test performed. Residents in their final three years of training were significantly less likely to have good balance/QOL scores compared with their more junior counterparts (6% vs 26%; p=0.0053)
2	Daryanto *et al*, 2022	Senior residents reported lower EE scores on MBI compared with junior residents in their 1st or 2nd PGY	Chi-squared test performed. Junior residents (PGY-1/2) scored significantly higher on EE domain of MBI than senior residents (p=0.021)
3	Gleason and Baker, 2020	Senior residents had higher prevalence of burnout compared with junior residents	Chi-squared test performed. Burnout rates were significantly lower among PGY-1 level trainees, with increasing prevalence of burnout each year (p=0.01)
4	Gleason and Malone, 2020	Burnout rates were similar between junior PGY levels 1–2 and senior PGY levels 3–. Lowest burnout was reported in residents undertaking a research year	Chi-squared test performed. No significant association between burnout and training level identified
5	Koo *et al*, 2021	PGY-2 residents reported higher levels of burnout. Senior-most trainees (PGY-4) had lowest burnout rates	Chi-squared test performed. Significantly higher burnout scores reported by PGY level 2 trainees (65% vs <45%) than in other cohorts (p=0.02)
6	Lichstein *et al*, 2020	Junior residents in PGY level 1–2 experienced higher EE and DP. High EE scores were associated with unmanageable workload and lack of support	Chi-squared test and logistic regression analysis performed. Junior trainees were significantly associated with higher EE (p=0.03) and DP (p<0.01) scores. Low PA scores were significantly associated with lack of support (p<0.01)
7	Marchalik *et al*, 2019	Burnout was more likely in interns and junior residents than in more senior residents	Mann–Whitney rank sum test performed. Senior residents were more likely to experience burnout than interns and junior residents (p=0.041)

DP, depersonalisation; EE, emotional exhaustion; MBI, Maslach Burnout Inventory; PA, personal accomplishment QOL; quality of life.

analysis.[34] Similarly, PGY-1 residents reported higher levels of EE compared with senior level trainees (p=0.021 and (OR 1.15, 95% CI 1.01 to 1.32; p=0.03, respectively).[24,27]

Contrary to this, Gleason *et al* reported that PGY-1 level trainees had the lowest rates of burnout across training years. Burnout levels increased the further along training residents were, peaking in graduating residents (p=0.01).[29] Chow *et al* reported similar findings, with trainees in the latter years of their CTS training reporting significantly increased burnout.[31]

Other studies found no association between training level and burnout. Instead, specific training years were identified as causing higher rates of burnout. For example, Koo *et al* reported that trainees in PGY-2 training had significantly higher burnout compared with other training years (p=0.02).[32]

Only one of the included studies reported no association between training level and prevalence of burnout.[33]

Identified interventions for burnout and well-being

Eleven studies exploring well-being and burnout interventions met the inclusion criteria (Table 7).[35-45] Participants' training level ranged from PGY level 1 to PGY level 4 and above. All papers specified surgical specialty. Four studies involved general surgery residents, one on otolaryngology residents, one on orthopaedic residents, one on neurosurgery residents and four on multiple surgical specialties.

Two studies were pilot studies,[40,45] two were cross-sectional studies[35,36] and two were longitudinal studies.[37,38] A further two opted for a quasi-experimental design.[39,40] Of the three remaining prospective studies, one was a randomised controlled trial,[40] one was an observational survey[42] while the other was an interventional study.[43]

All studies reported their recruitment strategy, with the majority using convenient sampling.[34–39,41–43,46] Only one opted for random sampling with a control.[40]

Sample sizes varied across studies, ranging from eight to 5,701 participants. All studies stated participants' gender except one.[36] Only three studies had a larger proportion of female participants.[38,39,45]

The volunteer-based nature of participant recruitment meant selection and non-response bias was present. Findings could not be generalised to the wider surgical trainee population as participants were self-motivated and self-aware. Participants experiencing burnout symptoms may have been either more or less likely to participate, contributing to response bias.

Study duration ranged between 4 weeks and a year. Studies from across the globe were included with seven studies from the USA,[35–39,41,46] two from the UK,[40,42] and one each from Canada and South Korea, respectively.[43,45]

Interventions performed and analysis

Table 8 outlines interventions from the included studies. Interventions varied significantly and consisted of mindfulness courses,[36,39–41,44] mentorship programmes,[37,43] Enhanced Stress Resilience Training (ESRT)[42] and Self-Compassion for Healthcare Communities (SCHC) training.[38,45]

Table 7 Sample and design of studies on interventions for trainee burnout and well-being

No.	Author and year	Sample size	Surgical specialty	Male vs female participants, n (%)	Study type	Recruitment strategy
1	Boden *et al*, 2023	12	Orthopaedic	M: 7 (58.3) F: 5 (41.7)	Prospective randomised controlled	Random
2	Brajcich *et al*, 2021	5701	General	M: 3219 (56.5) F: 2339 (41.0)	Cross-sectional survey	Convenient
3	Bui *et al*, 2020	161	Multiple	Unspecified	Cross-sectional survey	Convenient
4	Burnet *et al*, 2023	85	General	M: 52 (61.2) F: 32 (37.6)	Retrospective observational	Convenient
5	Kobritz *et al*, 2023	38	General	M: 21 (55.3) F: 18 (47.4)	Longitudinal survey	Convenient
6	Kratzke *et al*, 2023	40	General	M: 17 (42.5) F: 23 (57.5)	Mixed methods longitudinal survey	Convenient
7	Letica-Kriegel *et al*, 2023	37	Multiple	M: 14 (37.1) F: 23 (62.9)	Quasi-experimental design	Convenient
8	Luton *et al*, 2021	28	Multiple	M: 23 (60.5) F: 15 (39.5)	Prospective observational	Convenient
9	Pandit *et al*, 2022	21	Neurosurgery	M: 12 (57.1) F: 9 (42.9)	Quasi-experimental design	Convenient
10	Shin *et al*, 2023	15	Multiple	M: 6 (40.0) F: 9 (60.0)	Prospective pilot	Convenient
11	Zhang *et al*, 2017	8	Otolaryngology (ENT)	M: 5 (62.5) F: 3 (37.5)	Prospective interventional	Convenient

Table 8 Interventions performed to reduce burnout and improve well-being

No.	Author and year	Study duration	Data collection stages	Screening tool	Intervention	Duration of intervention measured	Well-being outcomes
1	Boden *et al*, 2023	2 months	2 stages: during app use and post-intervention	MBI PSS GAD-7	MSBR: Headspace Phone Application	2 months daily app use	Burnout Stress Anxiety
2	Brajcich *et al*, 2021	4 months	1 stage: post ABSITE exam 2019	MBI-HSS	Unionised Training Programme	N/A	Burnout Suicidality Job satisfaction Duty hour violations Mistreatment
3	Bui *et al*, 2020	4 weeks	1 stage: survey conducted over 4-week period	MBI PHQ-2	Wellness initiatives: facilitated discussion groups, mindfulness training, narrative medicine	Unspecified	Burnout Depressive symptoms
4	Burnet *et al*, 2023	13 months	1 stage: post-intervention	2-item MBI CAMS-R PANAS SCS-SF	Mindfulness conference	Weekly 1-hour conference: 5 min safe space, 10 min silent meditation, 15 min speaker, 30 min roundtable discussion	Burnout Attention, present-focus, Awareness and acceptance Self-kindness Common humanity, Mindfulness
5	Kobritz *et al*, 2023	9 months	2 stages: pre and post	MBI-HSS CD-RISC HTPE	MAP-IT Longitudinal Curriculum	60 min reflection, reading and discussion, every month	Burnout Resilience Humanistic skills
6	Kratzke *et al*, 2023	3 years	2 stages: pre and post	MBI-HSS PHQ-9 PSS STA	Self-Compassion for Healthcare Communities (SCHC) training	1 hourly session every week for 6 weeks	Burnout Depressive symptoms Stress Anxiety
7	Letica-Kriegel *et al*, 2023	1 year	2 stages: pre and post	2-item MBI	Facilitated Process Groups	1 hourly session every 6 weeks Meditation and facilitated discussion	Burnout Stress Lifestyle
8	Luton *et al*, 2021	6 months	1 stage: post-course	aMBI PSS 9PHQ-2 CAMS-R STAI-6	Enhanced Stress and Resilience Training (ESRT)	5-weeks of 75 min ESRT courses on mindfulness-based training	Burnout Stress Depressive symptoms Mindfulness Anxiety
9	Pandit *et al*, 2022	7 months	2 stages: pre and post	aMBI PSS CAMS-R	Mindfulness course	90 min weekly sessions over 8 weeks	Burnout Stress Mindfulness
10	Shin *et al*, 2023	6 weeks	2 stages: pre and post	MBI-HSS SCS DASS-21	Self-Compassion for Healthcare Communities (SCHC) training	Weekly hourly session for 6 weeks	Burnout Self-compassion Life satisfaction Resilience Depression Anxiety Stress
11	Zhang *et al*, 2017	1 year	5 stages: baseline, 3, 6, 9 and 12 months	MBI-HSS PSS WH-QOL	Formalised Mentorship Programme (FMP)	Mentor meeting every 3 months	Burnout Stress Quality of Life

aMBI, abbreviated Maslach Burnout Inventory; CAMS-R, Cognitive & Affective Mindfulness Scale – Revised; CD-RISC, Connor–Davidson Resilience Scale; DASS, Depression Anxiety & Stress Scale; DP, depersonalisation; GAD-7, Generalised Anxiety Disorder; HTPE, Humanistic Teaching Practices Effectiveness; MBI-HSS, Maslach Burnout Inventory - Human Services Survey; PA, personal accomplishment; PANAS, Positive and Negative Affect Schedule; PHQ-2/9, Patient Health Questionnaire-2/9; PSS, Perceived Stress Scale; SCS SF, Self-Compassion Scale Short Form; STA/I, Spielberger State-Trait Anxiety Inventory; WH-QOL, World Health Organisation Quality of Life Score.

Table 9 summarises the results and statistical analyses from the included studies. No significant changes were observed following intervention in four of the studies.[35,39,42,44] All other interventions improved burnout scores in at least one MBI domain.[36–38,40,41,43,45]

Mindfulness courses

Of the four mindfulness courses, two reduced burnout significantly.[36,41] No significant changes in burnout were found in the other two mindfulness studies.[39,44]

Table 9 Results and statistical analysis of studies on interventions for trainee burnout and well-being

No.	Author and year	Results	Statistical analysis
1	Boden *et al*, 2023	Prevalence of burnout reduced from 91.7% to 58.3% (p=0.059) following use of Headspace application	Paired *t*-test performed. Significant reduction in EE (p=0.005) and DP (p=0.01), but no significant change in PA scores in treatment group
2	Brajcich *et al*, 2021	No difference in burnout, suicidality, thoughts of attrition or dissatisfaction with time for rest scores between residents at unionised and non-unionised training programmes	Linear regression for continuous outcomes performed. No significant change in burnout was identified between residents at unionised and non-unionised programmes (OR 0.92, 95% CI 0.75 to 1.13)
3	Bui *et al*, 2020	Activities for wellness and dedicated faculty wellness champions were associated with reduced burnout and depression rates	Multivariate logistic regressions performed. Burnout was less likely in residents with dedicated faculty wellness champions (OR 0.116, 95% CI 0.022 to 0.604; p=0.01)
4	Burnet *et al*, 2023	Mindfulness conference attendance was associated with lower callousness on MBI. The more sessions attended, the lower the burnout rates. There was no significant change in overall burnout scores	Chi-squared test was performed. MBI callousness scores did significantly increase the longer it had been since a resident attended the mindfulness conference (p=0.0254)
5	Kobritz *et al*, 2023	No change in PA occurred. EE and DP scores did improve post MAP-IT. HTPE scores also improved	Wilcoxon signed rank test performed. Significant improvement in EE (p=0.038). DP scores also improved although not statistically significant (p=0.097)
6	Kratzke *et al*, 2023	EE, DP, PHQ-9 and PSS scores improved across 3 years of self-compassion training	Descriptive analysis performed. DP scores improved at similar rates across 3 years of the programme. EE scores showed greater improvements (58% in 2018 vs 71% in 2020)
7	Letica-Kriegel *et al*, 2023	Although positive perception noted in qualitative analysis, no significant change in stress and burnout symptoms was identified	Paired *t*-test performed. No statistically significant difference found between pre- and post-survey burnout and stress scores
8	Luton *et al*, 2021	No improvement in burnout, depressive symptoms or anxiety post-ESRT	Mann-Whitney U tests performed. No statistically significant changes in aMBI were found between pre- and post-intervention groups (p=0.630)
9	Pandit *et al*, 2022	Reduced emotional exhaustion and risk of burnout post-intervention. Understanding of mindfulness increased but not understanding of burnout	Two-way paired *t*-tests conducted. Significant reduction in emotional exhaustion subscale of aMBI (p=0.04). No significant difference found for DP and PA scores
10	Shin *et al*, 2023	Gaining self-compassion knowledge significantly predicted positive changes in burnout, resilience, and stress	RMANOVA performed. Post hoc tests using Bonferroni correction compared pre- and post-test results. Results were statistically significant for burnout (p=0.008), resilience (p=0.018) and stress (p=0.002)
11	Zhang *et al*, 2017	Junior PGY trainees had higher baseline burnout scores. Burnout scores improved significantly across all PGY levels following FMP	ANOVA and chi-squared tests were performed. Participants had significantly reduced EE and DP and increased sense of PA (p<0.0001). Significant improvement in burnout scores identified across all PGY levels (p<0.05)

DP, depersonalisation; EE, emotional exhaustion; ESRT, Enhanced Stress Resilience Training; MBI, Maslach Burnout Inventory; PA, personal accomplishment; QOL, quality of life; SCHC, Self-Compassion for Healthcare Communities.

Course delivery varied between a self-directed mindfulness application to mandatory programme-driven initiatives. The 'Headspace' mobile app was used for 2 months, and surveys were completed during and following app use completion. The average usage was 8 minutes, 2 days a week. Despite the limited exposure, mindfulness training via the Headspace application resulted in reduced EE and DP scores (p=0.01). In comparison, there was no change in the control group from baseline to 2 months post-treatment.[41] The programme-driven initiatives were set up at each institution prior to commencing the studies and comprised various techniques, all following a similar structure. Sessions included dedicated meditation time, group discussion and mindfulness skill-building.[36,39,40,44] Sessions in three studies occurred on a weekly basis,[40,44,45] one study took place every 6 weeks,[39] while the other study did not specify.[36] Dedicated faculty wellness champions and wellness opportunities provided by training programmes produced lower burnout rates (p=0.02).[36]

Mentorship programmes

Both mentorship programmes significantly reduced EE and DP scores.[37,43] Mentorship and Assessment of Mentoring and Professionalism in training (MAP-IT) was conducted online via Zoom breakout rooms (Zoom Video Communication Inc. Computer software). MAP-IT mentors met mentees monthly, and the programme consisted of 60 minutes of reflection, reading and open discussion time focusing on humanistic mentoring skills. Following MAP-IT, no significant change in PA scores occurred, although significant improvement was observed in the EE MBI domain (p=0.038). Overall, 46.2% of participants reported a reduction in burnout scores post-MAP-IT (p=0.035).[37]

The other formal mentorship programme (FMP) did not specify whether the programme occurred online or in-person. FMP encouraged mentors to meet their mentee's tri-monthly, with supplemental mentors available on an ad-hoc basis. FMP mentors offered guidance on research, surgical, clinical and personal development. Mentorship outcomes were measured at baseline, 3, 6, 9 and 12 months following administration of the FMP. Average baseline MBI scores were initially high (EE: 47.6 and DP: 50.6), with low PA score of 16.5. At 12-month follow-up the scores significantly improved to EE: 14.9 ($p<0.0001$), DP: 20.1 ($p<0.0001$) and PA increased significantly to 42.5 ($p<0.0001$).[43]

ESRT

ESRT is a secular mindfulness training adapted from mindfulness-based stress reduction (MBSR). The ESRT course conducted in the included study consisted of 1-hour sessions delivered by a qualified ESRT instructor for 5 consecutive weeks.[42] Due to the COVID-19 pandemic, ESRT was conducted virtually, which differs from the original ESRT protocol. ESRT reduced overall burnout scores by 38.9%. ANOVA analysis on the effects of ESRT showed potential in reducing burnout rates compared with the control group (mean±SD 5.14±2.35 vs 3.14±2.25; $p=0.002$).[42]

SCHC

SCHC is a brief form of the mindful self-compassion (MSC) programme used in healthcare. Both SCHC programmes were led by qualified instructors once a week for 6 weeks and involved several concepts: understanding self-compassion and self-criticism, mindfulness exercises, and tackling stress and burnout.[38,45] Both SCHC studies reduced burnout scores post-training.[38,45] Descriptive analysis showed no improvement in DP scores after one of the SCHC programmes. However, EE did improve (2018: 58% vs 2020: 71% improvement).[38] Similarly, increased self-compassion post-SCHC training significantly predicted burnout reduction ($p=0.018$).[45]

Unionisation

One study focused on structural changes in the form of unionisation of surgical training programmes. No significant difference was identified between residents at unionised versus non-unionised programmes.[35]

Discussion

This scoping review identified 22 studies. Burnout was prevalent regardless of gender, but female trainees may be more at risk due to increased exposure to mistreatment at work. Conflicting evidence was found on the prevalence of burnout across training levels. However, surgical specialty and programme-specific characteristics contribute heavily. Interventions decreasing burnout included mindfulness courses, mentorship programmes, training programme unionisation, and stress, resilience and self-compassion training. Apart from unionisation, all mentioned interventions had some success in reducing burnout.

One mindfulness course elicited no significant difference between pre- and post-survey burnout scores. Perhaps the burnout questions asked were too broad to reflect changes in burnout caused by the process groups.[39] Despite showing no significant changes, participants who did not attend any mindfulness conference had higher rates of burnout. This suggests attending even one session may improve well-being and burnout. Lack of significance may be because the mindfulness skills were not exclusively taught to cope with burnout and stress outside of the conference setting.[44]

Conversely, residents with dedicated faculty wellness champions experienced less burnout (OR 0.116, 95% CI 0.022 to 0.604; $p=0.01$).[36] This study, however, had a low response rate introducing non-response bias. Results may have been overestimated as trainees experiencing burnout symptoms were more likely to respond.

Headspace application use reduced burnout among orthopaedic trainees. This was the only study with a control group enabling a confirmed association to be made. The baseline burnout prevalence (98.5%) in this study was higher than prevalence estimates from previous literature.[46] Higher prevalence may be recorded as residents experiencing burnout were more likely to participate. However, findings may be more representative of orthopaedic trainees as survey data were not accessible to the residency programme.[41]

In comparison, both mentorship programmes reduced burnout. Whilst both FMP and MAP-IT interventions improved burnout and well-being within a short period, the wider training programme environment still contributes to surgical trainee burnout. In the FMP study period, no other major changes were made to the training programme, suggesting the improvements in burnout are attributable to the FMP. Lack of control groups in both studies and participant susceptibility to response and selection bias, due to the cross-sectional study designs, means confounding variables cannot be discounted.

The ESRT study had several limitations. Due to the small sample size, non-response and selection bias remains and, because of the timing of the study, COVID-19 likely influenced the results as the ESRT course was adapted to work around the pandemic restrictions. Generalisability may not be possible due to financial limitations and training programme differences. However, this study was able to reproduce the effects of ESRT previously observed in the USA, implying ESRT is feasible in the UK and potentially across the globe.

Self-compassion training improved self-compassion among surgical trainees and was a predictor of lower burnout but, again, the results may not be generalisable due to small sample sizes and the absence of control groups. As follow-up surveys occurred shortly after post-training, there is a lack of long-term outcome evaluation therefore the results may be exaggerated, although evidence suggests that burnout reduction persists years following

self-compassion training.[47] In one of the studies, significant improvements in self-compassion were only measured in the self-kindness and mindfulness subscale. Therefore, we cannot confirm improvement in overall self-compassion leads to decreased burnout.[45] Despite limitations, the studies increased our insights into how online SCHC programmes reduce burnout and promote well-being in surgical trainees.

Although burnout was not affected, sexual harassment was reported less frequently at unionised programmes. Despite sexual harassment being a predictor of burnout, this correlation did not translate on multivariate analysis. This suggests the reduction in sexual harassment may be attributable to confounding variables not accounted for in this study.[35]

As this is a new research area, a substantial risk of bias exists with more work required to establish definitive interventions for training programmes. However, the included studies do show promising results. Further research would confirm the effects of these interventions, especially around mindfulness and mentoring at institutional levels. Further controlled trials, specifically involving interventions across multiple sites and incorporating other burnout predictors such as harassment, may help reduce burnout among vulnerable populations.

Limitations

Despite all the included studies using the MBI for burnout assessment, there is no uniform consensus of MBI scoring. Therefore the definition of 'high-risk' of burnout varied, as some studies required high scores across all three MBI domains whereas other studies only required high scores in EE and DP domains. This affected the comparability of the studies and introduced heterogeneity in the results of burnout prevalence. Most studies had limited participants and no comparative control group, making it impossible to confirm any identified associations. Non-response and selection bias was rampant across the included studies. Varying locations, differing programme structures and studies involving participants from only one training centre reduced the generalisability of the results.

This review did not consider other important variables associated with burnout such as work hours and environment or personal circumstances. Moreover, the COVID-19 pandemic[15,20,24,39,42] would have influenced the number of resources available, work hours and workload – all factors known to contribute to burnout.[48–50]

Furthermore, the majority of the included studies in this review originated in the USA. Training programmes vary greatly among different countries, especially compared with surgical training programmes in the UK. Surgical trainees in the UK would benefit greatly from introduction of interventions aimed at tackling burnout due to the high prevalence. Balendran *et al* noted that three out of every five surgical trainees in the UK demonstrated burnout, which is one of the highest reported prevalences.[6] Randomised controlled trials should be undertaken in UK surgical training programmes to emphasise the feasibility of these interventions across training programmes in this country.

KEY MESSAGES

- Experiencing negative behaviours in the workplace leads to increased burnout regardless of gender
- Female trainees are more likely to experience mistreatment at work in the forms of gender discrimination and sexual harassment.
- Burnout among different surgical training levels was dependent on how supported trainees felt by their institution and faculties. The more support trainees received, the less burnout was reported.
- Institution and faculty-led interventions to tackle burnout among surgical trainees shows promise, but randomised controlled trials are required to ascertain a true correlation.

The association of burnout prevalence with gender was the primary aim in only three studies. Similarly, only one study explored burnout rates among different training levels as a primary outcome. Most studies opted for convenient sampling and did not involve a control group, therefore confounding variables could not be eliminated. Hence, any associations found on burnout prevalence cannot be confirmed. Follow-up times of the implemented interventions were short, with only two studies conducting follow-up surveys at either 1 month post-intervention or 3 months post-intervention completion. All other studies conducted follow-up surveys on intervention completion only. Due to impact bias, the duration of improvement may be overestimated.

Conclusion

Surgical trainees are at risk of burnout, and it is a faculty responsibility to look after their trainee's well-being during training. This review highlighted that trainees of all genders and training level are unfortunately subject to harassment and increasing prevalence of burnout. Female trainees in particular face greater discrimination, sexual harassment and abuse compared with their male counterparts. More education at institutions on the relationship between negative behaviours and well-being is needed, alongside faculty-led wellness initiatives to reduce burnout. Junior trainees may be at risk of higher burnout due to work hours and poor mentorship, which can be easily remediated through mentorship programmes.

Further research through randomised controlled trials is required to find conclusive associations between both contributing factors on the prevalence of burnout and the effectiveness of the proposed interventions highlighted in this review. A cultural shift towards educating trainees and faculty members on burnout and encouraging peer support can aid the reduction in burnout in surgical trainees.

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ORIGINAL RESEARCH

Cardiovascular morbidity, mortality and risk management in patients with abdominal aortic aneurysms

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Plain English Summary

Why we undertook the work: Abdominal aortic aneurysm (AAA) is a condition in which the main blood vessel in the abdomen dilates. Most people who develop an AAA do not die of the aneurysm but from other vascular complications such as heart attacks and strokes (major adverse cardiovascular event (MACE)). To help reduce this risk, guidelines suggest that patients are prescribed medications to lower cholesterol levels (lipid-lowering therapy) and to prevent blood clots from forming (antiplatelets). This review aims to measure how likely patients with an AAA are to experience or die from a MACE.

What we did: A review was carried out to consolidate studies that had previously looked at the chances of people with an AAA developing or dying from a MACE. Details about the patient, their health conditions and the medications they were receiving were gathered.

What we found: Out of the total group of 78,500 patients studied, 14.5% of people died from a cardiovascular event over a 5-year period. Only approximately 60% of patients were prescribed lipid-lowering therapy and antiplatelet therapy. On average, each year, 5.43% of the group was at risk of dying from a cardiovascular event.

What this means: This review shows that many patients with AAA are not getting the best possible treatments. There is still a high rate of MACE-related health problems and deaths in these patients. People diagnosed with an AAA usually have just one appointment with a vascular surgeon specifically for this condition. After that, we suggest that their regular primary care doctor handles ongoing cardiovascular-related check-ups and treatment as part of their regular care. More focus should be placed on improving the use of lipid-lowering therapy and antiplatelet therapy within primary care to help improve their outcomes.

Abstract

Introduction: Cardiovascular events are the most common cause of mortality in patients with an abdominal aortic aneurysm (AAA) regardless of intervention to treat the aneurysm. This systematic review aims to quantify the risk of cardiovascular morbidity and mortality in all patients with AAA before and after repair.

Methods: The review was conducted in line with the framework of Cochrane reviews and Standard Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Electronic databases were searched for studies that published cardiovascular mortality and/or morbidity rates of people diagnosed with an AAA. Studies only discussing AAA-related deaths or papers looking at aneurysms caused by connective tissue disorders, thoracic aortic aneurysms or ectatic abdominal aortas were excluded. Data on patient demographics, prevalence of comorbidities and medical therapy were extracted where possible.

Results: 17 studies with 78,500 patients were included. The weighted mean prevalence of antiplatelet therapy and lipid-lowering therapy prescriptions was 62.8% and 60.2%, respectively. Pooled mortality rates secondary to myocardial infarction were 5.7% at 5 years with a 2.87% risk of death per year and 11.4% at 10 years with a 1.48% risk of death per year. The pooled mortality rate secondary to an acute cerebrovascular event was 1.9% at 5 years with a 0.38% risk of death per year. The pooled overall cardiovascular mortality rate was 14.5% at 5 years with a 5.43% risk of death per year.

Conclusions: This review demonstrates suboptimal prescription of best medical therapy alongside a significant incidence of cardiovascular morbidity and mortality in patients with AAAs. Greater emphasis should be placed on optimisation of antiplatelet therapy and lipid-lowering therapy in primary care and vascular surgery services with the aim of improving cardiovascular-related outcomes for this patient cohort.

Key words: aortic aneurysm, major adverse cardiovascular events, platelet aggregation inhibitors, hydroxymethylglutaryl-CoA reductase inhibitors

Introduction

An abdominal aortic aneurysm (AAA) is a focal dilation of the abdominal aorta with a diameter of 3.0 cm or more. Within the UK the national screening programme has shown an AAA prevalence in men aged >65 years of 1.57%, similar to that in the USA.[1]

The implementation of screening programmes for AAAs across the UK and other countries has resulted in an approximately 50% reduction in aneurysm-related mortality.[2] However, it is recognised that the previously documented historical rupture rates may be higher than those observed in practice today. For example, data from the UK NAAASP suggest rupture rates of around 0.4% per annum for a large 5.0–5.5 cm AAA and around 0.03% per annum for a small aneurysm of 3 cm.[3] Rupture is therefore unlikely to be the primary cause of death in this cohort of patients.

The Multicentre Aneurysm Screening Study (MASS) trial demonstrated that cardiovascular events are the most common cause of mortality in men with AAA, regardless of intervention to treat the aneurysm.[4,5] The European Society for Vascular Society (ESVS) 2019 and 2024 AAA guidelines therefore recommend consideration of antiplatelet therapy, lipid-lowering therapy and antihypertensives in all AAA patients to reduce the incidence of major adverse cardiovascular events (MACEs; defined as incidence of non-fatal acute myocardial infarction, non-fatal stroke and cardiovascular death).[6,7] Yet such practice is still not commonplace.

Existing work studying the association between AAA and cardiovascular risk has been mainly focused on small aneurysms. Data from the UK Small Aneurysm Trial suggested that, for every 8 mm increase in aneurysm diameter, the relative risk of cardiovascular death increased by 1.34.[8] In addition, Bath *et al* concluded that patients with a small AAA have an annual risk of cardiovascular death of 3.0% (95% CI 1.7% to 4.3%), a similar risk to those patients who have already experienced a MACE.[2,9]

The aim of this systematic review is to quantify the risk of cardiovascular morbidity and mortality in all patients with AAA before and after repair, consolidating the evidence regarding the use and degree of medical management of cardiovascular risk in this patient cohort.

Methods

This review was registered on Prospero, carried out within the framework of Cochrane reviews and reported in line with the Standard Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A literature search of Cochrane, Medline and Embase databases was performed through OVID with no limitations on date of publication or by language. The search strategy used (((abdominal aortic aneurysm* or AAA) and (heart failure or acute coronary syndrome or myocardial infarct* or heart attack or angina or coronary disease or myocardial ischaemia or ischaemic attack or stroke or brain infarct* or cerebral infarct* or cerebrovascular or mortalit* or cardiovascular or cardiovascular disease*)).ti.) was adapted from that of a previous systematic review analysing cardiovascular disease and death in patients with small AAAs.[1] An additional retrocursive search was conducted through the bibliographies of included studies and the reference lists of relevant systematic reviews.

Type of studies

This review included all prospective observational studies and randomised controlled trials published as full papers reporting cardiovascular mortality and/or morbidity rates of people diagnosed with an abdominal aortic aneurysm. Patients undergoing all forms of treatment (surveillance, endovascular aneurysm repair/open repair for elective/ruptured aneurysms) including those deemed unfit for treatment were all included. We specified a minimum study number of 50 participants and a minimum of 1-year follow-up for mortality, with no upper limit of follow-up.

Studies not published in English and those that only discussed AAA-related deaths secondary to AAA rupture were excluded. Papers evaluating the outcomes of a non-operative intervention on AAA patients (eg, looking at the effect of red blood cell transfusion in AAA patients) were also excluded. Papers looking at AAA patients aged <45 years were excluded to account for patients with connective tissue diseases, which have a different aetiology from degenerative AAA. Papers looking at thoracic aortic aneurysms or patients with ectatic abdominal aortas (defined as a maximal diameter of 2.5–2.9 cm) were also excluded.

Type of outcome measures

The primary objective of this review was to quantify the risk of cardiovascular morbidity and mortality in patients with an AAA. Outcomes were guided by the traditional three-point MACE outcome, defined as the incidence of non-fatal acute myocardial infarction, non-fatal stroke and cardiovascular death.[10] Therefore, cardiovascular morbidity was defined as the incidence of a new non-fatal MACE following diagnosis of AAA, and cardiovascular death/mortality was defined as any non-aneurysm rupture-related death caused by a MACE. Mortality was stratified by follow-up intervals of 1, 5 and 10 years. Cardiovascular mortality occurring <30 days after an invasive treatment was considered post-procedural and therefore excluded. The secondary objective of this review was to quantify the prevalence of optimal medical therapy, defined as antiplatelet therapy and lipid-lowering therapy.

In addition to the outcome described above, data on patient demographics, prevalence of comorbidities (diabetes, hypertension, chronic kidney disease, peripheral arterial disease, ischaemic heart disease, previous cerebrovascular incident) and treatment strategy (medical treatment, endovascular repair, open repair) were collected.

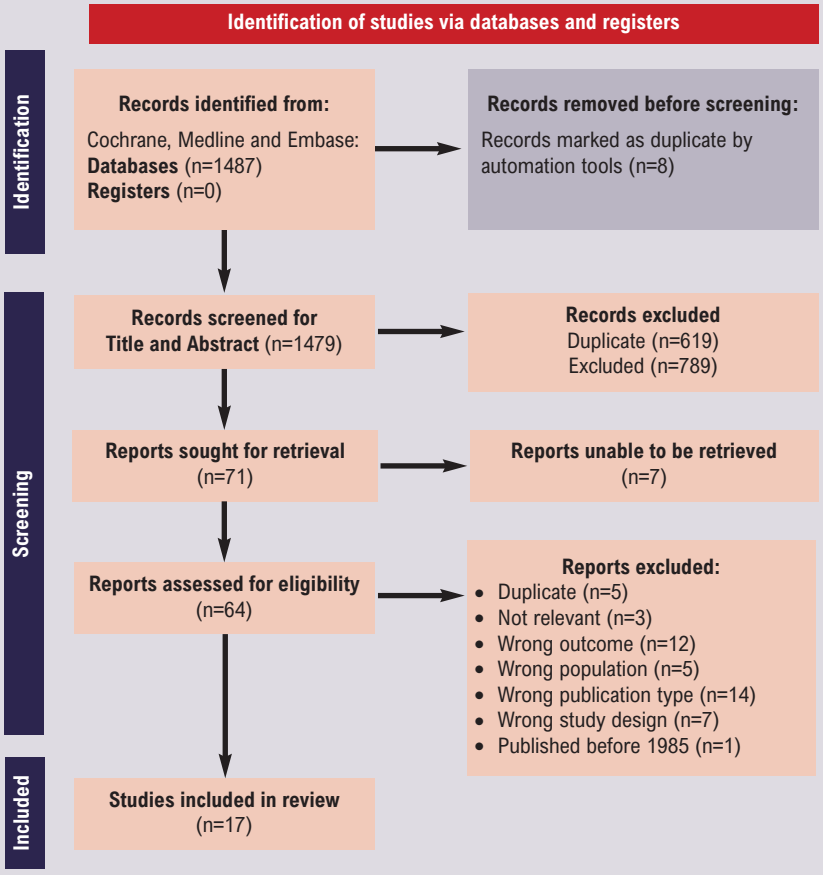
Assessment of risk of bias

Two authors independently assessed the quality and validity of the included papers using the Critical Appraisal Skill Programme (CASP) checklist for cohort studies and randomised controlled trials.

Statistical analysis

MetaXL version 5.3. statistical software was used to assess study heterogeneity and to calculate the rates of each outcome using a meta-analysis of proportions. Owing to significant heterogeneity, a random-effects model with double arcsine transformation was used. Survival function: $F(t;\lambda)=1-e^{-\lambda t}$ was used to approximate the risk of death per year assuming a constant hazard of death. A subsequent sensitivity analysis was conducted, excluding studies with a publication rate prior to 1 January 2000, so that only studies that reflect contemporary cardiopreventive medications and guidelines were included.

Figure 1 PRISMA flow diagram showing inclusion and exclusion of studies.



Results

Study and baseline characteristics

The literature search identified 1487 potential articles which was refined to 17 studies following assessment.[9,11–26] The PRISMA flow diagram is illustrated in Figure 1. Qualitative assessment of these papers suggested that the overall quality of the available evidence was low. Notably, there was significant variability in definitions of outcomes and length of follow-up within the series.

Of the 17 studies, four were randomised controlled trials and 13 were cohort studies. Publication dates ranged from 1989 to 2023. Study size ranged from 98 to 67,770 patients and mean follow-up was 56 months. A total of 78,500 patients were included, of which 97.5% (n=76,545) were men, and the mean age was 71.7 years. Characteristics of the included studies and participants are shown in Table 1.

Prevalence of cardiovascular comorbidities

Overall, 15 studies reported the prevalence of diabetes, hypertension, chronic kidney disease, peripheral arterial disease, ischaemic heart disease and previous cerebrovascular events in the baseline characteristics of the study (Table 2).

A total of 13 papers consisting of 9,757 patients showed a weighted mean prevalence of 16.0% for diabetes mellitus; 15 papers consisting of 10,326 patients showed a weighted mean prevalence of 57.9% for hypertension; four papers consisting of 3,723 patients showed a weighted mean prevalence of 19.5% for chronic kidney disease; five papers consisting of 4,037 patients showed a weighted mean prevalence of 35.2% for peripheral arterial disease; five papers consisting of 1,251 patients showed a weighted mean prevalence of 27.2% for ischaemic heart disease; and eight papers consisting of 4,877 patients showed a weighted mean prevalence of 17.4% for previous cerebrovascular event.

Prevalence of optimal medical therapy

The prevalence of antiplatelet therapy and lipid-lowering therapy was assessed in 10 papers (Table 2). Eight papers consisting of 8,233 patients showed a weighted mean prevalence of 62.8% (27.4–90.8%) for patients prescribed antiplatelet therapy and nine papers consisting of 7,750 patients showed a weighted mean prevalence of 60.2% (35.1–77.3%) for patients prescribed lipid-lowering therapy. None of the papers reported the prevalence of concurrent use of antiplatelet therapy and lipid-lowering therapy. Two papers consisting of 4,757 patients showed a weighted mean prevalence of 84.6% for patients prescribed antihypertensive therapy. Four other papers reported the use of agents such as beta blockers and diuretics. However, it was not specified whether these agents were initiated for hypertension or cardiac indications so they have not been included in the analysis.

Cardiovascular morbidity

Three studies reported the incidence of non-fatal acute myocardial infarction at 1 year. The smallest study reported a prevalence of 6.3% amongst the 526 patients included, whilst the largest study

Table 1 Characteristics of included studies and participants

Reference	Country	Study type	Median follow-up (months)	N	Male gender (N)	Mean age (years)	AAA diameter (cm), mean (SD)
Nicolajsen, 2023	Germany	Cohort	12	3035	2360	78	NR
Inoue, 2013	Japan	Cohort	30.4	285	229	NR	NR
Bryce, 2013	UK	Cohort	36	106	88	73	NR
Saratzis, 2013	UK	Cohort	34	383	351	69	6.2 (4)
Saratzis, 2012	UK	Cohort	17	224	212	69.73	6.07 (1.22)
Thompson, 2009	UK	RCT	120	67,770	67,770	69.2	NR
UK SAPT, 1998	UK	RCT	55.2	1090	902	69	NR
Roger, 1989	USA	Cohort	NR	131	104	NR	NR
Bath, 2016	UK	Cohort	30	526	515	72.1	3.85
Brown, 2011	UK	RCT	60	1252	1135	74.1	6.5 (0.9)
Forsdahl, 2010	UK	Cohort	120	345	272	66.1	NR
Vega de Ceniga, 2010	USA	Cohort	78.7	297	292	67	6.33 (1.79)
Brown, 2010	UK	RCT	81.6	404	347	77	6.7 (1)
Freiberg, 2008	USA	Cohort	120	416	252	75.4	NR
Baumgartner, 2008	USA	Cohort	12	1722	1389	68	NR
Newman, 2001	USA	Cohort	54	416	252	75	NR
Parr, 2011	USA	Cohort	36	98	75	73	NR

AAA, abdominal aortic aneurysm; N, number of participants; NR, not reported; RCT, randomised controlled trial.

Table 2 Prevalence of comorbidities and cardioprotective medications (% rounded up to nearest whole number)

Reference	DM n (%)	HTN n (%)	CKD n (%)	PAD n (%)	IHD n (%)	CVD n (%)	APT n (%)	LLT (n (%)
Nicolajsen, 2023	495 (16)	1780 (59)	527 (17)	1168 (39)	NR	545 (18)	2065 (68)	1914 (63)
Inoue, 2013	54 (19)	201 (71)	142 (50)	NR	NR	28 (10)	NR	NR
Bryce, 2013	9 (8)	72 (67)	8 (8)	NR	25 (24)	22 (21)	63 (59)	66 (62)
Saratzis, 2013	72 (19)	286 (75)	NR	71 (19)	NR	28 (7)	NR	222 (58)
Saratzis, 2012	NR	185 (81)	NR	55 (25)	53 (24)	14 (6)	NR	144 (64)
Thompson, 2009	NR	NR	NR	NR	NR	NR	NR	NR
UK SAPT, 1998	30 (3)	419 (38)	NR	NR	NR	NR	299 (27)	NR
Roger, 1989	10 (8)	62 (47)	NR	NR	NR	10 (8)	NR	NR
Bath, 2016	92 (17)	338 (64)	NR	NR	131 (25)	NR	224 (43)	316 (60)
Brown, 2011	129 (10)	1762 (27)	NR	NR	NR	NR	663 (53)	440 (35)
Forsdahl, 2010	NR	200 (58)	NR	NR	NR	NR	NR	NR
Vega de Ceniga, 2010	37 (13)	167 (56)	48 (16)	96 (32)	72	26 (9)	NR	NR
Brown, 2010	NR	NR	NR	NR	NR	NR	230 (57)	170 (42)
Freiberg, 2008	65 (16)	241 (58)	NR	NR	NR	174 (42)	NR	NR
Baumgartner, 2008	507 (29)	1437 (83)	NR	NR	NR	NR	1563 (91)	1330 (77)
Newman, 2001	43 (10)	188 (45)	NR	NR	NR	NR	NR	NR
Parr, 2011	20 (20)	75 (77)	NR	29 (30)	59 (60)	NR	62 (63)	65 (66)

APT, antiplatelet therapy; CKD, chronic kidney disease; CVD, cerebrovascular disease; DM, diabetes mellitus; HTN, hypertension; IHD, ischaemic heart disease; LLT, lipid-lowering therapy; NR, not reported; PAD, peripheral arterial disease.

containing 3,035 patients showed an incidence of 4.4%. The weighted event rate was 3.6% for a total of 5,283 patients. Two studies reported the incidence of non-fatal acute myocardial infarction at 5 years, demonstrating a weighted event rate of 4.1% for a total of 1,656 patients.

Two studies reported the incidence of non-fatal acute cerebrovascular event at 1 year. The weighted event rate was 3.7% for a total of 4,757 patients. Two studies reported the incidence of

Figure 2 Five-year and 10-year pooled mortality rates secondary to myocardial infarct.

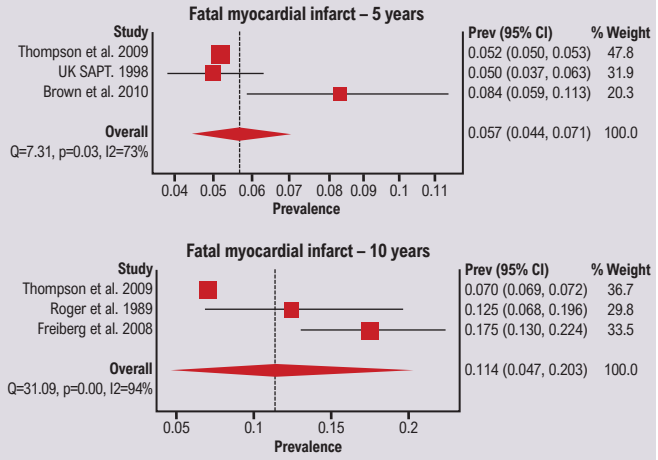


Figure 3 Five-year pooled mortality rate secondary to acute cerebrovascular event.

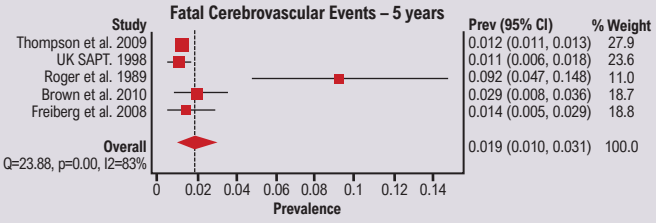


Figure 4 Five-year pooled mortality rate secondary to undefined cardiovascular mortality.

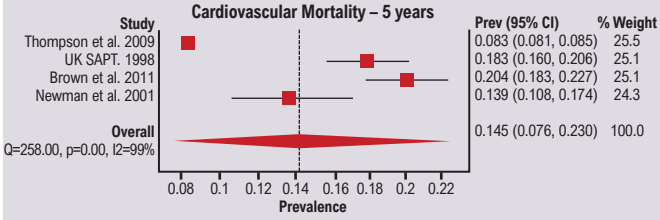
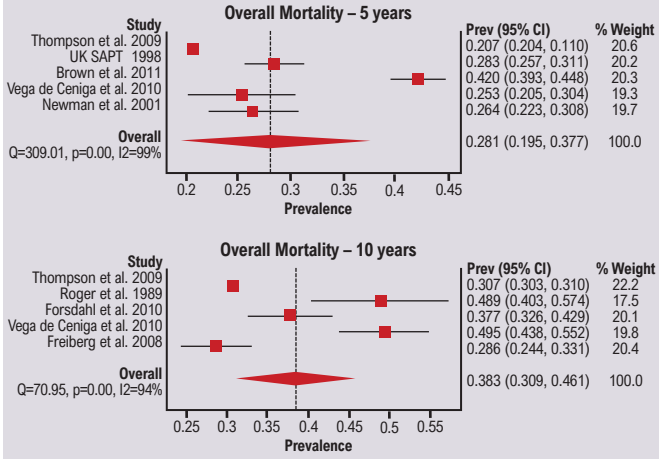


Figure 5 Five-year and 10-year pooled overall mortality rates.



non-fatal acute cerebrovascular event at 5 years, demonstrating a weighted event rate of 4.3% for a total of 1,656 patients.

Cardiovascular mortality

Three papers reported rates of cardiovascular mortality secondary to acute myocardial infarction at 5 years and three papers at 10 years. Pooled mortality rates secondary to myocardial infarction were 5.7% (4.4–7.1%) at 5 years with a 2.87% risk of death per year and 11.4% (4.7–20.3%) at 10 years with a 1.48% risk of death per year (Figure 2).

Five papers reported rates of 5-year cardiovascular mortality secondary to an acute cerebrovascular event; the pooled mortality rate was 1.9% (1.0–3.1%) at 5 years with a 0.38% risk of death per year (Figure 3).

Four papers reported rates of total undefined cardiovascular mortality at 5 years; the pooled mortality rate was 14.5% (7.6–23.0%) with a 5.43% risk of death per year (Figure 4).

All-cause mortality

Five papers reported overall mortality rates at 5 years and five papers at 10 years. The pooled overall mortality rate was 28.1% (19.5–37.7%) at 5 years with a 7.05% risk of death per year and 38.3% (30.9–46.1%) at 10 years with a 4.86% risk of death per year (Figure 5).

Sensitivity analysis

To strengthen the robustness of our findings, we performed a sensitivity analysis focusing exclusively on studies that reflect contemporary cardiopreventive medications and guidelines (ie, studies published before the year 2000 were excluded). Overall 5-year rates of cardiovascular mortality, cardiovascular mortality specifically from acute myocardial infarction and cardiovascular mortality specifically from stroke were 13.3% (5.5–23.4%), 6.3% (3.5–9.9%) and 1.3% (1.0–1.6%), respectively, which were similar to the primary analysis results of 14.5%, 5.7% and 1.9%.

Discussion

Using 5-year mortality rates, this review suggests the estimated per-year incidence of overall cardiovascular death, cardiovascular death specifically from acute myocardial infarction and cardiovascular death specifically from stroke are 5.43%, 2.87% and 0.38%, respectively. The mean incidence of cardiovascular mortality in the general global population is estimated to be 0.2% per year, which suggests that a patient diagnosed with an AAA will experience an approximately 27 times greater risk of cardiovascular death compared with the general population.[27] The high rates of cardiovascular-related mortality demonstrated in this review are in keeping with previous studies looking at AAA subgroups. Bath et al (2015) quoted a 3% risk per year of

cardiovascular death in patients with a small AAA,[2] while Sharma *et al* (2023) quoted a 2.31% incidence of cardiovascular death in patients with an unrepaired AAA.[28]

Increasing awareness of the substantial cardiovascular risk faced by patients with an AAA is reflected in the latest published ESVS 2024 guidelines, which has stated as a Class I recommendation that "all patients with abdominal aortic aneurysm should receive cardiovascular risk factor management with smoking cessation, blood pressure control, statin and antiplatelet therapy and lifestyle advice". Our review demonstrated weighted mean prevalence rates of 60.2% for lipid-lowering therapy, which is lower than a UK-based study showing statin prescription rates of 81% for patients with cerebrovascular disease and 75% for peripheral arterial disease.[29] These numbers suggest that there is room to improve the uptake of long-term cardioprotective medical therapy.

Research and funding should be directed towards interventions targeted at promoting lifestyle changes and optimising prescription rates of risk factor-lowering medications within this patient cohort.[30] Primary care and vascular surgery services are suitable settings to achieve this. However, patients diagnosed with AAA are typically seen by a vascular surgeon for a single consultative visit regarding this condition. Consequently, whilst specific cardiopreventive medications can be initiated in secondary/tertiary care, the majority of ongoing cardiovascular risk management should be conducted within primary care, where continuous monitoring and management of comorbidities can be effectively integrated into routine care. Factors such as time constraints, lack of appropriately trained staff and level of clinician education and confidence serve as barriers.[31] One effective approach was reported by Smits *et al* in 2023 in the Netherlands.[32] This involved a dedicated practice nurse protocol and annual clinician education meetings as part of an integrated cardiovascular risk management program.

The main limitation of this study is the significant variation in population and defined outcomes between included papers; considerable heterogeneity was reflected in the calculated χ^2 score. A wide range of definitions was used for cardiovascular mortality and the cardiovascular diseases identified, yet the results still reflect adverse cardiovascular events. Other factors contributing to heterogeneity included variations in follow-up timepoints and follow-up length, and different prevalences of cardiovascular risk factors. Given the heterogeneous nature of the populations, exact treatment strategies (conservative, endovascular repair, open surgical repair) and numbers of patients deemed unfit for intervention were difficult to determine. The small number of studies identified meant that it was not feasible to perform a sensitivity analysis or subgroup analysis due to the likelihood of generating false positive and false negative results.

The papers included in this study span from 1989 to 2023. Roger *et al* (1989) reported the highest rate of fatal cerebrovascular events and it is also the oldest paper included in this study.[18] There has been a decline in stroke rates over time accompanied by improvements in pharmacotherapy for cardiovascular risk reduction.[33] Therefore, the older papers in this study may not accurately reflect current event rates. However, consistency between the results of primary analysis and the results of sensitivity analysis strengthen the conclusions and credibility of the findings.

It is notable that women were poorly represented in the included papers. The risk factors, indications for treatment and outcomes following repair of AAAs in women is less well understood than in men.[34] Ninety-seven percent of the patients in this study were men, which limits the generalisability of the findings to women with AAAs.

KEY MESSAGES

- Using 5-year mortality rates, this review suggests the estimated per-year incidence of overall cardiovascular death is 5.43%, an approximately 27 times greater risk of cardiovascular death compared with the general population.
- 62.8% of patients were prescribed antiplatelet therapy and 60.2% of patients were prescribed lipid-lowering therapy, demonstrating suboptimal prescription of best medical therapy.
- Greater emphasis should be placed on optimisation of antiplatelet therapy and lipid-lowering therapy in this patient cohort with the aim of improving cardiovascular-related outcomes.

Conclusion

This review demonstrates a significant incidence of comorbidities and eventual MACE in patients with AAAs of all sizes, alongside suboptimal prescription of best medical therapy. Greater emphasis should be placed on optimisation of antiplatelet therapy and lipid-lowering therapy in this patient cohort with the aim of improving cardiovascular-related outcomes. Vascular surgery services provide opportunities to initiate cardiopreventive medical therapy and primary care services as a platform for ongoing cardiovascular risk management, where continuous monitoring and management of comorbidities can be effectively integrated into routine care.

Conflict of Interest: The authors declare that there are no conflicts of interest.

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ORIGINAL RESEARCH

Standards of radiation protection amongst UK vascular surgeons: a clinician's perspective

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Plain English Summary

Why we undertook the work: With increasing numbers of procedures in vascular surgery being performed by 'keyhole' techniques which require the use of ionising radiation (x-rays), vascular surgeons are being exposed to more radiation throughout their careers compared with 30 years ago. Excessive exposure to radiation can cause cancer and is related to other health problems such as cataracts and skin conditions. This survey looks at the awareness amongst vascular surgeons regarding radiation protection measures, the availability of personal equipment which would help minimise their radiation exposure and whether their employer effectively measures their exposure to radiation, as required by law.

What we did: To address the above questions, we conducted a survey of trainees in vascular surgery and consultant vascular surgeons in the UK. The survey contained 37 questions and was sent out online over a 6-week period, with the responses collected using the survey server SurveyMonkey and analysed.

What we found: This survey highlights a concerning lack of knowledge regarding radiation protection amongst the vascular surgical workforce, poor access to personal radiation protection and failures in monitoring an individual's exposure to ionising radiation.

What this means: The survey supports the urgent need to address training in radiation protection, improve access to personal equipment such as lead gowns and lead glasses, and for employers to better monitor an individual's exposure to radiation. This is necessary to protect the workforce against the potentially life-threatening effects of radiation.

Abstract

Objective: To evaluate training in radiation protection, knowledge of local policies and current practices regarding safe working with ionising radiation in vascular surgery units across the UK.

Methods: A validated 37 question online survey was distributed to vascular surgery trainees (VTs) and consultants (VCs) by the Vascular Society of Great Britain and Ireland (VSGBI), British Society of Endovascular Therapy (BSET) and Rouleaux Club through their national mailing lists between March and May 2024. Responses were collated using the survey server SurveyMonkey. Results were summarised using descriptive statistics and appropriate tests.

Results: Ninety-one VCs and 87 VTs, representing approximately 15% and 44% of the UK VC and VT workforce, respectively, responded. In total, 94% of VCs and 97% of VTs expressed concerns over the effects of ionising radiation on their health; 91% of VCs and only 74% of VTs had undergone formal radiation safety training. Of these, only 18% of VCs and 43% of VTs had undergone training within the last two years. Overall, 34% of VCs and most VTs (75%) did not know who their local radiation safety officer was; 4% of VCs and 32% of VTs ($p<0.001$) were completely unaware of local radiation safety policies. A total of 13% of both were not aware of 'As Low As Reasonably Achievable' (ALARA) principles, with 20% of VCs and 35% of VTs failing to consistently employ them. Custom-made or retrofitted lead gowns were accessible to 55% of VCs but only 2.4% of VTs ($p<0.001$). Radiation protection glasses were worn by 52% of VCs compared with 16% of VTs ($p<0.001$). 84% of VCs were allocated a dosimeter versus only 44% of VTs ($p<0.001$). Most VCs (76%) and VTs (86%) believed that their employer should prospectively record their annual radiation exposure into a National Registry. A total of 86% of VCs and 96% of VTs agreed that employers should record their cumulative radiation exposure

during their entire working life. One in four VCs and VTs experienced a health condition potentially related to their work with ionising radiation. Musculoskeletal pain was the most common, prevalent in 17% and 18% of VCs and VTs, respectively. Overall, 2% of VCs had a malignancy and 5% cataracts. Almost all VCs (94%) and VTs (96%) agreed that these illnesses should be recorded in a national registry.

Conclusion: This survey highlights significant and concerning deficiencies in knowledge, access to personal radiation protection and failures in monitoring individual exposure to ionising radiation amongst the UK vascular surgical workforce.

Key words: radiation protection, ALARA, ionising radiation

Background

The rapid evolution of endovascular technologies over the past 30 years has driven an exponential rise in the number of x-ray guided minimally invasive procedures undertaken by clinicians, including vascular surgeons, interventional radiologists, angiologists and cardiologists. In the UK approximately 60% of all aortic cases are performed endovascularly[1] compared with just 1% in 2001; and from 2000–2005 to 2015–2019 there was a 46% rise in peripheral endovascular procedures performed in the NHS.[2] As a result, clinicians are exposed to ionising radiation earlier in their training and far more frequently throughout their careers. Occupational exposure to ionising radiation is associated with an increased risk of malignancy, predominantly left-sided brain tumours,[3] breast cancer,[4] skin cancers, leukaemia[5] and thyroid cancer.[6,7] Regular exposure has also been linked to an increased risk of benign conditions such as cataracts,[8] musculoskeletal pain due to ill-fitting lead gowns, dermatitis and hair loss.[9]

Personal protective equipment (PPE), which includes well-fitted lead gowns with axillary shields, eye protection, thyroid and leg shields, can greatly reduce the radiation exposure to operators. Monitoring radiation doses and maintaining accurate records will ensure that annual recommended levels of exposure to ionising radiation are not exceeded. Additionally, access to a modern hybrid operating theatre and adherence to 'As Low as Reasonably Achievable' (ALARA) principles further reduces the radiation exposure to operators.

This survey aimed to evaluate training in radiation protection and knowledge of local policies. It also seeks to review current practices regarding safe working with ionising radiation and understand concerns regarding ionising radiation-linked health conditions amongst the UK vascular surgical workforce.

Methods

This online cross-sectional survey was aimed at vascular surgeons in the UK. The questionnaire was designed by a group of consultant vascular surgeons with input from interventional radiology and orthopaedic surgery colleagues. The questionnaire was pre-tested and validated for content and construct by three vascular surgeons, one interventional radiologist and three orthopaedic surgeons (see Appendix 1, online at www.jvsgbi.com, for the complete survey).

The survey was divided into eight parts – namely, specialty, ionising procedures performed, demographic data, beliefs and values, training in radiation protection, strategies employed to reduce ionising radiation exposure, access to personal protection and injuries potentially associated with working with ionising radiation – comprising 37 questions. There was a mixture of open and closed questions and all closed questions were mandatory. All responses were anonymised.

There are an estimated 600 consultant vascular surgeons and 200 trainees in vascular surgery in the UK. Invitations to complete the survey were sent via email by the Vascular Society of Great Britain and Ireland (VSGBI), British Society of Endovascular Therapy (BSET) and the Rouleaux Club through their national mailing lists.

The survey was administered, and the responses collated by the survey server SurveyMonkey over a 6-week period from March 2024 to May 2024. There were no set exclusion criteria, but only the responses of trainees, fellows and consultants working in vascular surgery were considered for analysis. The results were fully anonymised and analysed using Stata 18.0 and Pearson's χ^2 test was used to evaluate differences in categorical data between groups.

Results

Demographics

The survey was completed by 91 vascular consultants and 87 vascular surgery trainees, representing approximately 15% and 44% of the UK consultant and trainee workforce, respectively. Of all consultant respondents, 82% reported biological sex, the majority (83%) identified as male. Whilst fewer trainees reported biological sex (60%), a greater proportion of those who responded were female (42%) ($p<0.05$).

Procedures performed

Endovascular aneurysm repair was the most performed procedure by consultant (99%) and trainee (100%) vascular surgeons. Trainees were more likely to be involved in complex aortic cases than consultants: thoracic endovascular aneurysm repair (68% versus 62%), fenestrated endovascular aneurysm repair (72% versus 55%) and branched endovascular aneurysm repair (53% versus 39%).

Most consultants performed iliac (87%) and lower limb

endovascular revascularisation (82%) procedures. A greater proportion of trainees undertook iliac (94%) and lower limb (97%) angioplasty; more trainees (31%) were involved in deep venous interventions compared with consultants (19%).

Attitudes towards risk and training

Most consultants (94%) expressed concern over the effects of ionising radiation on their health, with 63% either very concerned or extremely concerned. The majority (91%) had undergone formal radiation safety training in the form of a face-to face (72%) or e-learning (66%) course. However, more than a third (35%) had received their training over five years ago and 9% had undergone training over 10 years ago. Only 18% had undergone training within the last two years.

Almost all trainees (97%) expressed concern about the effects of ionising radiation on their health; 67% were either very concerned or extremely concerned. However, only 74% of trainees had undergone formal radiation safety training and, of these, only 43% had undergone training within the last two years. Most training was in the form of an e-learning course (87%).

Awareness of local policies

Questions regarding awareness of local radiation policy were answered by 99% and 97% of consultants and trainees, respectively. Just over a third (34%) of consultants did not know who their local radiation safety officer was and half (50%) had never met them. Most trainees (75%) did not know who their local radiation safety officer was and the same number had never met them. Trainees (32%) were far more likely to be completely unaware of their local radiation safety policy compared with consultants (4%) ($p<0.001$). Moreover, 56% of consultant respondents and 83% of trainee respondents were either not aware or only somewhat aware of local policy regarding working with radiation during pregnancy.

Methods to reduce radiation exposure

Of those who answered (97%), 88% of consultant respondents were aware of ALARA principles. The majority (80%) either always or almost always employed ALARA strategies to minimise radiation exposure during endovascular cases. The most common practice employed by consultant operators to reduce exposure was shielding (91%) and keeping detectors close to the patient (90%). Minimising the use of digital subtraction angiography (DSA) (81%), reducing the frame rate of DSA acquisition (70%) and increasing the distance between the operator and C-arm during DSA (88%) were also frequently employed practices. Other strategies included awareness of C-arm angulation (83%) and, to a lesser extent, minimising the use of magnification (69%). Single use radiation protection shields (RADPAD®) were routinely employed by only 32% of consultant operators.

Of those trainees who responded (93%), 87% were aware of ALARA principles and 65% either always or almost always implemented them. Shielding (78%) and keeping the detector close to the patient (75%) remained the most frequently used strategy to reduce exposure but was overall less frequently used amongst trainee operators than consultant operators. Minimising the use of DSA (73%) and stepping away during DSA acquisition (79%) were also common; however, reducing the use of magnification (41%) and reducing the frame rate of DSA acquisition (54%) were less common.

Personal protective equipment (PPE)

Lead gowns

Custom-made or retrofitted lead gowns appropriate for build and gender were accessed by just over half (55%) of consultant respondents. Trainees were significantly less likely to have access to custom-made or retrofitted lead aprons (2.4%) ($p<0.001$) than consultants and only 3.8% of trainees versus 15% of consultants ($p<0.05$) had been measured or advised which lead gown available from the rack they should wear.

Over half (58%) of consultant respondents reported that their personal or departmental lead gowns were inspected annually for cracks. However, over a third (36%) were unsure. Only 10% of trainees reported that that their personal or departmental lead gowns were inspected annually; the vast majority (83%) were unsure.

Thyroid collars, eye protection, leg shields and lead caps

Thyroid collars were used by the majority of consultants (93%) and trainees (95%). However, radiation protection glasses were used less frequently (52%) by consultant operators. Of those who did not always wear radiation protection glasses, 41% reported not being provided with them. The use of radiation protection glasses was significantly less (16%) ($p<0.001$) amongst trainees. For those who did not wear protective glasses at all times, 39% did not have access to them.

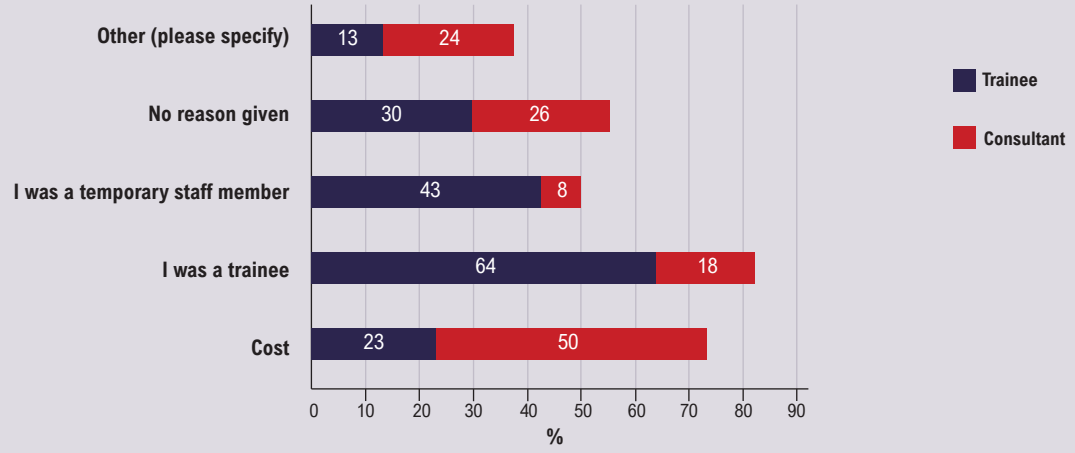
Questions on the use of leg shields and lead caps were answered by 93% of consultants and 92% of trainees. Leg shields were used by only a small number of consultants (18%) and trainees (13%). Of the remaining consultants and trainees, 41% and 63%, respectively, had not been provided with them. Similarly, only a small number of consultants used a lead cap (4.7%); of those who did not, 36% had not been provided with them. Only one trainee reported using a lead cap, 50% of the time; 65% of all trainees reported not being provided with them.

Difficulties in accessing PPE

Trainees (38%) were more likely to be denied access to eye protection than consultants (32%). Moreover, trainees were more likely to have not asked for eye protection (56%) than consultants (25%) ($p<0.001$).

Trainees were also more likely to be denied access to custom-made or retrofitted lead gowns (63%) than consultants (27%) ($p<0.05$). Additionally, trainees were more likely (63%) to have not asked for this PPE compared to consultants (33%) ($p<0.001$). The most common reasons given to trainees for refusal (n=61) was that

Figure 1 Reasons given for refusing access to personal protection equipment.



they were a trainee (64%) or temporary staff (43%). Of those consultants who reported reasons for refusal (n=66), cost was the most common reason given (50%) (see Figure 1).

Monitoring dose exposure

Questions regarding dose monitoring were answered by 95% and 92% of consultant and trainee respondents, respectively. The majority of consultants (84%) had been allocated a personal dosimeter and 72% wore these at all times. However, of those who also worked at remote sites, only 36% had a dosimeter allocated at these sites. Trainees were significantly less likely to have a personal dosimeter allocated (44%) ($p<0.001$) and only 28% wore these at all times. Of those trainees who travelled to remote sites, only 5.6% had a personal dosimeter allocated at this site. Furthermore, trainees were significantly less likely (3.8%) than consultants (41%) to have ever been given feedback on their dose exposure ($p<0.001$).

Real-time dosimetry has been shown to be effective in reducing overall operator dose exposure. However, only 7.0% of consultants consistently employed this. Of those consultants who did not, 48% did not have access to this. Only 3.8% of trainees reported consistent use of real-time dosimetry and, of those remaining, 68% did not have access.

Access to a hybrid operating room (OR)

Of all consultants (97%) and trainees (94%) who answered the questions regarding availability of a hybrid operating room (OR), the majority (68% and 73%, respectively) used a hybrid OR for both elective and emergency cases. 88% of all consultants had at some point requested a modern hybrid OR; 41% of these consultants reported having this request denied.

Monitoring compliance

Of all consultants (92%) who answered the question surrounding compliance, less than half (40%) agreed that their Trust accurately monitored their compliance to nationally legislated dose exposures; of these, 8% strongly agreed. Although fewer trainees responded to this question (84%), trainees were significantly less likely to agree than consultants that their Trust accurately monitored their dose exposures (only 8.2%) ($p<0.001$). Trainees were far more likely to strongly disagree (48%) that Trusts accurately monitor their compliance compared with consultants (13%) ($p<0.001$).

Most consultants (86%) agreed or strongly agreed that employers should record cumulative radiation exposure during an operator's entire working career compared with almost all trainees (96%). Additionally, the majority of consultants (76%) and trainees (86%) agreed that employers should prospectively record and centrally upload annual radiation exposure to a national registry. Only 23% and 12% of consultant and trainee respondents, respectively, felt that the radiation protection afforded to healthcare professionals was adequate.

Incidence of workplace radiation exposure-related health problems

Around one in four consultants (25%) and trainees (23%) who responded had experienced a health condition potentially associated with their work with radiation. Musculoskeletal pain was the most common, prevalent in 17% and 18% of consultants and trainees, respectively. Of consultant respondents participating in this survey, 2% had experienced a malignancy (one basal cell carcinoma and one parathyroid adenoma), 5% reported radiation-induced eye disease and 7% reported skin conditions such as hair loss and dermatitis. Of the trainee respondents, one trainee reported a malignancy and 8% skin conditions. Notably, 37% of trainees and 60% of consultants knew of someone with a potentially radiation-associated condition. Almost all consultants (94%) and trainees (96%) agreed or strongly agreed that all potentially radiation-associated illnesses amongst radiation workers should be captured within a national registry.

The free text comments from this survey are collated in Figure 2.

Figure 2 Free text responses to questions.

Question	Trainee Responses	Consultant Responses
Do you have a dosimeter(s) allocated to you?	• The trust I worked for ordered a dosimeter, it arrived the day I left the trust. • Generic registrar dosimeters. • Have been working at [my current] trust for 5 months, have requested a dosimeter on several occasions and it has still not arrived. • It took 3 years to get one. • Have at certain trusts … not at other trusts in the region.	• Not sure. • Requested one. • Issued monthly, under lead, collar, and hands. • Poorly regulated - no supervision of collection.
Have YOU experienced any of the following potentially radiation-associated conditions (select all options which apply)?	• Rare left sided body tumour • No, but I worry about it a lot, as the protection for vascular surgery trainees is appalling. We are deemed transient and not worth bothering about. Especially if you are female, and a small one at that - it is tremendously difficult to find leads that fit well, and the thyroid collars are generally old and hang somewhere around the umbilicus.	• Parotid adenoma
In the past, have you requested and been denied access to any of the following?	• If the consultant does not wear these things it feels out of place to ask. I have raised about female lead apron protection but get little traction. • This question is difficult to interpret as a trainee, you are subject to what is available in your rotations.	• Trust provides me with good protection • New hybrids in planning / being built (4 responses)
What was the reason given for refusing the above?	• I do not know who to ask who may be able to provide them, I do raise it in trainer feedback. • As a LED I count for less than a trainee despite being basically near permanent. • I am not part of regular exposure team, i.e. I am not a radiologist.	• Ongoing investigation of dosimeter as to need. • Radiation protection officer advised against the use of lead caps due to best evidence. • System that doesn't work due to leadership.
Do you believe that the radiation protection afforded to healthcare professionals is adequate?	• There is a lot of disregard surrounding a very dangerous environment that we should be protecting all staff subject to it. • As trainees we should be afforded protection to carry out our roles, jobs and training. • For IR and substantive consultants, it is good. For rotating trainees, it is non-existent in most places. • I think the registrar cohort experience is very much different to consultant experience. I think we get lucky to be involved in endovascular work therefore we try to avoid mentioning any radiation issues as this would delay us acquiring our training or competencies.	• Not consistent / too few hybrid theatres / no PPE budget. • There's a shortage in the radiation protection afforded to HCPs. • HCPs also need to engage, some don't. • Personal responsibility is also important. • Trainees and rotating staff are at a disadvantage. • For many years we did not even have thyroid collars! It's getting better but we should have personal lead aprons and goggles (prescription if required). • As a consultant I have access to better protection than as a trainee. Our vascular trainees need better protection supplied to them, similar to the vascular IR trainees.

Figure 2 Free text responses to questions (continued)

Question	Trainee Responses	Consultant Responses
Can you suggest any other measures to drive radiation safety?	• I think we should be proactive in being part of radiation protection and work with our employers to ensure our safety. • Access to personal radiation protection that is our responsibility to look after would be a great first step, as most of the gowns we have access to are old and do not fit. • Fines for trust that don't provide minimal standards, anonymous surveys of practice. • There should be national standards of protective equipment available, that is audited and there should be consequences for units that do not adhere to this. Being a trainee, a small female or whoever is in the department is no less deserving of proper protective equipment than anyone else. You should not have to jeopardise yourself to help someone else, especially when protective equipment is available; it just requires units to have it and be properly educated. There should also be a radiation safety induction and guide to equipment for new staff members. • Checklist when starting to be filled and signed by supervisor. • Radiation protection as part of Trust induction. • Remove trainees from units that don't prioritise their safety. • It should be monitored nationally. The variation between different trusts is huge. • The guidelines for radiation safety in pregnancy are an absolute joke and just gas light women. There needs to be catch up fellowships for those of us who stop radiation work during pregnancy. At present I will have to prolong my training as reasonable adjustments cannot be made. • Implement what is said in the training – not just ask us to go through radiation protection training and then not provide basic safety equipment that's been outlined in the very same training!	• "No entry" policy with a nominated 'doorman/woman' in each hybrid theatre. • A National Quality improvement programme. • Biggest gap relates to trainees - no options for custom-made lead / glasses / other equipment which often means using uncomfortable and ill-fitting PPE. • Include radiation safety update training as part of consultant time to train sessions. • Ongoing education. • Have a defined standard set of protective equipment in a range of size and gender dependent kits. • Limit career exposure by limiting maximum time a practitioner can work with radiation during their career. • Needs education and re-certification for professionals. • Incorporate [training] in national training schemes and mandatory CPD. • Regular radiation safety training with simulation • More educational posters to remind people. • Increase awareness, increase training and finance to support safety/protection. • Offer radiation protection devices/equipment to all newly appointed professionals during the induction. • Verbal/noise cues from the machines telling you to step back. Real time dosimeters. • Eye and head protection should be a legal requirement. Organisations should be legally required to provide this. • Make it mandatory for employers to supply at least the minimum required. I think eye protection glasses and brain protection caps should be included. • Mandate trainees having access to monitoring. • Protective items [should be] issued from the deanery to trainees. • RPOs typically have no understanding of endovascular procedures and work off a screen, [they] need to come and see what is happening. • Education of the wider surgical team, highlighting it's a workplace health and safety requirement. • Radiation use should be suspended at trusts who do not meet set standards. • Self-awareness and being held to account as the main operator for the entire team. • Sometimes the resources and expertise are there but people just don't ask!! i.e. our trainees complain to the ARCP panel but do not actually let the staff in the trust know! • More hybrid facilities - use hybrid OOH. • Replace outdated hybrid room C-arms.

Discussion

The employer has a legal obligation to minimise the extent to which employees are exposed to ionising radiation by providing systems of work which restrict exposure to ionising radiation and through the provision of adequate and suitable PPE. Employers are also legally compelled to ensure that all practitioners are adequately trained for their role and undertake continuous education and training; and monitor, record and maintain records relating to an individual's radiation exposure.[10]

Surgeon education has been shown to decrease the overall radiation dose in complex endovascular procedures[11] and trainees who feel their consultants consistently practise ALARA strategies are more likely to do so themselves.[12] In this study 26% of trainees and 9% of consultants either did not or did not recall having training in radiation safety. Moreover, nearly half of all consultants (44%) and 57% of trainees undertook their training more than five years ago and two years ago, respectively. This would partly explain why 13% of trainees and consultants were not aware of ALARA principles with approximately 6% of trainees and consultants never or almost never employing this in their endovascular practice. The International Commission on Radiological Protection (ICRP) makes specific recommendations that training should be initiated at the start of a career (ie, during medical school) and that specialty- and role-specific training should continue during training.[13] Once training is completed, it should be updated at least every 36 months. Training in radiation protection in the UK clearly falls far short of these standards.

Whilst the majority of the vascular workforce did have access to a hybrid OR in this survey, 32% of vascular consultants and 27% of vascular trainees did not, and this is despite evidence of lower patient radiation doses, shorter screening times, and less contrast use with a hybrid OR compared to a conventional OR with a mobile C-arm.[14] Those units without access to a hybrid OR are in the minority and fall outside the Provision of Vascular Services 2021 recommendation that all arterial centres should provide, as a minimum, a 24/7 hybrid OR.[15]

This survey also highlights the poor access to personal radiation protection experienced by the vascular workforce and shows a significant difference between the personal protection afforded to vascular surgery trainees compared with consultants, with only 2.4% of trainees having access to custom-made or retrofitted lead gowns compared with 55% of consultants. Poor access to PPE and a lack of dose monitoring has also been reported amongst interventional radiology trainees.[16] As endovascular techniques advance, trainees are more likely to be exposed to ionising radiation earlier and for longer in their careers. Moreover, the trainee cohort in this survey comprised of significantly more female operators than the consultant cohort. Ill-fitting lead gowns can leave large amounts of the body unprotected, specifically radiosensitive areas such as breast tissue,[4] hence the updated recommendation by the European Society of Vascular and Endovascular Surgery (ESVS)[9] that all female operators should have lead gowns with axillary supplements and sleeves to reduce the risk of breast cancer. This study demonstrates that the UK is a long way from achieving this goal.

ESVS radiation protection guidelines also recommend that operators always wear appropriately fitted lead glasses during radiation-guided procedures.[9] However, only 16% of trainees and 52% of consultants consistently used lead glasses in this survey, with one in five consultants and approximately one in three trainees not having access to them. The survey highlights both a gross failing by the employer to provide the workforce with adequate radiation protection as well as poor compliance in utilising certain PPE, and this should be urgently addressed.

Whilst exposure to high doses of ionising radiation has long been known to be harmful, it is increasingly apparent that long-term exposure to low-dose ionising radiation is also harmful.[9] However, over half of the vascular surgery trainees in this survey and almost one in five consultants did not have access to a personal dosimeter, meaning that neither the annual safe level nor the cumulative lifetime radiation exposure was being recorded in these clinicians. A study of vascular surgery trainees in the United States demonstrated that excess radiation exposure in trainees was more prevalent than anticipated, with multiple trainees exceeding annual radiation dose limits.[17] Moreover, less than half of all consultants and only 4% of trainees received feedback regarding their dosimeter readings, again representing a missed opportunity to engage the workforce and potentially improve radiation safety.[17]

One in four vascular consultants and trainees experienced a health condition potentially related to their work with ionising radiation, but this can only be inferred as dose data and worker classification information was not collected in this survey but, more importantly, would not have been available for the majority of respondents. Musculoskeletal pain was the most common, prevalent in 17% and 18% of vascular consultants and trainees, respectively. The prevalence of back pain amongst the trainee cohort is more than four times higher than the age-matched background population.[18] However, the prevalence of back pain in consultant operators, who are more likely to have custom-made leads, was similar in prevalence to the background population. Well-fitted lead aprons in trainees may therefore help mitigate against the development of back pain.

Of concern, 2% of vascular consultants had experienced a malignancy, 5% reported radiation-induced eye disease and 7% of consultants and 8% of trainees had developed skin conditions. A national database of the incidence of potential radiation-linked health conditions across all groups working with ionising radiation in healthcare would help identify areas where radiation safety could be enhanced, noting that our understanding of the impact of ionising radiation on healthcare professionals and patients is continually growing. There was strong support for this approach from respondents in this survey.

Across both consultant and trainee groups there was also strong support for a national registry to monitor annual and lifetime occupational radiation exposure. This would potentially help

strengthen the governance surrounding the monitoring, documentation and feedback of annual and lifetime dosimeter readings. In order for a registry of this nature to be effective, compliance with monitoring and the use of PPE is essential. This survey reports poor compliance as well as the lack of provision of PPE and monitoring. The former is interesting given the level of concern expressed by clinicians, and perhaps is a reflection of poor education and awareness.

The main limitation of this study was the small sample size, particularly in the vascular consultant cohort where 15% of the workforce was represented compared with 44% of the vascular trainee workforce. Responder bias could also not be excluded and those more concerned about radiation protection may have been more likely to respond. If this is the case, then the problems highlighted may be far greater than reported in this survey. In addition, there was a greater proportion of female respondents in the vascular trainee group compared with the consultant group. This may be due to apprehension amongst female trainees regarding the higher incidence of breast cancer reported in US orthopaedic surgeons compared with the general US female population,[4] or fears surrounding radiation protection during pregnancy.

Conclusion

This survey highlights significant deficiencies in knowledge, access to personal radiation protection and failures in monitoring individual exposure to ionising radiation amongst the vascular surgical workforce in the UK. Moreover, trainees are more likely to struggle to access radiation protection equipment compared with their consultant colleagues. The data emphasise the failings by the employer to meet its legal obligations and the urgent need in the UK to improve standards for healthcare professionals working with ionising radiation by improving access to personal radiation protection, developing more robust training pathways and improving the governance surrounding the monitoring of exposure to ionising radiation.

KEY MESSAGES

- This is the first survey which captures vascular surgery consultant and trainee experiences of working with ionising radiation in the UK.
- The survey highlights deficiencies in knowledge and training with respect to strategies to reduce ionising radiation exposure and awareness of local policies, amongst the vascular surgical workforce.
- The access to personal protective equipment is shown to be poor, with trainees struggling to obtain appropriately fitting lead gown and glasses to a greater degree compared to their consultant colleagues. Failures in monitoring exposure to radiation was also shown.

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ORIGINAL RESEARCH

Nurse-delivered endothermal venous ablation: 12 years' experience at a single UK centre

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Plain English Summary

Why we undertook the work: Varicose veins and venous disease (veins in the legs that do not return blood properly) affect many people through a range of symptoms including complications such as bleeding, clotting and the development of wounds that are difficult to heal (venous leg ulcers). Early assessment and early access to surgical treatment can improve people's lives and help to heal venous leg ulcers more quickly. Early access to this type of surgery can be difficult in the UK due to a lack of resources within the NHS. The aim of this report is to describe innovative delivery of a venous service through advanced nursing practice.

What we did: A specialist nurse was trained to deliver this type of surgical procedure to overcome difficulties in accessing care at one UK hospital. A range of data around this practice and the patients treated was collected for a period of 12 years.

What we found: It was found that this type of surgical procedure can be safely delivered by a trained specialist nurse. Patients experienced shorter waiting times (average 53 weeks reduced to 17 weeks) and positive outcomes that were comparable to surgeon-delivered procedures.

What this means: Access to care and patient waiting times can be improved through specialist nurse care. Services for this patient group may become more sustainable by embracing specialist nurse-delivered procedures.

Abstract

Background: Despite new evidence supporting early assessment and intervention for patients with venous disease, there remain significant barriers to service delivery in the UK. The aim of this report is to describe the innovative delivery of a venous service through advanced nursing practice. Single-centre data are presented from 12 years of nurse-delivered venous interventions.

Methods: An existing nurse specialist was trained to (1) receive and vet referrals, (2) assess patients and (3) perform endovenous laser ablation (EVLA) and foam sclerotherapy. Consultant surgeons provided mentoring and assessment over a 10-month period, with ongoing team support thereafter. Qualifications were obtained in medical ultrasound and prescribing. Procedures were performed under local anaesthesia in a clinical treatment room setting. Audit data were maintained throughout. Complications were reported via risk management systems.

Results: Between 2012 and 2023, 6655 referrals were vetted and, of these, 3710 (56%) were seen and assessed. Of the 3710 assessed, 2148 (58%) patients (median (IQR) age 51 (40–53) years, 55% female) underwent nurse-delivered EVLA of the great (84%) or small (16%) saphenous vein. Complications were recorded for 25 cases (1.2%). Median waiting time before the nurse-delivered service was 53 weeks (2011). Across the reported period of nurse-delivered service, this reduced to a median of 17 weeks. In 2023, median (IQR) waiting time for the venous leg ulcer cohort was 7 (3–11) weeks. Early follow-up showed vein closure rates of 95%. High levels of patient satisfaction were recorded: where a score of 10 was most satisfied, the median (IQR) satisfaction score for clinical outcome was 8 (6–8) and satisfaction with a nurse-delivered service was also 8 (7–8).

Conclusions: The venous service within this single UK centre is being delivered through advanced nursing practice, improving waiting times and access to intervention. A significant efficiency in consultant surgeon time is being realised, increasing the capacity of the vascular unit. A low complication rate and positive patient satisfaction suggests that nurse-delivered EVLA is a safe innovation in service delivery.

Key words: venous, leg ulcer, nurse, endothermal, early intervention

Introduction

Attention is currently being directed towards the care of patients with venous disease in the UK. Contemporary research supports early intervention of incompetent superficial truncal veins, especially beneficial to patients suffering from venous leg ulceration (VLU). However, there are significant difficulties in the delivery of venous services impeding the implementation of best practice.

In 2012 a group of consultant vascular surgeons at a single UK centre aspired to improve the delivery of their venous service. Unable to increase their medical workforce and faced with expanding workloads of increasing complexity, the capacity to deliver timely venous interventions was failing; median (IQR) referral to treatment time (RTT) in 2011 had risen to 53 (45–59) weeks.

This report aims to describe innovative practice designed to address barriers to service delivery through the development of advanced nursing practice at a single UK vascular surgery unit. Data are presented from 12 years' experience of nurse-delivered venous interventions.

Background

Assessment and treatment

The assessment and treatment of patients presenting to vascular services with symptomatic varicose veins and the consequences of chronic venous insufficiency represents a high-volume workload; more than 30,000 procedures per year are carried out in England alone.[1] Varicose veins affect 10–40% of the adult population in the UK and are associated with a wide range of symptoms including significant complications such as bleeding, superficial thrombophlebitis and VLU.[2] VLU is the most severe manifestation of chronic venous insufficiency and is associated with a significant impact on quality of life through pain, impaired mobility, foul smelling exudate, depression, loss of self-esteem, social isolation, employment difficulties and the need for long-term clinical support.[3] It is no surprise that the management of this chronic recurring condition carries a significant financial burden to the National Health Service (NHS) in the UK, thought to consume over £2.7 billion of funding per year.[4]

The traditional paradigm in the treatment of this condition has consisted of high ligation and stripping of the superficial truncal veins, often combined with phlebectomies of truncal tributaries.[5] In the case of VLU, the classic narrative has been to treat with compression therapy until wound healing is achieved, only addressing underlying aetiology surgically at this late stage. Referral and treatment pathways have been shown to be poorly established and poorly understood; often patients with VLU are never considered for surgical management of their underlying venous insufficiency.[6]

The advent of endovenous approaches, in particular endothermal ablation of the superficial truncal veins, has led to a phasing out of traditional high ligation and stripping in all but the most complex of cases.[7] Current National Institute for Health and Care Excellence (NICE) guidance recommends endothermal ablation as the first choice for intervention, where clinically and technically appropriate.[8] The advantages over open surgery are numerous and include short recovery time, fewer complications, treatment under local anaesthesia and shorter hospital stay.[9]

Evidence and barriers to best practice

The potential for surgical treatment of incompetent superficial truncal veins to benefit and improve VLU treatment are best summarised in the results of several studies challenging traditional rationale. The ESCHAR trial, published in 2007, concluded that most patients with VLU would benefit from superficial venous surgery as an adjunct to compression through significantly improved ulcer-free time post wound healing.[10] More recently, the EVRA trial has demonstrated accelerated healing times of venous leg ulcers alongside increased ulcer-free time through early ablation of underlying incompetent superficial truncal veins.[11] It was concluded that an early intervention strategy was highly likely to be cost-effective and associated with long-term improvements to patients' quality of life.[12] By its own merit, the results of the EVRA trial alone ask for a change in behaviour to facilitate early venous assessment and intervention.[13]

Actual and anticipated barriers to early assessment and intervention were identified in a post EVRA trial study. These included lack of operating space or time, theatre capacity, lack of trained staff, duplex scanning capacity, primary/secondary care integration/referral, financial reimbursement, resistance from colleagues, cost of change, local and national guidelines.[14] Vascular surgery services in the UK do not appear to have the capacity, workforce or financial ability to implement the evidenced changes required to improve access to venous interventions for this patient group. This has been demonstrated through sequential Vascular Society of Great Britain and Ireland (VSGBI) reports showing an

ever-increasing burden of vascular disease upon the population, resultant year on year rises in service demand and consistent deficits in the number of both vascular consultants and trainees to meet current and future requirements.[15,16]

An inability to surpass these barriers will result in a missed opportunity to improve access to treatment and patient outcomes; success, as the title of one post EVRA study suggested, could provide a "new hope for people with venous ulcers".[17]

A 2023 All-Party Parliamentary Group on Vascular and Venous Disease report, addressing the future of venous disease, recognised the condition as a growing problem being addressed by a shrinking workforce.[18] The same document realises that there exists a workforce shortage of vascular surgeons and of trainee posts in the UK, resulting in the prioritisation of some vascular conditions over others, potentially impacting negatively upon the wellbeing of those suffering from venous disease.[18]

Both the All-Party Parliamentary Group and VSGBI reports recommend innovation at service level and change in how clinicians practice to better use limited resources.[15,16,18]

Nurse-delivered surgical procedures

A recent series of papers published between 2022 and 2024 examined the worldwide phenomenon of nurse-delivered surgical procedures. They found a near 70-year modern history of nurses performing surgeries across 26 countries, spanning most surgical specialties including urology, oncology, cardiothoracic, orthopaedic and vascular surgery.[19–21] The reasons for development of nurses to deliver surgical procedures varies; however, one common theme, recognised by the World Health Organisation (WHO), is task shifting in response to supply and demand deficits.[22]

This report presents data from 12 years of innovative venous service delivery through nurse-delivered surgical procedures at a single UK centre, conceived by vascular consultant surgeons and developed as a solution to vascular service delivery supply and demand deficits.

Methods

Patient pathway

The reporting vascular unit is a tertiary referral centre and university teaching hospital serving a population of more than 500,000 across a large geographical area. Primary care referrals are received from a network of 70 GP practices across this area.[23]

In 2018, NHS Scotland issued a protocol for access to varicose vein surgery where indications for treatment equated to CEAP C4–C6 symptoms.[24] In accordance, patients referred with uncomplicated varicose veins (CEAP C0–C3) are not offered treatment at this centre. Referrals are returned to primary care at the vetting stage where referral criteria are not met; similarly, patients who do not meet referral criteria when assessed in outpatient clinic are not offered treatment. Prior to nurse delivery of the venous service, there was no accelerated pathway for patients suffering C6 symptoms (active VLU).

Development

An existing vascular nurse specialist (VNS) was trained to deliver the unit's venous service, accounting for approximately 20% of the VNS job plan. This comprised receiving direct referrals, delivery of 'one-stop' assessment clinics and venous interventions (endovenous laser ablation (EVLA) and foam sclerotherapy). This initiative was conceived and driven by consultant surgeons to improve patient access to venous interventions, release medical workforce capacity and ensure continued delivery of a venous service at this centre.

The VNS was mentored by two vascular consultant surgeons. Nurse practice education facilitators (PEFs) were employed in the production of a locally agreed capability and competency framework, informed by mentors, using best available evidence and developed alongside hospital and nursing management teams.

At first, the VNS shadowed venous assessment clinics, building the experience and competence to deliver this part of the service with autonomy. In assessment, all patients were physically examined, verbally discussed their condition and underwent duplex ultrasound imaging performed by the VNS. Ultrasound skills were taught locally by resident vascular sonographers before undertaking a formal postgraduate qualification in medical ultrasound with a vascular focus. A record was maintained of all assessments and ultrasound investigations completed in the compiling of evidence towards competency.

EVLA was taught by one mentor. The procedure and skills required were broken down into component parts and progressively taught over a six-month period. An additional four months of supervised practice was completed where the VNS was observed and assessed as competent in delivering the procedure in its entirety. A prospective audit was maintained of all patients treated. Patient group directions were originally used in the prescribing of procedural medications; over time this was superseded by a qualification in non-medical prescribing and entry onto the Nursing and Midwifery Council registry of nurse prescribers.

EVLA was initially performed by the VNS in a day case operating suite under local anaesthesia, with intraoperative ultrasound performed by the VNS. In 2014 the transition was made to EVLA delivered in a clinical treatment room. Local anaesthesia (1% lidocaine) and tumescent saline were used in every case. Ultrasound-guided foam sclerotherapy (UGFS) of varicose saphenous tributaries was considered and performed in selected EVLA cases either concomitantly or within 8 weeks post EVLA.[25] The decision to treat tributaries, either concomitantly or staged, was made on a case-by-case basis, considering the ability to treat the saphenous vein beyond the origin of the tributary, the size of the tributary and the potential impact on symptomatic relief.[26,27]

Compression stockings (Class II) were fitted immediately after the procedure with instructions to remain in situ for 7 days; additional compression bandaging was applied over the treated area with instructions to remove after 48 hours. In the delivery of EVLA, a 1470 nm diode laser was employed, operated in

continuous mode between 5W and 7W power, delivering 30–50 Joules of energy per cm, dependent upon the vein being treated and vein diameter, in accordance with manufacturer guidance. In the delivery of UGFS, foam sclerosant was produced using either 1% or 3% sodium tetradecyl sulfate liquid converted to foam sclerosant via the Tessari technique.

In the first 24 months of practice (2012–2013), procedures were listed under the mentoring consultant vascular surgeon's name alone and clinical correspondence signed by both mentor and VNS, constituting 2 years of close supervision. From 2014 onwards, following continued audit, review and discussion with the wider clinical and management teams, procedures were listed under the name of the VNS and clinical correspondence conveyed independently. Similarly, consent to treatment was observed and co-signed throughout the development period; a standard operating procedure for VNS obtained consent was developed by the PEF team alongside the capability and competency framework.

Although the VNS delivered EVLA independently once competent, support from consultant vascular surgeon colleagues was always available if required; this supportive team approach was integral to the clinical governance of this service development. Where complications occurred, they were reported via the DATIX risk management system, discussed at service level clinical governance meetings and escalated as appropriate.

Post-procedure evaluation

Within this centre, post-EVLA follow-up is not routine practice. However, in the evaluation of nurse-delivered treatment efficacy, a selection of patients received post-procedure ultrasound imaging in year 1 (2012) and year 2 (2013), performed by a vascular sonographer independent of venous service delivery 6 months post-procedure. Sonographer capacity restricted post-procedure ultrasound evaluation to 40 patients in 2012 and a further 40 in 2013; these were selected at random by the sonographer. Successful vein closure was defined as non-compressibility and absence of flow signal/colour filling along the full length of the treated saphenous vein on duplex ultrasound; proximal occlusion of the saphenous vein was expected to be within 5 cm of the saphenofemoral/popliteal junctions.

Evaluation of patient satisfaction was performed by questionnaire across the 2014/2015 period and again during 2016/2017. Main questions consisted of Likert scale responses, with 10 representing most satisfied; visual analogue pain scores ranked 10 as highest level of pain experienced. Full recovery was reported as time to return to work and/or return to normal daily activities. The questionnaire was of local design and did not use a validated assessment tool.

Identification of complications

Intraoperative complications were identified and recorded at the time of procedure delivery. Postoperative complications were identified following re-referral to the service from primary care or by direct contact with the service, instigated by the patient. It is likely that the incidence of minor to moderate postoperative complications, such as superficial thrombophlebitis of saphenous tributaries, has been under-reported in the absence of routine follow-up.

Data collection

Quantitative data were collected prospectively by the VNS for the purpose of audit, professional development and local clinical governance. VNS logbook entries were cross-checked against local health intelligence data for completeness.

Results

Referral and cases delivered

Over a 12-year period (2012–2023) 6655 referrals were received and vetted by the VNS. Of these, 3710 (56%) were seen and assessed; the remainder did not meet referral criteria. Of the 3710 assessed, 2148 patients (58%) underwent EVLA performed by the VNS. Of the remaining patients assessed, 441 (12%) underwent UGFS alone, 26 (0.7%) were listed for high ligation with or without phlebectomies under a vascular surgeon and 1095 (29%) were not offered treatment as symptoms were either below treatment criteria or was contraindicated.

EVLA of the great saphenous vein was performed in 1813 cases (84%) and of the small saphenous vein in 335 cases (16%). EVLA cases included 956 men (45%) and 1192 women (55%) with a median (IQR) age of 51 (40–53) years. UGFS was administered either concomitantly or within 8 weeks of EVLA to saphenous tributaries in 337 cases (16%). EVLA results by year are shown in Table 1.

Median (IQR) time spent per year delivering EVLA was 189 (91–105) hours and delivering outpatient assessment clinics was 108 (105–113) hours, a combined average of 297 hours per year.

Waiting times (RTT)

In 2011, prior to the service being nurse delivered, median (IQR) RTT for this patient group was 53 (45–59) weeks. Median (IQR) RTT across the reported 12-year period of nurse-delivered service was 17 (12–26) weeks, a 68% reduction. Of the 183 EVLA cases performed in 2023, 40 (22%) had active venous leg ulcers; the median (IQR) RTT for this subgroup in 2023 was 7 (3–11) weeks.

Complications

Complications were recorded for 25 cases (1.2%); these comprised three cases of endothermal heat-induced thrombosis, two intraoperative complications arising from equipment failure, one case of thermal injury and 19 presentations of postoperative superficial thrombophlebitis (see Table 2).

Follow-up and patient satisfaction

In 2012, 40 patients received duplex ultrasound follow-up at 6 months post EVLA and 36 patients were found to have successful

Table 1 EVLA results by year

Year	Cases, n	RTT weeks*	GSV, n	SSV, n	Male, n	Female, n	Age years*	+ UGFS, n
2012	269	16 (13–20)	208 (77%)	61 (23%)	87 (32%)	182 (68%)	51 (39–62)	49 (18%)
2013	275	15 (11–20)	241 (87%)	34 (13%)	102 (37%)	173 (63%)	50 (39–62)	43 (16%)
2014	258	18 (15–28)	221 (86%)	37 (14%)	102 (40%)	156 (60%)	50 (38–60)	36 (14%)
2015	329	17 (14–31)	280 (85%)	49 (15%)	156 (47%)	173 (53%)	51 (39–63)	52 (16%)
2016	299	17 (12–23)	257 (86%)	42 (14%)	150 (50%)	149 (50%)	51 (40–62)	32 (11%)
2017	195	17 (11–23)	164 (84%)	31 (16%)	93 (48%)	102 (52%)	51 (39–63)	38 (19%)
2018	105	29 (13–36)	90 (86%)	15 (14%)	51 (49%)	54 (51%)	54 (43–68)	17 (16%)
2019	90	27 (16–32)	78 (87%)	12 (13%)	50 (56%)	40 (44%)	55 (39–71)	11 (12%)
2020	28	41 (15–65)	23 (82%)	5 (18%)	13 (46%)	15 (54%)	62 (44–75)	3 (11%)
2021	26	43 (17–65)	23 (88%)	3 (12%)	18 (69%)	8 (31%)	54 (42–64)	5 (19%)
2022	91	14 (7–26)	73 (80%)	18 (20%)	50 (55%)	41 (45%)	55 (42–68)	19 (21%)
2023	183	14 (6–19)	155 (85%)	28 (15%)	84 (46%)	99 (54%)	52 (42-62)	32 (17%)
Cumulative totals								
2012– 2023	Cases, n	RTT weeks*	GSV, n	SSV, n	Male, n	Female, n	Age years*	+ UGFS, n
	2148	17 (12–26)	1813 (84%)	335 (16%)	956 (45%)	1192 (55%)	51 (40–63)	337 (16%)

*Median (interquartile range).

EVLA, endovenous laser ablation; GSV, great saphenous vein; RTT, referral to treatment time; SSV, small saphenous vein; UGFS, ultrasound-guided foam sclerotherapy.

Table 2 EVLA complications by year

Year	Cases, n	Phlebitis, n	EHIT, n	Thermal injury, n	Equipment fail, n	Total, n
2012	269	5 (1.8%)	1 (0.4%)	0	0	6 (2.2%)
2013	275	5 (1.8%)	1 (0.4%)	0	1 (0.4%)	7 (2.5%)
2014	258	2 (0.8%)	0	0	0	2 (0.8%)
2015	329	0	0	0	0	0
2016	299	0	0	0	0	0
2017	195	4 (1.2%)	0	0	0	4 (2.0%)
2018	105	0	0	0	0	0
2019	90	0	0	0	0	0
2020	28	1 (3.6%)	0	1 (3.6%)	0	2 (7.1%)
2021	26	0	1 (3.8%)	0	1 (3.8%)	2 (7.7%)
2022	91	0	0	0	0	0
2023	183	2 (1.1%)	0	0	0	2 (1.1%)
Cumulative totals						
2012–2023	Cases, n	Phlebitis, n	EHIT, n	Thermal injury, n	Equipment fail, n	Total, n
	2148	19 (0.89%)	3 (0.13%)	1 (0.05%)	2 (0.1%)	25 (1.2%)

EVLA, endovenous laser ablation; EHIT, endothermal heat-induced thrombosis.

vein closure (90%). A further 40 patients were followed up in the same way in 2013, all of whom were found to have successful vein closure (100%).

Patient satisfaction questionnaires were assessed in 2014/2015 and again in 2017/2018; of the 300 questionnaires distributed, 217 responses (72%) were received. Median (IQR) visual analogue pain score for the intraoperative period was 2 (2–3), with median time to full recovery 3 (2–4) days. Median satisfaction score for clinical outcome was 8 (6–8) and with a nurse-delivered service it was also 8 (7–8).

Discussion

The cases described represent a significant workload across the 12-year period. Time spent per year delivering EVLA combined with time spent delivering outpatient assessment clinics released a compelling amount of consultant surgeon time. This is a significant efficiency in a surgical speciality where lack of medical workforce capacity is recognised to be negatively impacting the clinical outcomes of this patient group.[16]

The types of complications encountered were not unexpected and mirrored those described by other authors outlining EVLA experience.[28] Of the complications reported, six were procedural complications occurring during treatment; this is conservatively comparable to the surgeon-delivered EVLA reported in studies such as the CLASS trial (1%).[29] However, lack of routine clinical follow-up has almost certainly resulted in under-reporting of

postoperative complications, which were far more commonplace at 6 months within the CLASS trial (48.6%).[29]

Efficacy of vein closure during the initial years of practice was also reassuring and was comparable to several studies reporting closure rates of 93–96% in surgeon-delivered EVLA.[30,31] The safety of nurse-delivered EVLA is further demonstrated by patient-reported low intraoperative pain scores alongside high overall satisfaction described in patient feedback.

Early access to both venous assessment and intervention is clearly beneficial to the patient group and is desired by those delivering venous services. RTT data for NHS England has previously been reported over a comparable 12-year period (2006/7 to 2017/18). Average waiting times ranged from 64 to 125 weeks, illustrating the extent of difficulty vascular services are experiencing in the delivery of timely venous assessment and intervention across the largest parts of the UK.[1]

Waiting times at this single UK centre were positively affected by nurse delivery. Across the reported period, RTT was consistently lower than the peak 53-week RTT recorded prior to this innovation; a 68% reduction in waiting time is a considerable improvement. Predictably, RTT rose significantly during the period of COVID-19 restrictions; however, data show that recovery post restriction was swift. The ability to recover waiting times rapidly post COVID-19 restriction is largely attributable to a nurse-delivered service not having to compete for resources. The VNS has a focused well-defined scope of practice that does not encroach upon other surgeon-delivered activity nor the resources allocated to that activity such as theatre space, time or workforce – barriers to early access identified in post EVRA trial studies.[13] Designing a venous service in this way would appear to be a more sustainable method of delivering assessment and intervention to this patient group.

In the time since the EVRA trial was published, the Royal Society of Medicine Venous Forum has published recommendations for the treatment of patients with venous leg ulcers. Their guidance includes the goal of venous intervention delivered within 2 weeks of assessment.[21] Through active promotion of early intervention, this nurse-delivered venous service made significant steps toward this goal, managing the VLU subgroup with priority and achieving RTT of 7 weeks in 2023.

Limitations

These data and the narrative describe the development of a venous service in a previously untested and innovative direction. There was no preconception of analysis beyond local audit; as such, this report lacks the rigour of formal research design and methodology.

Clinical follow-up was limited to a small percentage of reported cases (15% in 2012/2013, only 4% of total cases reported). The implication of incomplete follow-up could be overestimation of treatment efficacy and under-reporting of post-procedure complications. Prospective studies should aim to integrate comprehensive clinical follow-up within the study design to avoid the potential risk of study bias and ensure complete reporting of post-treatment complications as a patient-related outcome measure (PROM).

This report would be greatly enhanced by the inclusion of data derived from validated outcome measures of quality of life, PROMs and patient satisfaction/feedback. Evaluation of patients perceived (venous) health before and after treatment would help in the evaluation of VNS-delivered treatment efficacy. Validated tools such as the Aberdeen Varicose Vein Questionnaire and the Venous Clinical Severity Score would be ideally placed to achieve this.[32]

Impact upon surgical trainees

In 2024 the Association of Surgeons in Training released a joint statement raising concern following the publication of a case series of laparoscopic cholecystectomy performed by a surgical care practitioner.[33] Of the three concerns raised, one is pertinent to this report of nurse-delivered venous practice – a worry raised in various forms and forums that nurse-delivered surgeries deprive surgical trainees of training opportunities.

Evidence reporting the impact of nurse-delivered activity upon the development of surgical trainees is lacking. However, factors detrimentally impacting their training in general are well reported. The Rouleaux Club (Vascular Trainees' Association for Great Britain and Ireland) published a report in 2021 examining stressors resulting in vascular trainees resigning a National Training Number (15% attrition 2013–2019). Of the contributors cited, loss of training opportunities due to nurse-delivered activity or interprofessional task shifting does not feature. Key detrimental factors included impact of geographical relocation, poor work/life balance, unpredictable working hours, fatigue and lack of rest post on-call. Trainees expressed that they did not believe these factors would improve as their careers progressed.[34]

Within the reporting vascular centre, maintaining the ability to deliver a venous service for the benefit of the patient group was a core service priority; this was severely threatened, predominantly by woefully diminished workforce capacity. Prior to the service being nurse-delivered, surgical trainees rarely had the opportunity to experience EVLA/UGFS due to irregularity of lists and prioritisation of other vascular surgical procedures from the arterial workload. The question that should be asked is: If there is an impact on surgical trainees, does that impact outweigh the detrimental blow to patients who are unable to access venous services and benefit from best practice?

Scarcity of vascular curriculum surgical trainees and subsequent rota pressures contribute heavily to the issue. At the reporting centre there are periods where the vascular unit is without a vascular trainee and the accepted norm is to host but one trainee from the vascular programme per rotation. The VSGBI Vascular Surgery Workforce and Wellbeing Survey 2021 confirms that vascular services in the UK have experienced increases in activity, admissions and waiting lists year-on-year from 2012, with projected increases beyond 2030. The same report shows a UK-wide deficit of both established consultant vascular surgeons and of vascular

specialty trainees (29% increase required), consistently increasing activity and consistently too few surgeons and trainees.[15] This is not conducive to maintaining the full spectrum of vascular services needed to care for patients. The goal of 'best practice' becomes even less attainable when patient 'demand' continues to outstrip our ability to 'supply' services.

As recruitment to interventional radiology declined and emphasis on endovascular approaches to vascular surgery increased, trainees sought greater access to endovascular training.[35] It has been the experience of this reporting centre and VNS that varicose veins and chronic venous disease are rarely a training priority for incumbent vascular surgical trainees. The exception was found to be in the learning of percutaneous access skills to augment arterial endovascular training. These were more easily taught in venous cases, where procedures are of shorter duration, use smaller access devices conducive of early-stage learning and were performed in a more relaxed environment. For this reason, nurse-delivered EVLA had a positive effect on the training opportunities of vascular surgical trainees within the reporting centre. The VNS and regular EVLA list became a fixture in trainees' educational regimen. The quality and value of this experience should be studied further, as should the overall impact on training opportunities and the real-world experiences of vascular surgical trainees and specialist nurses alike.

Conclusion

A new gold standard of care is emerging in the UK for patients with venous leg ulcers and symptomatic chronic venous disease, delivering improved clinical outcomes through early assessment and early intervention. The potential exists to heal wounds faster and reduce recurrence, improving quality of life and easing the burden placed upon healthcare systems. However, current vascular services have self-identified barriers preventing optimum delivery of this care, including workforce shortage, overall capacity and financial restriction. A greatly increased number of clinicians must be found to deliver venous services if the gold standard is to be achieved and sustained.

Nurse-delivered surgical procedures are far from novel and are well reported across the globe for multiple surgical specialties.[19] The data reported suggest that endovenous interventions can be safely performed in the outpatient clinical setting by a suitably trained and mentored VNS and that the patient group can be satisfied and accepting of this innovation.

Given the barriers to service provision described, the increasing UK venous caseload and diminishing medical workforce, there should be ample opportunity for trainee exposure to venous cases regardless of which experienced professional delivers the education.

Multiple UK centres have since developed similar nurse-delivered venous practice. Prospective audit and multicentre research should be undertaken as the evolution of modern sustainable venous services continues. Fostering a culture of inclusivity and cooperation across professions could help to achieve a new higher standard of care for this in-need patient group.

KEY MESSAGES

- Workforce shortage, capacity and financial restrictions are barriers to the delivery of best practice.
- Endovenous interventions have been safely performed by a trained nurse specialist at this centre.
- Venous services could be developed and sustained by incorporating nurse-delivered venous interventions.
- Reduced waiting times can be achieved through nurse specialist service delivery.

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ORIGINAL RESEARCH

Current practice in ultrasound grading of carotid artery stenosis in the UK and Ireland

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Plain English Summary

Why we undertook the work: Ultrasound uses sound waves to create an image from inside the body. It is commonly used to assess the blood vessels in the neck. This can determine the speed of blood flowing through the vessel and if there is any disease and a significant narrowing within the blood vessel. The speed of the blood within a diseased vessel can help classify and determine the amount of disease within the blood vessel. Twenty years ago (early 2000s) it was reported that vascular centres used different ultrasound practices to classify disease within blood vessels. Guidance on how to classify disease within blood vessels of the neck were then published in the UK and Ireland in 2009 to help standardise practice between vascular centres in different hospitals.

What we did: This audit determined whether vascular centres now follow the guidance that was set out 15 years ago or whether variation still exists. An online questionnaire form was sent out to all the hospital trusts in the UK and Ireland that perform surgery on blood vessels in the neck. The form asked how they use ultrasound to classify the amount of disease in blood vessels in the neck.

What we found: The form was answered by 46/80 (58%) vascular centres in the UK and Ireland. 70% of respondents reported using the 2009 UK recommendations, while 22% reported using some. To classify moderate and severe disease many centres now use the same speed of blood flow, with some practices being used by as many as 81% (for moderate disease) and 90% (for severe disease) of centres. However, this audit identified that there was still variation between centres in other practices that classify severe disease, particularly in practices that were not covered by the 2009 recommendations. The audit also showed that fewer centres have the time and resources to perform their own internal audits.

What this means: The 2009 recommendations have helped to standardise the practices and the speed of blood flow that is used to classify moderate and severe disease within blood vessels of the neck. However, vascular centres do vary in how they apply these recommendations. There remains variation in practices used to classify severe disease, along with inconsistent practices on internal audits.

Abstract

Introduction: Ultrasound is usually the first-line imaging modality in the UK and Ireland for evaluating the severity of carotid artery disease. The last UK and Ireland audit on grading of internal carotid artery (ICA) stenosis with ultrasound was reported in 2006 whilst UK recommendations were published in 2009. This audit aims to summarise current practices.

Methods: Seventy-two UK hospital trusts and eight within Ireland that perform carotid surgery were identified. One vascular unit from each trust (n=80) was invited to complete an online questionnaire based on their current carotid ultrasound assessments including velocity thresholds (peak systolic velocity (PSV); end diastolic velocity (EDV)) and PSV ratios (PSV in the ICA:PSV in the common carotid artery (CCA)) used to grade a stenosis, the use of St Mary's ratio (PSV in the ICA:EDV in the CCA) and the criteria prioritised to grade a stenosis.

Results: The questionnaire was answered by 58% (46/80) of vascular units. 70% of respondents reported using the 2009 UK recommendations, with 22% reported using a subset. To grade moderate disease (>50% stenosis), 81% use a PSV of >125 cm.s-1, only 36% use EDV and 71% use a velocity ratio of >2.0–4.0. To grade severe disease (>70% stenosis), 90% use a PSV of >230 cm.s-1, 43% use EDV and 86% use a velocity ratio of >4.0. Whilst the majority (78%) of units use the St Mary's ratio to grade in deciles, there was more variation in the number of PSV and EDV thresholds used by different centres to grade severe

stenosis. There was a combined total of 13 distinct (PSV, EDV and ratios) thresholds being used to grade >80% stenosis. The criteria prioritised to grade a stenosis and how near occlusion was defined on duplex imaging was variable, and there were inconsistent practices on internal audits and quality assurance.

Conclusion: The 2009 recommendations have standardised key practices in grading moderate and severe disease with PSV, velocity ratios and in the use of the St Mary's ratio to grade in deciles. However, vascular units vary in the application of these recommendations and the use of indices not included in the guidelines.

Key words: audit, diagnostic, imaging, velocity, criteria

Introduction

The degree and severity of a stenosis near the carotid bifurcation and internal carotid artery (ICA) will determine the risk/benefit relationship for a patient undergoing carotid endarterectomy surgery.[1] The diagnostic accuracy of duplex ultrasound in grading ICA stenoses is comparable to computerised tomographic angiography (CTA) and magnetic resonance angiography (MRA), and it remains an instrumental diagnostic tool for identifying and grading the severity of carotid artery disease.[2,3] By exploiting the exponential relationship that exists between an increase in blood velocity and a narrowed lumen,[4] velocity thresholds and protocols have been published to promote consistency in how ultrasound can be used and interpreted to grade the severity of carotid disease.[5–7] However, the specific velocity thresholds and the choice of parameters that are used to estimate the narrowing can still vary considerably between vascular units. A recent study in the USA reported that, due to the differences that exist between vascular units, twice as many patients would be diagnosed with a moderate (≥50%) stenosis if they had been assessed at a different unit.[8]

The vascular units in the UK and Ireland that were audited in 1999[9] and in 2006[10] also demonstrated differences in the duplex parameters and velocity thresholds that were used to grade a carotid artery stenosis. In 2009 this prompted a working group for the Vascular Society of Great Britain and Ireland to release recommendations for reporting carotid ultrasound investigations.[6] These recommendations reiterated an earlier consensus by the Society of Radiologists in Ultrasound (SRU) in how to grade moderate (>50%) and severe (>70%) disease.[5] The UK recommendations also promoted the use of the St Mary's ratio criteria to grade in deciles >50%[11] and the use of a criterion to grade >90% stenosis[12] that is not string flow or near occlusion. More recently, these recommendations were highlighted by the European Society for Vascular Surgery guidelines.[2,13] Thus, the objectives of this audit were to describe the current clinical practices for grading carotid artery disease within the UK and Ireland and to determine whether vascular units follow the UK working group's recommendations[6] that were set out 15 years ago.

Methods

To evaluate the current ultrasound criteria that are used to grade carotid artery stenosis, an audit of vascular units in each of the UK and Ireland hospital trusts was conducted between February and July 2023. One vascular unit from each of the NHS trusts (n=72) in the UK (identified by their listing on the National Vascular Register) and Ireland (n=8) that perform carotid surgery were invited to take part (total n=80). Data were collected using an online questionnaire (Online Surveys, Jisc, UK). Vascular units were invited via email to complete the questionnaire. Units that had senior members and contact details registered on a database by the College and Society for Clinical Vascular Science of Great Britain and Ireland (CSVS; previously known as the Society for Vascular Technology of Great Britain and Ireland, SVT) were approached to answer the questionnaire. Suitable participants from vascular units that were not registered on the CSVS database were contacted by telephone and/or email to take part.

Questionnaire development

The questionnaire was devised by the Oxford University Hospitals (OUH)'s Carotid Audit team that includes clinical vascular scientists, vascular surgeons and neurologists who specialise in stroke. A panel discussion was used to accept, adapt or reject questions to be asked, with the aim of keeping the questions brief, easy to answer and to a limited number. The strengths of the questionnaire, according to the Survey Checklist Manifesto,[14] were that it avoided statements, constructed specific response options with options to specify and expand on key questions, avoided multi-barrelled items, asked each question at a time, used positive language and avoided reverse-scored items. Having an appropriate number of response options was not possible in some of the questions asked, particularly in Q4 where the requirement was to enter several velocity thresholds and ratios. It was decided that a question with many specific response options with the possibility to expand was a better approach than to limit the number of response options. The Online Surveys (Jisc, UK) platform added a professional visual layout, consistency and clarity to each of the questions.

The short questionnaire included 14 questions that were based on current clinical practices when performing carotid ultrasound assessment (see Appendix online at www.jvsgbi.com) and previous audits in the field.[8–10] This included completing a table (early in the survey, Q4) on the velocity thresholds (peak systolic velocity (PSV); end diastolic velocity (EDV)) and PSV ratios that are used to grade

each stenosis category, whether their criteria used the St Mary's ratio (PSV at the ICA:EDV at the common carotid artery (CCA)), the criteria used, the criteria prioritised to grade a stenosis, the criteria used to define string sign or near occlusion and whether quality assurance (QA) or an internal audit had been completed in the unit recently. Each question had a section for the participant to add any other information that was deemed relevant, including any use of their own criteria that had been developed within the unit and that was not listed within the questionnaire. Only one question, based on the location of the vascular unit, was made compulsory to help identify any duplicate answers that would come from the same vascular unit or trust. The primary objective was to determine for each stenosis category the number of distinct thresholds used for each velocity criteria (PSV, EDV, PSV ratio) and their distribution. The second objective for this audit was to determine whether units were using the 2009 UK recommendations or their own criteria, and the methods used to determine a unit's own criteria (and three questions about pre-surgery decisions from the questionnaire have been omitted from further analysis).

Data and statistical analysis

Data from each questionnaire were extracted and managed in Excel (Microsoft) before being analysed using R (RStudio) and Prism (GraphPad). Data with multiple choice answers were categorised and reported accordingly. Any information that was text based was reviewed, interpreted and defined by a senior vascular scientist and a clinical vascular scientist who had previous experience in qualitative research.

Results

Population

Forty-six vascular units, each from separate healthcare trusts, answered the survey, corresponding to 58% of the trusts that perform carotid surgery within the UK and Ireland (n=35, 4, 4 and 3 for England, Scotland, Wales and Ireland, respectively), with only one duplicate response that was excluded. Most of the questionnaires were answered by responders affiliated with the CSVS (93%), with 11% also affiliated with the British Medical Ultrasound Society (BMUS) and 2% only affiliated with BMUS or the Society of Radiographers (SOR). When reporting whether they followed the Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom,[6] 70% said yes, 22% said some, 7% were unsure and 2% reported 'other'.

Velocity criteria

Due to an incomplete response, four units were excluded from further data analysis on the velocity criteria and data are presented for the other 42 separate units (91% of the respondents). Table 1 shows the number of different PSV, EDV and PSV ratio thresholds used to grade each stenosis category. For PSV ratios, the highest number (n=5) of distinct thresholds was for grading ≥50% stenosis. Together with the PSV and EDV thresholds, the highest total number of distinct thresholds (n=13) was for ≥80% decile. Interestingly, all units reported using a PSV for grading ≥70% stenosis whereas, in comparison, PSV ratio and EDV were only used by 90% and 43% of the vascular centres, respectively.

Table 1 Number (n) of separate PSV, EDV or PSV ratio thresholds being used to categorise carotid stenosis, and number of vascular units (% of available data) using each stenosis category.

Stenosis category	PSV n (%)	EDV n (%)	PSV ratio n (%)	Total number of separate thresholds
0–29%	2 (26)	1 (17)	3 (26)	6
30–49%	3 (26)	1 (17)	3 (24)	7
<50%	2 (83)	2 (26)	2 (76)	6
≥50%	2 (88)	3 (36)	5 (86)	10
≥60%	3 (67)	4 (38)	4 (60)	11
≥70%	3 (100)	4 (43)	3 (90)	10
≥80%	4 (55)	5 (40)	4 (43)	13
≥90%	4 (86)	4 (29)	3 (71)	11

PSV, peak systolic velocity; EDV, end diastolic velocity.

Table 2 shows each distinct threshold used for grading a carotid stenosis and the number (%) of units using each threshold. The majority of units use the PSV and PSV ratios recommended in the UK guidelines (highlighted in bold in Table 2). For grading moderate disease (≥50% stenosis), a PSV of >125 cm.s^{-1} and PSV ratio of 2–4 is used by 81% and 71% units, respectively. For grading severe disease (≥70% stenosis), a PSV of >230 cm.s^{-1} and PSV ratio of >4 is used by 90% and 86% of units, respectively, but fewer units use the recommended criteria for grading ≥90% ICA stenosis with a PSV >400 cm.s^{-1} and PSV ratio >5 (76% and 67%, respectively). Some vascular units did report the use of EDV, particularly when grading a severe stenosis, with 43%, 40% and 29% reporting the use of EDV criteria to grade ≥70%, ≥80% and ≥90% stenosis, respectively. Figure 1 shows each PSV and EDV threshold used by every vascular unit to grade ≥70% stenosis and highlights that, by using these two parameters, there are five different criteria (labelled a–f) currently in use to grade a severe stenosis.

Criteria prioritised to grade a stenosis

All vascular units reported on which parameters are used when grading a carotid stenosis. A mean±SD of 5±2 separate ultrasound parameters are used by each unit to grade a carotid stenosis, with the most common criteria being PSV (used by 94% of the units) and PSV ratio (83%), followed by use of St Mary's ratio (78%) and B-mode assessment (74%). EDV is used by 46% of the units, North American Symptomatic Carotid Endarterectomy Trial (NASCET) calliper and European Carotid Surgery Trial (ECST) calliper measurements by 44% and 17% of units, respectively. Other criteria commented on were the use of colour Doppler assessment

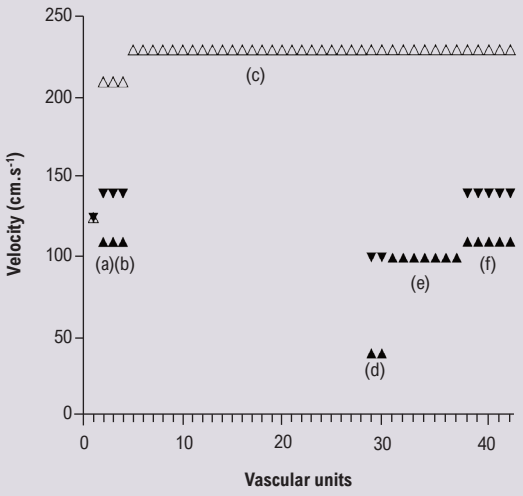
Table 2 List of the velocity thresholds and ratios reported to be used to categorise each ICA stenosis category and the number of vascular units (% of available data) using each category.

Stenosis category	PSV ($cm.s^{-1}$)	n (%)	EDV ($cm.s^{-1}$)	n (%)	PSV ratio	n (%)
0–29%	<100	3 (7)	<40	7 (17)	<1.8	1 (2)
	<125	8 (19)			<2.0	7 (17)
					<3.2	3 (7)
30–49%	<125	7 (17)	<40	7 (17)	<1.8	1 (2)
	100–130	1 (2)			<2.0	6 (14)
	110–130	3 (7)			<3.2	3 (7)
<50%	**<125**	**34 (81)**	<40	10 (24)	<1.8	1 (2)
	110–130	1 (2)	<125	1 (2)	**<2.0**	**31 (74)**
≥50%	**>125**	**34 (81)**	<40	8 (19)	<1.8	1 (2)
	>130	3 (7)	40–100	6 (14)	2.0–2.4	1 (2)
			<125	1 (2)	2.0–3.2	1 (2)
					<3.2	3 (7)
					2.0–4.0	**30 (71)**
≥60%	>125	22 (52)	<40	1 (2)	>1.8	1 (2)
	>130	4 (10)	40–100	7 (17)	2.0–4.0	18 (43)
	>180	2 (5)	40–110	7 (17)	2.4–3.3	1 (2)
			<125	1 (2)	3.2–4.0	5 (12)
≥70%	>125	1 (2)	40–100	2 (5)	>3	1 (2)
	>210	3 (7)	>100	7 (17)	3.4–4.9	1 (2)
	>230	**38 (90)**	110–140	8 (19)	**>4**	**36 (86)**
			<125	1 (2)		
≥80%	>125	1 (2)	40–100	1 (2)	>3.7	1 (2)
	>210	3 (7)	>100	7 (17)	>4	14 (33)
	>230	17 (40)	>125	2 (5)	>5	3 (7)
	>300	2 (5)	>140	6 (14)		
			>180	1 (2)		
>90%	>125	1 (2)	>100	7 (17)	>4	1 (2)
	>210	2 (5)	>125	2 (5)	**>5**	**28 (67)**
	>380	1 (2)	>140	1 (2)	>10	1 (2)
	>400	**32 (76)**	>200	2 (5)		

PSV, peak systolic velocity; EDV, end diastolic velocity.

UK 2009 recommendations are highlighted in bold type.[6]

Figure 1 Cut-off values for peak systolic velocity (PSV; open triangles) and end diastolic velocity (EDV; closed triangles) used for grading ≥70% stenosis in each vascular unit. Upward and downward triangles represent a cut-off point for velocities that are above or below a threshold, respectively. The units are grouped by their given PSV and EDV criteria (each distinct criterion is labelled a–f).



by 11%, one (2%) reported using their own PSV criteria and 11% highlighted the use of ECST calliper measurements only in the presence of a large carotid bulb.

When asked which parameters were prioritised when grading a carotid stenosis, 65% of vascular units reported that they did prioritise, 30% reported that they did not prioritise and 4% did not know. A list of the criteria prioritised and number (% of those reporting yes) of responses for each set of criteria is shown in Figure 2. Overall, the most popular criteria included the use of PSV (28%) with or without another parameter, followed by PSV ratio (20%), St Mary's ratio (11%), B-mode (2%), EDV (7%) and NASCET calliper (4%).

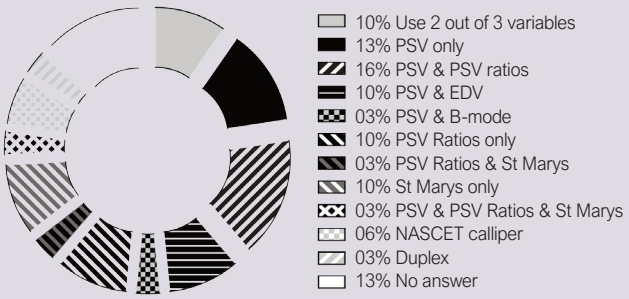
Near occlusion

Forty-five units (98%) answered the question on how they defined 'near occlusion/string sign based on duplex imaging'. To define string sign, the appearance of a narrow channel of flow characterised using colour Doppler (89%) and velocity measurement (76%) was the most common answer. 70% of units highlighted the importance of using low velocities, but only a small proportion of units mentioned a specific velocity criterion of <20 $cm.s^{-1}$ (4%) and >400 $cm.s^{-1}$ (2%). The use of B-mode (30%) and waveform characteristics (22%) was also reported, as was the collapse of the distal vessel (7%), power Doppler (9%), EDV (4%) and B-flow/microvascular imaging (4%).

Internal audits and quality assurance

All units answered whether they performed an internal audit or QA in relation to the use of ultrasound to grade a carotid stenosis; 22% of units reported that they had, 37% reported they had not with 26% reporting that they 'would like to but no time' and 'other' was reported by 15%. Some (39%) expanded on how recent the last review occurred. One unit had just completed an audit, one reported performing regularly, three within the last year, three within the last three years and two within the last 10 years. Some of the

Figure 2 Pie chart of the parameters prioritised to grade carotid stenosis and number (% of those answering yes) of vascular units using each set of parameters. EDV, end diastolic velocity; PSV, peak systolic velocity.



responses highlighted the ongoing comparisons during MDTs of duplex with other imaging modalities (eg, CTA) or following surgery, particularly if there were discrepancies, or regularly sampling either 5% of all the scans or comparing assessments that have been repeated before surgery. Forty-five units (98%) answered the question on whether there was intention to perform an internal audit in the future and when this would take place, whereas 53% reported not applicable, and 11%, 13% and 9% reported that it will be performed in 6 months, 12 months or 2 years' time, respectively, and 13% reported 'other'. Two units expanded on their answers and reported that it would occur when staffing levels are sufficient.

Discussion

This audit confirms that most vascular units within the UK and Ireland now use the same PSV and PSV ratios for grading moderate and severe carotid artery disease and that the 2009 UK recommendations have been well received. However, some disparity remains between vascular units, with more variation in grading severe rather than moderate disease, some units also use EDV to categorise a stenosis, a lack of consensus in the parameters that should be prioritised when grading a stenosis or in how a near occlusion and string flow is defined on ultrasound, and inconsistent practice on internal audits and QA.

When comparing the results from this audit to the two previous audits conducted in the UK and Ireland,[9,10] there is much less variability apparent in current practice. The most popular criterion used in 2000 to categorise a carotid stenosis was the ratio of the PSV to the EDV in the ICA (used by 36% of the units), with many cut-off values reported to have been devised in-house. Only one vascular unit reported using an in-house criterion within this audit. Other vascular units reported PSV, EDV and PSV ratios established within the literature, such as those recommended by the SRU in 2003[5] and later supported by the Vascular Society of Great Britain and Ireland in the UK in 2009.[6] The recommendations in the UK were prompted by the 2006 UK and Ireland audit[10] which highlighted that a variety of PSV and EDV criteria were being used to categorise severe stenosis of ≥70%. This audit confirms that these published guidelines and recommendations have reduced the variability between vascular units but, specifically, only in the PSV and PSV ratio criteria being used to grade a ≥50% stenosis (81% use >125 cm.s^{-1} and 71% use a ratio of 2–4) and a ≥70% stenosis (90% use >230 cm.s^{-1} and 86% use a ratio of >4).

However, there remains considerable variability in the practices and criteria not reported within current UK recommendations. Although the UK recommendations report that the EDV within the ICA should be recorded, it does not expand on an EDV cut-off value that can be used to grade a stenosis. This contrasts with the SRU 2003 guidelines which recommend using EDV values in the ICA of 40–100 cm.s^{-1} to grade 50–69% stenosis and >100 cm.s^{-1} to grade >70% stenosis. The CSVS (to which 93% of responders to this audit were affiliated) guidelines on performing carotid ultrasound reports on the usefulness of using EDV values suggested by the SRU 2003 guidelines to grade a stenosis.[15] In this audit 46% of the vascular units reported using ICA EDV cut-off values, with up to 17% specifically using values that are recommended by SRU guidelines (see Figure 1e). Thus, with some vascular units also using EDV to grade ≥70%, ≥80% and ≥90% stenosis, vascular centres have opted to use a range of previously published thresholds, adding to the variability in practices. Of note, Columbo *et al*[8] recently described considerable variation in the thresholds used for carotid stenosis grading using ultrasound between centres in the USA and concluded that this variation could change the diagnosis of patients, depending on where the carotid ultrasound was performed. Their audit of 338 vascular testing centres described a total of 29 and 37 different PSV, EDV and PSV ratio thresholds for grading ≥50% and ≥70% stenosis, respectively. There is a similar amount of variability present in the UK and Ireland, with a total of 10 and 13 different separate cut-off values used among just 42 centres.

Although 65% of vascular units said they prioritised a specific criterion to grade a stenosis, which criteria they used varied, indicating there is uncertainty as to which are the best criteria to use. Only 10% reported using the UK recommendations (an agreement between two out of three parameters is used to grade a stenosis). Prioritising the use of a single velocity measurement parameter such as the PSV with visual appearance (B-mode and colour Doppler) is supported by SRU 2003.[5] More recent guidelines by the Neurosonology Research Group of the World Federation of Neurology[7] highlight the variability that can arise between measurements from using only the PSV (due to technological limitations and complexity of the circulation) and the benefit of using a multi-parametric approach. Although uptake of some of this guidance was apparent with half of the vascular units using PSV in combination with other parameters, there was no consensus on which group of parameters is best to grade a stenosis.

The St Mary's ratio (comparing PSV in the ICA to the EDV in the CCA) is recommended in the UK to grade in deciles >50% and is currently being used by 78% of vascular units. However, the

accuracy of ultrasound to stratify disease and separate deciles within moderate (>50% vs >60%) or severe disease (>70% vs >80%) has been disputed and discouraged in current guidelines.[5,7] What was apparent within this audit was that some vascular units use EDV to grade >60% and >80% stenosis, as the PSV and PSV ratios in their respective deciles (50% and 70%) are the same. There is now growing evidence that asymptomatic patients have a higher risk of stroke when categorised with an 80–99% stenosis compared with a 50–79% stenosis,[16] possibly warranting consideration for vascular intervention. Thus, there is clinical need to stratify significant disease outside the current dichotomised norm of >50% and >70% stenosis.

Only 17% of the vascular units reported using the ECST calliper method to measure the degree of stenosis, and this was in relation to the recommendation of it being an additional measurement in the presence of a large carotid bulb. Although Walker and Naylor[10] reported that 43% of respondents indicated that they did not know which criteria they were using, in those that did report using the ECST method, velocity cut-offs were generally around a PSV of 180 $cm.s^{-1}$ or lower. These velocities were reported by one vascular unit in this audit (Figure 1) who did not expand on whether this was due to ECST-based criteria. However, Figure 1 also confirms the shift to grading the stenosis using NASCET-based ratios and velocity criteria, which could be one reason why the data for PSV had less variability. Of note, by only comparing PSV and EDV to categorise >70% stenosis (Figure 1), there were 25 different criteria being used in 2006. This number has now decreased substantially to six (labelled a–f in Figure 1). However, although 90% of the vascular units now use the same PSV of >230 $cm.s^{-1}$ to grade >70% stenosis, 57% follow the UK guidelines (Figure 1c) with the other 43% reporting a mixture of EDV and PSV to grade this category. Additionally, there was a mixed response to defining near occlusion or string sign based on duplex imaging. The UK recommendations[6] describe near occlusion with a PSV that is high, low-string flow with a variable PSV ratio and St Mary's ratio. Although the use of colour Doppler and velocities were common answers to the question in this audit, there was no clear definition on the criteria and parameters to stratify this clinically important disposition.

Finally, only 24% of centres reported that they have performed an internal audit or a QA. In comparison, the audit in 2000 by Perkins *et al*[9] described 51% of the vascular units validating their duplex criteria against angiography, with 36% using criteria validated in the literature or by another vascular unit. In our study, few vascular units clearly described the practice of comparing the ultrasound data to other imaging modalities, with many describing lack of time and resources as a key factor in not conducting any audit. Although there is renewed guidance on performing QA and audits on staff performance[17] and equipment,[18] it is apparent that there is now more of an emphasis on using criteria published in the literature without performing additional internal audits to corroborate the suitability of the criteria to their own practices or equipment, which could influence the grading of the severity of the disease.[19–21] The 2006 Health Technology Assessment in using imaging modalities to assess carotid stenosis in the UK[22] reported the cost effectiveness of ultrasound and its comparability to other imaging modalities in accurately grading carotid artery disease. However, it was also reported that ultrasound imaging should be carefully audited when used routinely in clinical practice to maintain accuracy. To increase consensus and lessen the variability between centres, it could be recommended that a central audit office is formed to regularly analyse, monitor and compare the diagnostic accuracy of each vascular centre.[22]

Limitations

There was a good overall response rate to the questionnaire (58%), and although the response was a little lower than the two previous audits in the UK, there was a greater emphasis within this audit on gaining a response from each separate health board trust that performs carotid endarterectomy rather than gaining many vascular units or vascular scientists to complete the questionnaire. It was also presumed that separate tertiary vascular units would follow the same protocol and criteria and, to evade duplicate answers, it was decided that a response from one vascular unit from each trust would suffice. There was also emphasis on gaining a broader response in the clinical practice of the vascular units, which included a combination of velocity cut-off values for each stenosis category, parameters used, how near occlusion is defined and on whether internal audits are performed without jeopardising an incomplete response. Using a forced choice format would have added a substantial amount of time to answering the questionnaire but would have ensured that each question was answered and highlight any questions unanswered.[14] A check-all-that-apply format could also have resulted in respondents picking more items towards the top of the list.[14] However, this was not apparent in the data collected. Despite only making one question compulsory (location of the vascular unit), there was an excellent response to each of the questions, excluding the four incomplete answers received for the velocity cut-off criteria. Some questions could have been more specific about the vascular unit's practice; however, it was decided that giving the option to further expand on all the questions was better practice than having a substantial number of incomplete answers. Finally, the method of promoting and dispersing the questionnaire, with the help of the CSVS database, could be interpreted as being reflected in the affiliation of each respondent to the society (93%), but this could also reflect the association and impact of the CSVS within vascular units in the UK and Ireland.

Conclusion

This audit demonstrates that previous guidelines and recommendations have had an impact on clinical practices in grading carotid artery disease within the UK and Ireland. The 2009 UK recommendations have standardised key practices when grading moderate and severe disease with PSV, velocity ratios and

KEY MESSAGES

- The 2009 UK recommendations for grading carotid artery disease with ultrasound has standardised key practices in grading moderate and severe disease with peak systolic velocity, velocity ratios and in the use of the St Mary's ratio to grade in deciles.
- Vascular units vary in the application of some recommendations, including the use of end diastolic velocity to grade severe disease, the parameters to prioritise when grading disease, how near occlusion is defined on duplex imaging and performing internal audits and quality assurance.
- There is room for further guidance in these important practices when performing carotid ultrasound.

in the use of the St Mary's ratio to grade in deciles. But vascular units do vary their practices in areas of carotid ultrasound that are not reported in the current recommendations, such as the use of EDV, prioritising parameters to use when grading a stenosis and in how near occlusion is defined. Together with a lack of emphasis by vascular units to perform internal audits and QA, there is room for further guidance in these important practices when performing carotid ultrasound.

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PROTOCOL

Use of rigid dressings versus soft dressings in the management of lower limb amputations: a systematic review protocol

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Plain English Summary

Why we are undertaking this work: Amputations of the lower limb are occasionally a necessary treatment performed in such cases as severe diabetic foot infection, severely impaired blood supply to the legs or major trauma. After amputation, the remaining limb is usually bandaged to help with wound healing, pain control and swelling reduction. Several studies have investigated different types of dressings to assess if they have an impact on wound healing and mobility after surgery. This review will put together the findings of those studies to guide management of patients after amputation.

What we will do: We will review the results of published studies that compare rigid and soft dressings in patients who have undergone lower limb amputation. We will assess the benefits of each type of dressing and summarise the findings.

What this means: A review of the existing evidence will help us determine if rigid dressings have the potential to improve results after surgery compared with soft dressings. We will then be able to develop clinical guidance for the management of patients after lower limb amputation.

Abstract

Background: Amputation of the lower limb is a procedure that is commonly performed, most notably in patients with diabetes, lower limb ischaemia and trauma. Wound dressings can impact patient outcomes such as wound healing, complication risk and time taken to prosthesis fitting. Recent studies have investigated the effect of rigid versus soft dressings with regard to these outcomes. The aim of this systematic review is to compare the effectiveness of rigid dressings against soft dressings among patients who have undergone lower limb amputation.

Methods: A literature search will be conducted in OVID Medline, EMBASE and the Cochrane CENTRAL databases, reference lists from included articles and previous reviews on the topic. The terms used in the search will include “above knee amputation”, “through knee amputation”, “below knee amputation”, “lower limb”, “rigid dressing”, “removable rigid dressing”, “plaster dressing”, “soft dressing”, “elastic dressing” and “elastic bandage”. Randomised clinical trials that look at both transfemoral and transtibial amputations for any indication will be included if they compared the impact of using rigid dressings versus soft dressings on patient outcomes. The primary study outcome is a composite of infection, dehiscence, collection or amputation-related readmission within 30 days or reoperation within 90 days. The Cochrane Risk of Bias (RoB 2) tool for randomised trials will be used for bias risk assessment and a meta-analysis of clinically homogenous studies will be performed using Review Manager (RevMan). A narrative systematic summary will be performed for data not amenable to meta-analysis.

Ethics and dissemination: This is a systematic review of published literature data and therefore ethics approval is not required.

Key words: soft dressing, rigid dressing, lower limb amputation, above knee amputation, below knee amputation

Introduction

Amputation is often the most appropriate treatment for patients with a non-salvageable ischaemic limb, fulminant diabetic infection or after major trauma.[1] The aim of the procedure is to relieve pain, preserve life and facilitate prosthetic reconstruction of the limb. In the UK, the annual lower limb amputation (LLA) rate is 11 per 100,000 in the population aged 25+ years.[2] However, LLAs continue to be associated with high rates of postoperative complications, with additional surgical revisions and delayed wound healing being the most common.[3]

At the end of the amputation procedure a local wound dressing is applied, and this is usually followed by application of dressings that cover the residual limb, which helps protect the wound, reduce swelling and shaping of the residual limb. These measures aim to facilitate successful wound healing, reduce pain, maintain the range of motion and strength of the lower limb, and expedite prosthetic fitting.[4] There are two main types of dressings that can be applied after a LLA – namely, soft and rigid dressings. The type of stump dressing used has an impact on these goals as inadequate shrinkage of the residual limb and swelling can impair circulation and wound healing.[5]

Soft dressings comprising elastic materials such as crepe bandages and compression socks are the most commonly used postoperative dressing owing to their low cost, availability and ease of application.[6] Rigid dressings, on the other hand, employ hard exterior materials. These include removable rigid dressings such as vacuum-formed removable rigid dressings, and conventional rigid dressings such as plaster of Paris and plastic casts. They have grown in popularity as some specialists believe that they promote faster wound healing and reduce the time to prosthetic fitting.[7] Additionally, rigid dressings have been proposed to provide the residual limb with better protection from trauma by reducing the incidence of injury following falls.[5] However, they are more expensive than conventional dressings and, in many cases, require skilled personnel to safely apply them.[8]

Since the removable rigid dressing was first described by Wu *et al* in 1977,[9] several studies have investigated its efficacy against soft dressings in LLA. Despite this, there has been no clinical consensus on which type of dressing leads to better patient outcomes. A 2018 Cochrane review concluded that there was insufficient evidence that either type of dressing is superior following amputation.[10] The conclusions were made mainly due to the limitations in the design and execution of the studies included. However, two randomised clinical trials (RCTs) have since been published and their results may have a bearing on that conclusion.[11,12] Despite a recent systematic review published by Koonalinthip *et al* in 2023 which incorporated the two published RCTs, the results remained inconclusive owing to the inclusion of several poor-quality non-randomised studies.[13] This systematic review aims to determine the clinical effectiveness of rigid dressings compared with soft dressings in the management of the residual stump following LLA. We intend to measure wound complications as a composite primary outcome derived from the existing literature, as this is expected to serve as a robust measure of the clinical effectiveness of rigid dressings.

Methods

This systematic review is prospectively registered on the International Prospective Register of Systematic Reviews (PROSPERO) database (reference: CRD42024563421). The methods used in this review and its reporting are in line with the Preferred Reporting items for Systematic Reviews and Meta-analyses Protocols (PRISMA-P) guidelines and checklist.[14]

Search strategy

Sources that will be used to obtain studies for this review are EMBASE, OVID MedLine, Cochrane CENTRAL and CINAHL databases, and reference lists from previous reviews and included articles. No search date constraints will be applied.

A search with pre-defined search terms will be conducted in consultation with a qualified medical librarian. The databases will be searched for studies comparing the effects of rigid dressings versus soft dressings using keywords, equivalent terms and medical subject headings to maximise the search sensitivity. Search terms will include and are not limited to "lower limb amputation", "above knee amputation", "below knee amputation", "rigid dressing", "semi-rigid dressing" and "soft dressing". A draft search strategy is shown in Appendix 1 (online at www.jvsgbi.com).

Inclusion criteria

All English language prospective RCTs of adult patients comparing the use of rigid dressings against soft dressings among patients who have undergone LLA at the transtibial, transfemoral or through-knee level will be eligible for inclusion in this systematic review. The types of rigid dressing include, but are not limited to, plaster cast socket, Unna semi-rigid dressings and vacuum-formed removable rigid dressings. Soft dressings include elastic bandages, cotton stockinette, compression socks and crepe bandages. The use of local wound dressings without a formal stump dressing is also permissible and will be included in the comparison as a type of soft dressing.

Study selection

The COVIDENCE web tool will be used for screening, study selection, data extraction and quality assessment. Search results will be uploaded to the web tool, followed by automatic duplicate identification and the manual removal of duplicates. These will then be screened independently by two authors. Eligibility of studies will be determined based on the title and abstract initially. After elimination of ineligible studies at this initial stage, full review of the manuscripts of the remaining articles will take place. Studies will be included by consensus and, if this is not reached, a third reviewer will provide arbitration. Where necessary, study authors will be contacted for further data or clarification.

Data extraction and management

Summary statistics of participant baseline characteristics, dressing type, study sample size, primary outcomes and amputation type will be collected and presented in a table. In addition, conflicts of interest, study funding and other sources of bias will be reported where available.

Raw data will be extracted from the manuscripts and entered into a dedicated Microsoft Excel (Microsoft, Redmond, Washington, USA) spreadsheet and Review Manager (RevMan) (Cochrane Collaboration, London, UK) prior to analysis.

Assessment of methodological quality

The risk of bias in selected RCTs will be assessed using the revised Cochrane Risk of Bias (RoB 2) tool for randomised trials.[15] Two authors will independently assess each study, with any disagreements resolved by consensus or arbitrated by a third author. A narrative summary will be provided for studies deemed to have a critical risk of bias or no information and these will be excluded from data analysis and synthesis.

The Grading of Recommendations, Assessment, Development and Evaluations (GRADE) system will be used to assess the certainty of the evidence for each outcome.[16] Outcome certainty will be rated as "very low", "low", "moderate" or "high" per guidelines.

Outcomes

The primary outcome will be a composite of wound complications, defined as infection, dehiscence, collection or amputation-related readmission within 30 days or reoperation within 90 days.

The secondary outcomes include healing time, defined as time in days from amputation to wound closure; length of hospital stay following surgery; time to prosthetic fitting, defined as time in days from surgery to first prosthetic fitting; post-procedural pain; patient satisfaction; and adverse effects which include return to theatre post-amputation, joint contracture and death from any cause.

Statistical analysis

A forest plot summary will be provided for all meta-analyses. Continuous outcomes will be analysed and reported using mean or standardised mean difference (SMD) with a 95% confidence interval (CI). Dichotomous outcomes will be reported as risk ratios with 95% CI and, for time-to-event data, a hazard ratio with a 95% CI will be reported. Clinical homogeneity of selected RCTs will be assessed with respect to patient demographics, type of intervention and types of outcome assessment. If clinical homogeneity criteria are satisfied, statistical heterogeneity will be assessed using the χ^2 and I^2 tests. A fixed effects model meta-analysis will be performed for studies where statistical heterogeneity is ≤60%, and for those >60% a random effects model will be used. Subgroup meta-analysis of studies included in any random effects model will be considered if the cause of statistical heterogeneity can be identified, such as a difference in amputation indication or presence of diabetes. A narrative review will be provided for outcomes that cannot be quantified or analysed in a meta-analysis.

KEY MESSAGES

- The aim of this review is to compare the effect of rigid dressings versus soft dressings on patient outcomes following major lower limb amputation.
- All English language randomised clinical trials comparing rigid dressings against soft dressings in patients who have undergone lower limb amputation will be included.
- The primary outcome will be a composite of wound complications defined as infection, dehiscence, collection or amputation-related readmission within 30 days or reoperation within 90 days.

Discussion

Amputation is a major life event for patients, their families and wider support network. All aspects of clinical care that is involved in such an event should be optimised in order to minimise complications and facilitate rehabilitation so that patients recover and take the next stage in their life journey. Professional bodies such as the British Association of Chartered Physiotherapists in Amputee Rehabilitation recommend rigid dressings,[17] while others including Cochrane deemed that there was uncertain evidence in this area.10 A robust updated look at the evidence in this area will provide clarity in light of recent RCT evidence. This will inform future practice and help improve patient outcomes following LLA.

Conflict of Interest: The authors declare that there are no conflicts of interest.

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ABSTRACTS

VASGBI Annual Scientific Meeting 2024, Leeds, 9-10th September, oral presentation top abstracts

Authors of the top scoring abstracts submitted were given the opportunity to give an oral presentation of their work during our free paper session. The first paper, by Akshay Shah *et al* was awarded first prize.

Platelet function in patients undergoing major non-cardiac vascular surgery (PLUGS): A prospective cohort study

Akshay Shah,[1] Grace Polley,[2] Kasia Bera,[3] Keith Maher,[4] Stephen Von-Kier,[4] Antonio Barbosa,[4] Louis Corrigan,[5] Sabeena Sharma,[6] Michael Desborough,[7] Stuart McKechnie[2,6] on behalf of the PLUGS Investigators

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Background

$P2Y_{12}$ inhibitors, such as clopidogrel, pose challenges to vascular anaesthetists particularly when regional/central neuraxial anaesthesia is being considered. Current guidelines recommend discontinuation of clopidogrel 5–7 days prior to major surgery to reduce the risk of bleeding, but also before attempting central neuraxial anaesthesia to mitigate the rare risk of developing a vertebral canal haematoma.[1] However, guideline recommendations do not take into consideration the individual variability in pharmacodynamic responsiveness to clopidogrel. Approximately 32% of patients on clopidogrel may be non-responders.[2] The leading question in a VASGBI research priority setting exercise was – "Can regional anaesthesia safely be performed on patients taking clopidogrel and similar antiplatelet agents?".

Aims

The aim of this study was to characterise platelet function in patients undergoing vascular surgery using near-patient viscoelastic testing (Thromboelastography (TEG®) 6S).

Methods

PLUGS was a single-centre, prospective, non-interventional cohort study conducted at the John Radcliffe Hospital, Oxford, UK. The study was prospectively registered (ISRCTN11959105). Inclusion criteria were: (i) age >18 years; (ii) scheduled to undergo vascular surgery (carotid endarterectomy, abdominal aortic aneurysm (open or endovascular), lower limb arterial revascularisation and lower limb amputation); and (iii) established on antiplatelet therapy for at least 7 days before entering the study. Study-specific blood samples were collected at pre-operative assessment clinic (POAC) visit and on the day of surgery. Baseline demographic, laboratory procedure-related, and clinical outcome data were collected for each participant. The primary outcome of interest was the proportion of patients with antiplatelet drug resistance at (i) initial presentation to POAC and (ii) on the morning of the surgery.

Results

Between 9 June 2022 and 17 April 2023, 80 participants were enrolled of which 64 proceeded to have surgery. The mean (SD) age was 71.7 (12.1) years, and 69 participants were male. Fifty-two participants had >2 pre-exisiting comorbidities. The commonest operation was abdominal aortic aneurysm repair (n=25) followed by carotid endarterectomy (n=20). The proportion of patients with antiplatelet resistance at POAC ranged from 25% to 70% (Table 1a). Approximately three-quarters of patients taking clopidogrel displayed antiplatelet resistance. Medication compliance was generally good

Table 1

a) Platelet function at pre-operative assessment clinic (n=80)

	Aspirin (n=20)	Clopidogrel (n=20)	DAPT (n=20)	Control (n=20)
MA_{AA}, mm	39.7 (15.2)	43.8 (17.9)	28.1 (16.8)	61.1 (5.1)
AA-inhibition, %	48.9 (28.5)	38.4 (35.7)	68.0 (31.9)	9.8 (16.7)
MA_{ADP}	58.9 (11.3)	54.8 (11.1)	47.8 (16.5)	55.8 (11.4)
ADP-inhibition, %	9.9 (13.1)	18.1 (16.9)	31.5 (31.0)	10.1 (19.1)
vWF	1.7 (0.51)	2.0 (1.2)	1.89 (0.5)	1.6 (0.5)
No. of patients with antiplatelet resistance, n (%, 95% CI)	6 (30, 11-54))	14 (70, 45-88)	5 (25, 8-49)	-

b) Platelet function on day of surgery (n=40)

	Aspirin (n=13)	Clopidogrel (n=6)	DAPT (n=10)	Control (n=12)
MA_{AA}, mm	44.6 (13.9)	37.5 (22.1)	27.5 (17.0)	61.8 (3.3)
AA-inhibition, %	36.5 (25.3)	64.0 (48.6)	70.6 (35.8)	11.9 (24.7)
MA_{ADP}	61.6 (5.4)	51.3 (11.6)	49.9 (11.1)	47.2 (21.2)
ADP-inhibition, %	6.4 (7.9)	31.0 (14.4)	27.9 (22.2)	14.8 (23.3)
No. of patients with antiplatelet resistance, n (%, 95%CI)	2 (15, 2-45)	5 (83, 35-99)	3 (3, 6-65)	-

c) Effect of stopping clopidogrel on clot strength (MA_{ADP}) and ADP-induced platelet inhibition (n=8)

	Pre-operative	Day of surgery	Mean difference (95%CI)	P value
MA_{ADP}	52.7 (10.7)	56.1 (11.7)	3.4 (16.3 to -10.2)	0.57
ADP-inhibition, %	20.7 (18.6)	10.6 (15.5)	-10 (18.3 to -25.4)	0.16

AA, arachidonic acid; ADP, adenosine diphosphate; CI, Confidence interval; DAPT, Dual antiplatelet therapy; MA, maximum amplitude
Protocol definitions of resistance:
For aspirin – group (i), drug resistance was be defined as an arachidonic acid (AA)-induced platelet-fibrin clot strength (MA_{AA}) > 47 mm plus an AA-induced platelet inhibition rate < 50% (18). For $P2Y_{12}$ inhibitors (clopidogrel) – group (ii), drug resistance was be defined as an adenosine diphosphate (ADP)-induced platelet-fibrin clot strength (MA_{ADP}) > 47 mm plus an ADP-induced platelet inhibition rate < 50%.

with only four patients forgetting to take their medications (on 1-2 days) in the preceding two weeks. On the day of surgery, the proportion of patients with antiplatelet resistance ranged from 15.3 to 83.3% (Table 1b). In an exploratory analysis, stopping clopidogrel 5-7 days before surgery demonstrated no statistically significant changes in platelet clot strength and ADP-induced platelet inhibition (Table 1c).

Conclusion

This study confirms a high prevalence of antiplatelet, particularly clopidogrel, resistance.[3] This combined, with the introduction of CYP2C19 genotype testing, offers an opportunity for precision-based medicine in vascular surgery. Using our approach, a large, adequately powered, multicentre study is feasible to confirm our findings and to clarify the role of resistance testing on clinical outcomes.

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A single institute, 3-year, service evaluation of outcomes for carotid endarterectomy using general or regional anaesthesia techniques

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Following the completion of the GALA study in 2008[1] controversies still exists among vascular units regarding the preferred anaesthetic technique for carotid endarterectomy (CEA).

As part of a service evaluation, patients undergoing CEA at St Mary's Hospital, Imperial College Healthcare NHS Trust, were retrospectively analysed between December 2019 and December 2022. Aims were to compare these data to the National Vascular Registry (2021)[2] and to explore if anaesthetic technique influenced duration in recovery, use of postoperative vasopressors or admission to critical care. Analysis was performed using R v.4.0.0.

One hundred and forty-seven patients were identified (Table 1), 72% male (n=106), median age 71 (IQR 64-78), 86% (n=126) suffered an acute stroke or transient ischaemic attack (TIA). Median duration from symptoms to surgery was 12 days (IQR 7-25), mirroring national data (13 days, IQR 8-22).[2]

General anaesthesia (GA) accounted for 51% of cases with the remainder performed under regional anaesthesia (RA), (79%, intermediate and 21%, deep cervical plexus). 30% performed under GA also included a regional component. This was in stark contrast to national data with 64% of cases being performed under GA alone, 11% under GA with a block or local anaesthetic (LA) component and only 18% were performed under block alone.

Table 1 Comparison between those having regional vs general anaesthesia for carotid endarterectomy

	All (*n=147*)	Regional* (*n=71 (49%)*)	GA* (*n=74 (51%)*)	*P* value
Male sex	106 (72%)	52 (73%)	52 (70%)	0.71
Age on procedure date	71 (64 – 78)	72 (66 – 80)	69 (62 – 76)	0.22
Stroke or TIA	126 (86%)	58 (82%)	66 (88%)	0.34
Symptoms to surgery (Days)	12 (7 – 25)	10 (7 – 23)	14 (7 – 33)	0.14
Preoperative				
Performance status (admission)	1 (1 – 3)	1 (0 – 1)	0 (0 – 1)	0.28
ASA	3 (3 – 3)	3 (3 – 3)	3 (3 – 3)	0.99
Stroke	85 (57%)	34 (48%)	49 (65%)	0.03
Ischaemic Heart Disease	49 (33%)	29 (41%)	20 (27%)	0.08
Essential Hypertension	103 (70%)	48 (68%)	53 (72%)	0.72
Hypercholesteraemic	103 (70%)	50 (70%)	51 (69%)	0.86
Diabetes Mellitus	43 (29%)	22 (31%)	19 (26%)	0.60
COPD or Asthma	29 (20%)	17 (24%)	12 (16%)	0.30
Obesity	25 (17%)	12 (17%)	13 (17%)	1.00
Ex or current smoker	83 (56%)	41 (58%)	40 (54%)	0.14
Intraoperative				
Shunt placed	27 (19%)	7 (10%)	20 (27%)	0.01
Surgery duration (Mins.)	117 (91 – 143)	106 (78 – 134)	126 (101 – 148)	0.006
Intra-operative vasopressor	125 (87%)	52 (72%)	73 (99%)	<0.0001
Fluids administered (mL)	1000 (500 – 1975)	600 (0 – 1000)	1700 (1000 – 2000)	<0.0001
Postoperative				
Duration in recovery (Mins.)	325 (255 – 575)	320 (240 – 493)	335 (256 – 588)	0.50
Return to theatre	6 (4%)	5 (7%)	1 (1%)	0.11
Recovery vasopressor	47 (32%)	22 (31%)	25 (33%)	0.90
Critical care review	35 (24%)	21 (30%)	14 (19%)	0.17
Critical care admission	33 (22%)	20 (28%)	13 (17%)	0.16
Discharge				
Length of stay (Days)	2 (1 – 4)	2 (1 – 3.25)	2 (1 – 4)	0.82
Performance status (discharge)	1 (0 – 2)	1 (0 – 2)	1 (0 – 2)	0.73
Stroke at one year	7 (5%)	5 (7%)	2 (3%)	0.27

ASA, American Society of Anesthesiology. COPD, Chronic Obstructive Pulmonary Disease. GA, General Anaesthetic. TIA, Transient Ischaemic Attack.

** 2 patients in cohort missing values for method of anaesthesia, therefore unassigned to either GA or regional anaesthesia techniques.*
Data are presented as absolute counts or median values and in parenthesis either the interquartile range or a percentage.
Comparisons are either by a Mann-Whitney U test or a Fisher's exact test as appropriate.
P values displayed are uncorrected for multiple comparisons.

No differences were identified in the incidence of preoperative hypertension, hypercholesterolaemia, diabetes mellitus, chronic lung disease, obesity or smoking status in RA or GA. However, GA patients trended towards a reduced incidence of preoperative ischaemic heart disease, 27% vs 41% (P=0.08), but an increased incidence of preoperative stroke, 65% vs. 48% (P=0.03). Our

institution rarely utilised shunts (19%), compared to national data (64%). Shunt usage was reduced in RA, 10% vs 27% (P=0.01). In those patients undergoing GA, 67% had concomitant near infrared spectrophotometry monitoring documented.

Surgery duration was reduced in RA patients (P=0.006), they also received less intraoperative fluid (P<0.0001) and were less likely to require intraoperative vasopressors (P<0.0001). No differences were detected when comparing duration in recovery or postoperative vasopressor requirements. There were no statistical differences in return to theatre rate (7% vs. 1%, P=0.11), or critical care admission (28% vs. 17%, P=0.16) when comparing RA to GA.

The length of stay and discharge performance status was consistent between RA and GA; at one year there was no statistical differences in incidence of stroke (7% vs. 3%, P=0.27).

In this hypothesis generating service evaluation, despite our unit using differing anaesthetic strategies to published national data, we demonstrated similar outcomes. Anaesthetic choice did not appear to influence use of vasopressors in recovery, duration in recovery or admission to critical care, although this may be affected by study power. These data may reflect the conclusions from the pragmatic GALA trial illustrating that major perioperative outcomes after CEA are broadly similar between RA and GA and are reflective of unit experience and expertise.

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Inter-test reliability of point of care platelet function tests: comparison of multiplate and TEG platelet mapping in patients with peripheral arterial disease taking clopidogrel

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A high proportion of patients with peripheral arterial disease (PAD) take clopidogrel as a routine antiplatelet. For patients undergoing vascular surgery, neuraxial anaesthetic blockade (NAB) is typically preferred over a general anaesthetic due to concurrent patient illness. Current guidance suggests omission of clopidogrel for 5-7 days for NAB, which may not be feasible for emergency surgery. A proportion of the population have a genetic polymorphism in clopidogrel metabolism, resulting in a reduced antiplatelet effect, contributing to High on Treatment Platelet Reactivity (HTPR). These patients potentially could have NAB earlier than 7 days; however, this requires accurate and reproducible point of care (POC) testing of platelet function, this currently is an under investigated area, with no common consensus on a reliable POC cut-offs. Our study primarily aims to determine the degree of correlation between TEG-6S PlateletMapping (PM) and Rotem Multiplate (RM) POC analyser and the proportion of patient suitable for NAB using surrogate HTPR cut-offs from cardiac anaesthesia, with a secondary aim to determine any difference in platelet inhibition between a cohort of ward and clinic patients.

We conducted a single-centre, prospective cross-sectional study of vascular ward and claudication clinic patients at the Royal Sussex County Hospital (Brighton, UK). Venous blood was obtained and analysed by both RM and PM. Baseline demographic and clinical data was collected prospectively. The study gained ethical approval from London – Fulham Research Ethics Committee. Informed consent was obtained from participants.

Sixty patients were recruited, 68% were male; the median age was 68 years. We found a moderate correlation from the two analysers for paired samples (R=0.63, P<0.001)). Using published consensus cut-off values for HTPR of area-under-the-curve (AUC) 46U for RM and maximum amplitude (MA) 47mm. 67.7% of RM and 69.5% of PM measured patients were safe to proceed with NAB. No difference was found in in AUC or MA between ward and patients, however fibrin was higher in ward patients compared to clinic (17.0 versus 12.6, P=0.003), in addition AUC was found to be higher in females versus males (78 and 61U respectively, P=0.049). Statistical analyses was carried out using GraphPad Prism 8 software.

Guidelines regarding the role of platelet testing in peri-operative decision making exist in relation to cardiac surgery, but not yet for use of NAB in vascular surgery.[1] Our finding suggests that there may be a high proportion patient suitable for safe NAB whilst taking clopidogrel, however variability in POC results remain which adds uncertainty in identification of these patients. Further work is required in this field. This maybe the first step in developing a personalised antiplatelet management for patients needing vascular surgery.

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NEWS

Updates from the Vascular Societies

JVSGBI is owned by the Vascular Society for Great Britain and Ireland (VSGBI), for all affiliated societies and the wider vascular community. Here's the latest society news.

Rouleaux Club

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ROULEAUX CLUB
UK Vascular Trainees' Association

It's hard to believe that it's been almost a year since Dublin, but time flies and the Rouleaux Club are once again preparing for a busy schedule at the upcoming 2024 ASM in Brighton.

As in previous years, the association will be hosting an 'Introduction to Vascular Surgery' course on the Wednesday of the conference, which is opened to medical students and resident doctors who have an interest in the specialty. Once again, the Rouleaux Club are grateful to the support from our industrial partners who support these events and really add to the hands-on experience of the participants.

On the Thursday, the Rouleaux Club are teaming up with the Vascular Society to run the case-based 'MDT session', which this year runs standalone in the schedule. On the final day, we will be hosting our annual 'Rouleaux Club Symposium', which this year is themed around the current state of vascular training in the modern NHS. These run alongside sessions from the Venous Forum and Circulation Foundation, which also have Rouleaux Club representation.

The ASM will also be the opportunity where the winners of the annual essay competition and the inaugural 'Averil Mansfield Award for Trainer of the Year' will be announced. The Averil Mansfield Award, named in honour of Professor Dame Mansfield, is a joint Rouleaux Club/Vascular Society initiative which aims to recognise excellence in training. This year nominations from over 25 individual surgeons were received and after a demanding process of shortlisting and interviews, the Rouleaux Club are delighted to announce the winner at the Gala Dinner.

At the ASM I will be handing over the presidency to Lauren Shelmerdine and demitting from the association. I'd like to thank all the executive committee for their hard work and dedication over the last year and I wish Lauren every success in her future role.

Andrew Nickinson
Rouleaux Club President

Society of Vascular Nurses (SVN)

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Conference

The SVN are working alongside the joint societies preparing for the annual vascular conference in Brighton. We have a full and varied programme and of particular note is the session around compassionate leadership in honour of past president Wendy Hayes, who sadly passed away before conference last year. This symposium will look at preventing burnout and promoting civility in the work place. Some members of the SVN have been granted bursaries to assist with the financial cost of attending conference.

The SVN have 3 committee spaces to fill this November and have had a number of applicants, the results of the voting will be shared at the AGM during conference.

Nurse delivered venous intervention survey

Members views were sought on nurse delivered venous intervention. Total of 154 individual full members.
28% response rate.
Only 2.5% currently perform endovenous intervention.
10% are interested in developing into this role in the future.
Trust waiting time for venous intervention ranged from 4-72 weeks.

Sustainability statement

The SVN have developed a sustainability statement. We aim to support the NHS by developing a sustainable committee and society, minimising waste whilst supporting excellence in clinical practice, education, research and professional networking cross vascular services. The statement can be viewed on our website.

Education

This year the SVN has focused on education for both members, allied health professionals and the public. There have been a number of SVN webinars hosted by legs matter covering both venous and arterial disease. These webinars had an excellent turn out and there are further events planned.

Professional Links

We continue to represent the voice of vascular nursing within various forums, including VVAPPG, Venous Forum, Legs Matter, NICE and research and audit meetings.

Jane Todhunter
President SVN

Vascular Anaesthesia Society of Great Britain & Ireland (VASGBI)
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The aim of the Vascular Anaesthesia Society of Great Britain and Ireland is to promote excellence in the peri-operative and anaesthetic care of patients undergoing vascular surgery. We develop educational materials, sponsor research, facilitate surveys and foster good working relationships with colleagues whose share our aim of delivering excellent care to patients with vascular disease.

In March 2024 we hosted the biennial 'CPD in vascular anaesthesia' meeting organised by Dr Dan Taylor and his team from Guys and St Thomas'. A record number of delegates registered for this event which is designed as an update for anaesthetic colleagues who don't necessarily have a regular commitment to vascular surgery.

Leeds was the venue for the VASGBI ASM in September 2024. We enjoyed a varied programme with input from representatives of the wider multi-disciplinary team. We heard about modern strategies for dialysis access, carotid stenting and deep venous arterialisation, prehabilitation, avoiding post-operative complications and exercise therapy for peripheral arterial disease from our surgical, medical and physiologist colleagues. We were delighted to welcome patient representatives who talked to us about communicating risk, use of patient decision aids and the AAA journey from a patient's perspective. The anticipation of a presentation from the head coach of the Leeds triathlon training centre inspired some of us to get up and enjoy a 5 mile run along the canal before the start of the second day.

Members of our committee are involved in various different workstreams, many in conjunction with other national bodies. We continued to work with the RCoA to update the vascular anaesthesia section of the GPAS guidelines and have also been involved in updating the VASGBI approved 'Anaesthesia for Vascular Surgery' PIL; 14-VascularSurgery2020web.pdf (rcoa.ac.uk) we hope clinicians find this useful for patients. We are part of the Study Advisory Group for the NCEPOD 'Acute Limb Ischaemia' project and a stakeholder in the redesign of the Vascular Services QIP.

Our website has had a makeover Home - VASGBI making it easier to identify upcoming events and find links to educational resources.

We have updated the clinical guidelines area of our website; this area is accessible to VASGBI members only, but if you are interested in any of our clinical guidelines please get in touch via our administrator Jane Heppenstall jane.heppenstall@vasgbi.com

In the year ahead we are aiming to complete e-learning modules on 'Anaesthesia for vascular access' and 'Anaesthesia and analgesia for Major Lower Limb Amputation'. If you are interested in contributing please get in touch vanessa.fludder@nhs.net

Our biennial trainee symposium will be on March 14th 2025 organised by our trainee representative Hefin Llewelyn. The programme can be viewed on our website VASGBI Trainee Symposium 2025 - VASGBI. It is a virtual event designed to cover the FRCA curriculum, so is perfect for residents preparing for the final FRCA exam.

Applications are open (but will close soon) for our trainee research development grants VASGBI Trainee Development Grant — National Institute of Academic Anaesthesia (niaa.org.uk)

The next VASGBI ASM will be held in London at the RSM on 15th and 16th September 2025.