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165 Editor's foreword

Chetter I

EDITORIAL

166 Mentorship: an overview

Long J, Popplewell M, Egun A

REVIEW

169 Psychological needs of individuals with peripheral arterial disease: a narrative review

Jubouri M, Hayden E, Kocsis A, Shalhoub J

ORIGINAL RESEARCH

181 Surgical Site Infection in Major Lower Limb Amputation (SIMBA): an international multicentre audit: baseline unit survey

The SIMBA Collaborative Group

190 Arterial assessment of the lower limb and foot: perceived benefits and disadvantages of current methods in contemporary practice

Doyle KJ, Levy NF, Atkin L, Ousey KJ, Childs C

199 Outcome measurement for vascular amputee patients: a scoping survey of UK clinical practice

Essop-Adam A, Singh SJ, Haunton VJ, Meffen A, Sayers RD

PROTOCOL

208 Validation of the Clinical Frailty Scale in vascular surgery: a protocol

Elks N, Hitchman L, Lathan R, Pathmanathan S, Carradice D, Chetter I

CLINICAL AUDIT

215 An audit of Global Vascular Guidelines implementation at two large teaching hospitals in differing healthcare settings

Vijayanathan A, Bilyy A, Barki D, Patel A, Arudchelvam J, Sandford B

223 An audit of glycaemic control and impact on surgical outcomes among inpatients with critical limb-threatening ischaemia (CLTI)

Tippireddy R, Barki D, El-Tayer O, Ng J, Nair H, Sandford R

CASE REPORTS

229 Infection of small abdominal aortic aneurysm following a diagnosis of large vessel vasculitis and initiation of immunosuppression: presentation, diagnosis and management

Eraneva-Dibb E, Khan B, Davy S, Bera KD

234 First reported case of successfully deploying the GORE Thoracic Branch Endoprosthesis under local anaesthesia

Hennessy M, Hussey K, Robertson E

ROULEAUX CLUB ESSAY COMPETITION

238 Rouleaux Club Winning Student Essay 2024

NEWS

242 Updates from the Vascular Societies

REVIEWER ACKNOWLEDGEMENT

244 Volume 4

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About the VSGBI

The Vascular Society of Great Britain and Ireland (VSGBI) is the pre-eminent organisation in the country promoting vascular health by supporting and furthering excellence in education, training and scientific research.

The Society represents and provides professional support for over 600 members, including vascular surgeons, vascular radiologists and others involved in independent vascular practices in Great Britain and Ireland.

The Society focuses on non-cardiac vascular disease, including diseases of the aorta, peripheral arteries, veins and lymphatic. Vascular specialists are trained in the diagnosis and management of conditions affecting all parts of the vascular system.

The VSGBI is a charitable organisation funded by members subscriptions, an annual scientific meeting, grants and donations. It has a professional structure including a permanent Secretariat, Executive Officers and Council elected by Members.

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Membership of the Society is widely recognised in the vascular community as a mark of professional achievement.

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- The VSGBI promotes vascular education and training, runs training courses (ASPIRE and ASPIRE Digital). **Specialist Affiliate members gain free membership of European Vascular Surgeons in Training** and has lobbied for positions such as the post CCT Fellowships, and the Endovascular Fellowships.
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- The VSGBI publishes virtual educational resources which are available to members.
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- The Society's Professional Standards Committee, (PSC) offers support to individuals and hospitals. For further information visit www.vascularsociety.org.uk Council and Committees page. Details of the support and advice scheme are given in the Professional Standards Committee section.
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Editor's foreword

Welcome to the August 2025 edition of the *JVSGBI*, which contains articles that I am sure will be of interest to a wide range of readers.

These include the first in a series of editorials by Long and co-authors outlining the principles of, and evidence for, mentorship. Subsequent editorials will detail mentorship processes and the plans of the VSGBI workforce committee to make mentorship readily available for early year vascular consultants.

A narrative review by Jubouri *et al* addresses the important topic of psychological challenges for patients with peripheral arterial disease highlighting prevalence, assessment and approaches to management.

Three original research articles present survey results. This type of research frequently provides crucial intelligence regarding the necessity, design, feasibility and deliverability of future higher level research. The first original article, from the SIMBA collaborative group assesses SSI prophylaxis practice in patients undergoing major lower limb amputation and evaluates how closely this practice aligns with guidelines. The second original article evaluates practices and perceptions of vascular assessment in the community and acute care settings. The final original article assesses the use and value of physical performance based outcome measures in patients undergoing major lower limb amputation.

A protocol for a study to validate the Clinical Frailty Scale in patients undergoing vascular surgery (major lower limb amputation, aortic aneurysm repair, lower limb revascularisation and carotid endarterectomy) and to evaluate its prognostic value is also presented.

Two clinical audits are also included in this edition. The first evaluates compliance with global vascular guidelines in 2 different healthcare settings whilst the second assessed glycaemic control in patients with chronic limb threatening ischaemia and impact on outcome.

Two novel and interesting case reports, the prize winning 2024 Rouleaux Club student essay and updates from affiliated societies are also included.

Finally, we present with thanks our acknowledgement to our invaluable reviewers.



Ian Chetter
Editor in Chief JVSGBI
Vascular Society GBI President

EDITORIAL

Mentorship: an overview

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Introduction

This is the first in a series of editorials on mentorship in which we will define mentorship, provide evidence for its impact and benefit, and detail why now is the right time to embed it in our specialty and how we plan to do this with a detailed overview of the structure, objectives and early outcomes of the Vascular Society of Great Britain and Ireland (VSGBI) Mentorship Programme.

What is mentorship?

The Oxford English Dictionary defines a mentor as “an experienced and trusted adviser”. In practice, mentorship is a structured relationship in which an experienced professional (senior) supports the personal and professional growth of another (junior). Mentorship

programmes aim to develop reciprocal and supportive relationships focused on the mentee's overall personal and professional development built on trust, openness and commitment.^{1,2}

Mentorship differs from coaching and supervision (see Table 1). Coaching is typically short-term and skill-focused, aimed at improving specific performance areas, while supervision ensures safe, effective clinical practice and accountability. By contrast, mentorship is usually a longer-term holistic partnership emphasising reflective practice, professional identity, career development and resilience.³ It may be formal, with agreed

goals and timelines, or informal, arising naturally from professional relationships. Both approaches hold value, though formal structured mentorship offers clear expectations, accountability and measurable outcomes.⁴

Evidence of benefits

Trust-level evaluations show that well-supported mentorship strengthens teams, enhances staff well-being and improves patient care.⁵ Professional bodies from the General Medical Council (GMC) to the Royal College of Surgeons now advocate mentorship as a key workforce strategy, citing benefits beyond technical skills including decision-making, leadership and work-life balance.^{6,7}

Across surgical specialties, structured

Table 1 Comparison of mentorship, supervision and coaching.

Aspect	Mentorship	Coaching	Supervision
Definition	Long-term, holistic relationship supporting professional growth, identity, resilience, and career development	Short-term, goal-focused relationship aimed at improving specific skills or performance	Ensures quality and safety of work; typically short-term and task-focused
Focus	Reflective practice, career planning, personal development	Skill enhancement, performance improvement	Safe, effective completion of clinical or professional tasks
Duration	Long-term, flexible	Short-term, tied to specific objectives	Usually throughout a training period or specific task
Nature	Reciprocal, supportive, flexible	Collaborative, goal-oriented	Directive, evaluative
Outcome	Professional confidence, resilience, leadership, network development	Improved performance or skills	Safe practice, compliance, competence

Adapted from multiple sources ^{1,3,7}

Key words: mentorship, professional development, early-career consultants

Table 2 Benefits of mentorship.

Benefit	Description
Professional confidence	Mentorship supports new consultants in developing confidence as they transition to independent practice
Clinical and professional skill development	Mentors share tacit knowledge and practical insights not always captured in formal training, bridging the gap between theory and practice
Emotional support and resilience	Mentorship provides a safe non-judgemental space to discuss challenges, reducing stress and feelings of isolation
Career progression and leadership	Structured mentorship facilitates career planning
Service quality improvement	Mentorship promotes adoption of innovative evidence-based practices, leading to improved patient outcomes

Adapted from multiple sources ^{1,4,6}

mentorship – defined as a formal programme with clear objectives, planned interactions and ongoing evaluation – has consistently demonstrated positive outcomes. In trauma and orthopaedics, it improved career clarity and reduced professional isolation.⁸ A 2024 national survey in urology found that almost all early-career consultants valued mentorship, with 90% supporting the creation of a formal national programme.⁹ In ENT, a national mentorship programme showed that participants sought careful mentor–mentee matching and regular review to address career guidance, academic development, psychosocial support and networking needs.¹⁰

The academic NIHR Mentorship Programme offers an evidence-based nationally recognised framework for supporting early-career healthcare professionals. Notably, it benefits from significant investment and institutional support, making it a flagship model for structured mentorship. An overview of key benefits is summarised in Table 2. Mentees report increased professional confidence, improved reflective practice, emotional support, leadership growth and enhanced service quality.¹¹

Mentorship in vascular surgery

Every surgeon remembers the people who shaped their early career – the colleague whose advice made all the difference, the senior who gave a timely nudge forward or the one who simply listened and understood. Mentorship provides this steady presence of someone more experienced who helps to guide, encourage and challenge at the right time. The transition from trainee to early-career consultant is one of the most demanding phases of a surgical career. New consultants must manage complex clinical decisions, take responsibility for patient outcomes and lead multidisciplinary teams without the ‘safety net’ of supervision from senior colleagues. Increasingly, mentorship is recognised in healthcare as a key factor in successfully bridging the transition from trainee to independent

consultant, helping surgeons navigate new responsibilities while continuing to grow personally and professionally.¹² Structured mentorship in this situation offers an invaluable safe and confidential space to reflect, learn and build confidence without fear of judgement. Mentors bring perspective and provide practical knowledge that training alone struggles to capture: how to navigate difficult clinical decisions, how to process the emotional impact of complications, how to balance ambition with personal well-being and how to keep going when self-doubt arises.^{1,13}

What’s in it for mentors and mentees?

Mentorship is a reciprocal relationship. For mentees, it offers guidance on clinical decisions, career planning and professional and personal development, facilitating access to professional networks and career opportunities.^{4,12} The experience can be equally rewarding for mentors, allowing them to give back to the profession, refine leadership and communication skills and gain fresh perspectives from new colleagues. Mentorship encourages reflection on one’s own practice and can inspire new approaches to patient care. By sharing expertise and shaping the next generation of vascular surgeons, mentors reinforce their professional identity and make a meaningful, lasting contribution to the specialty.^{2,14}

Why structured mentorship matters now

Mentorship is not only beneficial for individual surgeons but is also a strategic investment in the future of vascular surgery. Rising work-force pressures, increasing complexity of cases and advances in technology create a challenging environment for new consultants.¹⁵ Without structured support, these pressures can contribute to stress, burnout and early attrition, with implications for patient care.^{16,17}

Embedding mentorship now ensures early-career consultants are supported not only clinically but also in developing resilience, leadership skills and professional networks. This approach aligns with broader NHS and Royal College of Surgeons’ initiatives to improve retention, staff well-being and service quality.¹⁸ By proactively supporting early-career consultants, mentorship helps reduce the personal and professional costs of burnout, strengthens retention and cultivates a resilient vascular surgery workforce, benefiting individuals, teams and the specialty as a whole.

The VSGBI Mentorship Programme

The VSGBI is establishing a structured mentorship programme, drawing on proven models including the NIHR Mentorship Programme. The first cohort intake will begin in November 2025 with a one-day in-person training session for both mentors and mentees. By providing structured guidance and support during these formative years, the programme will foster safer practice, build stronger teams and cultivate sustainable careers where vascular surgeons can thrive. Importantly, it ensures that the experience and wisdom of senior vascular surgeons are passed forward, shaping the next generation and securing the long-term strength and excellence of the specialty.

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REVIEW

Psychological needs of individuals with peripheral arterial disease: a narrative review

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Plain English Summary

Why we undertook the work: Peripheral arterial disease (PAD) is a condition affecting blood flow to the legs, causing pain, reduced mobility, and, in severe cases, the risk of amputation. While physical symptoms are well understood, the impact of PAD on mental health, such as stress, anxiety, and depression, is often overlooked. This study reviewed existing research to better understand how PAD and mental health interact to influence with each other and to explore how psychological care could improve outcomes for these patients.

What we did: We reviewed studies from multiple scientific databases, focusing on the interaction between PAD and mental health. We also reviewed psychological assessment tools and therapies, including counselling and mindfulness, to see how they can help patients with PAD. For this, we conducted a thorough literature search using multiple search terms and electronic database.

What we found: Key themes included the role of life experiences, such as childhood trauma, and the benefits of mental health care integrated with physical treatment. Patients with PAD often experience depression, anxiety, and stress, which worsen their quality of life and ability to manage the disease. Life challenges, such as financial difficulties or traumatic childhood experiences, increase the likelihood of psychological issues in patients with PAD. Integrating mental health care with physical treatments like exercise therapy can improve both physical recovery and mental well-being.

What this means: Addressing mental health is vital for improving care for patients with PAD. Tailored psychological therapies, delivered as part of a multi-disciplinary team, can reduce distress, improve physical health, and enhance overall quality of life. Future research should focus on long-term benefits of such integrated approaches and explore better ways to identify and support patients with the greatest mental health needs.

Abstract

Background: Peripheral arterial disease (PAD) is a chronic, atherosclerotic condition that affects over 200 million individuals worldwide, with significant morbidity and mortality. While its physical manifestations, such as intermittent claudication and chronic limb-threatening ischemia, are well-established, the psychological burden of PAD remains underexplored. This narrative review aims to explore the psychological needs of individuals with peripheral arterial disease (PAD), highlighting the bi-directional relationship between PAD and mental health concerns.

Methods: A comprehensive literature search was conducted using strict search terms and multiple electronic databases including PubMed, Ovid/Medline, Google Scholar and Scopus. A systematic literature search identified key psychological themes, including the role of adverse childhood experiences (ACEs) in shaping mental health vulnerabilities and disease outcomes.

Results: The evidence underscores the bi-directional relationship between PAD and psychological concerns, as well as the urgent need for a multidisciplinary approach in PAD care. Integrating mental health professionals into vascular teams enables the provision of tailored psychological therapies, such as cognitive-behavioural therapy, mindfulness, and trauma-informed care. These interventions have demonstrated efficacy in reducing psychological distress, improving treatment adherence, and enhancing physical outcomes. Moreover, early identification of mental health concerns, especially in patients with high ACE scores or severe PAD symptoms, can guide individualised care plans to optimise outcomes.

Conclusion: Future research should explore the long-term benefits of integrated care models, addressing both physical and psychological needs. By prioritising mental health alongside traditional vascular interventions, clinicians can improve not only survival rates but also the holistic well-being of patients with PAD.

Key words: peripheral arterial disease (PAD), peripheral vascular disease (PVD), mental health, psychology, multi-disciplinary team (MDT)

Introduction

Peripheral arterial disease (PAD) is an atherosclerotic occlusive process that involves the arteries of the extremities and burdens up to a quarter of a billion individuals globally. It is ranked as the third leading cause of atherosclerotic morbidity after coronary artery disease and stroke, making it one of the leading causes of disability. The incidence of PAD is known to increase with age, with nearly one in five of those aged over 60 being affected. Given the ageing population, both the incidence and prevalence of PAD will continue to rise.¹ Diagnosis and severity of PAD are based on history, physical examination, walking distance, ankle-brachial pressure index (ABPI) assessment and arterial imaging. The hallmark presenting symptom of PAD is intermittent claudication, described as leg pain which occurs while walking. Other reported symptoms include altered peripheral sensation, cold extremities, muscle weakness and sexual dysfunction. These symptoms impair the mobility and functional ability of patients, leading to loss of independence, social deprivation, increased risk of other cardiovascular pathologies, reduced health-related quality of life (HRQoL)^{2,3} and disease progression. PAD is a pathological continuum that can progress to chronic limb-threatening ischaemia (CLTI) affecting nearly 6.5 million individuals globally, characterised by rest pain, non-healing ulcers or tissue loss which, if untreated, can result in limb amputation in about 30% of cases or even mortality in 25%.⁴ Not only is PAD a health burden to patients, but it is also a financial burden to health systems, with studies reporting annual costs reaching US\$6.31 billion.⁵ The National Health Service (NHS)'s expenditure on treating PAD is a significant amount, with some studies estimating costs ranging from £4 million to over £206 million annually, depending on the specific treatments and populations involved.⁶

The mental health status of patients with PAD is also an important consideration. The psychological aspects of PAD are often overlooked or forgotten, particularly given the physical, social, financial and quality of life (QoL) burdens posed. The impact of PAD on mental health is being increasingly acknowledged, rising simultaneously with the growing incidence of PAD, as well as the increased adoption of the 'bio-psycho-social' model in modern practice, especially given the clinical relevance of mental health to all disease processes.⁷ Yet, while the physical manifestations of PAD are well established, the literature covering psychological manifestations remains limited. However, available evidence shows that the commonly reported mental health concerns secondary to

PAD include stress, anxiety and depression. These, in turn, have been shown to be independently associated with functional impairment, as well as being known risk factors for suboptimal postoperative recovery.^{8,9}

Beyond the psychological burden affecting many patients with PAD there is now evidence that a patient's psychological history, particularly in the form of adverse childhood experiences (ACEs), impacts not only their risk of developing physical disease, including vascular disease, but can also impair their ability to interact with healthcare and to manage their condition. This has been shown to have a longitudinal negative effect, lasting well into adulthood.¹⁰ Hence, it is of interest and importance to explore the relationship between ACE and PAD.

This narrative review aims to explore the psychological needs of individuals with PAD, highlighting the bi-directional relationship between PAD and mental health concerns. The review also describes the current evidence on mental health impacts, ACE and psychosocial interventions, while identifying gaps in integrated care pathways.

Methods

We conducted a narrative review following the SANRA (Scale for the Assessment of Narrative Review Articles) guidelines.¹¹ Searches were conducted in PubMed, Ovid/Medline, Scopus, and Google Scholar using Boolean combinations of terms including "peripheral arterial disease", "PAD", "mental health", "depression", "anxiety", "stress", "quality of life", "psychological intervention", "ACE", "psychosocial", and "multidisciplinary care". We included English language articles from January 2000 to January 2024, focusing on studies of adults with PAD that reported psychological outcomes or interventions. Systematic reviews, observational studies, clinical trials and high-quality narrative reviews were included. Critical appraisal was conducted informally based on study design, sample size, use of validated assessment tools and relevance to PAD. Themes were inductively identified from recurring findings across studies.

Themes identified include QoL/HRQoL, disease acceptance and coping, patient activation, psychological therapies, ACEs and the incidence of psychological concerns such as anxiety, stress and depression (Table 1) as well as the impact of these on both physical/social functioning and clinical outcomes.

Overall, the body of literature exploring psychological aspects of PAD is heterogeneous in methodology and variable in quality. Most

Table 1 Summary of studies included in the review

Study reference	Year	Study design	Sample size	Psychological concern assessed	Assessment tools	Key findings
Rezvani <i>et al.</i> ¹	2022	Cross-sectional	1,696	Depression, anxiety	PHQ-9, GAD-7	Walking impairment linked to higher depression ($\beta=-0.36$, $p<0.001$) and anxiety ($\beta=-0.24$, $p<0.001$)
Jelani <i>et al.</i> ¹⁹	2020	Observational	1,243	Depression	PHQ-8	Females had higher depression scores ($p<0.001$); depression associated with younger age and sedentary lifestyle
Brostow <i>et al.</i> ¹⁶	2017	Systematic Review	28 studies	Depression	Various (BDI, CES-D, HADS)	Depression prevalence: 11–48% (cross-sectional), 3–36% (longitudinal); associated with functional impairment
Thomas <i>et al.</i> ¹⁵	2020	Prospective cohort	1,275	Depression, anxiety, stress	PHQ-8, GAD-2, PSS-4	35% screened positive for psychological concerns; stress most prevalent; significant reductions after 12 months
Chyrek-Tomaszewska <i>et al.</i> ²¹	2024	Case-control	319 (159 PAD, 160 control)	Depression, anxiety	HADS	PAD patients had more frequent symptoms; depressive symptoms associated with pain and prior interventions
Ragazzo <i>et al.</i> ¹⁸	2021	Cross-sectional	113	Depression, anxiety	BDI, BAI	Depression correlated with reduced walking distance and exercise avoidance; anxiety less predictive
Aquarius <i>et al.</i> ¹³	2006	Cross-sectional	188	Stress	PSS-10, WHOQOL-100	Stress predicted lower walking distance ($p=0.001$) and worse QoL ($p<0.001$)
Welch <i>et al.</i> ²⁴	2023	Retrospective + Survey	104	Depression	PHQ-9	37% had mild+ depression; under-diagnosis and under-treatment noted; 9.5% mortality within 6 months for depressed group
Czarnecka <i>et al.</i> ²⁵	2021	Cross-sectional	212	Disease acceptance, coping	AIS	PAD patients had significantly lower acceptance and coping scores than surgical controls ($p=0.000$)
Garnefski <i>et al.</i> ³⁵	2013	Non-randomised trial	13	Depression	PHQ-9	Self-help CBT intervention significantly reduced depressive symptoms ($p<0.01$)

CBT, cognitive behavioural therapy; PAD, peripheral arterial disease; QoL, quality of life.

included studies were cross-sectional or observational in design, with a few systematic reviews and one non-randomised trial. While many studies utilised validated patient-related outcome measures (PROMs) and psychological tools, the absence of longitudinal designs limits causal inference. Several studies lacked adequate control for confounding variables, and reporting on recruitment procedures and attrition rates was inconsistent. Using informal criteria from the Newcastle-Ottawa Scale and ROBINS-I for non-randomised studies, methodological quality was generally moderate, with a moderate risk of bias in over half of the studies due to self-reported outcomes and lack of blinding. This underscores the need for robust, longitudinal and interventional research designs.

Measurement tools

Several tools have been developed globally to assess the mental and social health of patients, as well as their HRQoL. These tools are often known as PROMs. These questionnaires can be used either generically to assess patients' overall health or as disease-specific tools focused on PAD. It is important to note that disease-specific PROMs exhibit higher sensitivity and specificity relative to generic ones.¹² Another way of categorising PROMs includes those tools which cover the full spectrum of PAD, or other tools which can be applied to subtypes on that spectrum. In the case of PAD, disease-specific PROMs include the peripheral artery

disease quality of life questionnaire (PADQOL), vascular quality of life questionnaire (VascuQoL), Australian vascular quality of life index (AUSVIQOL), peripheral artery questionnaire (PAQ), intermittent claudication questionnaire (ICQ), walking impairment questionnaire (WIQ) and Edinburgh Claudication Questionnaire. Meanwhile, key examples of generic PROMs are the EuroQoL-5D (EQ-5D-3L), Nottingham health profile (NHP), 36-item short form (SF-36®), McMaster Health Index and World Health Organization Quality of Life Assessment-100 (WHOQOL-100) tools.^{4,12,13} However, the validity and full applicability of these PROMs remain an area for further investigation.¹⁴ A summary of these PROMs can be found in Table 2. With regard to psychological assessment, commonly used questionnaires include the Generalized Anxiety Disorder-7 (GAD-7) and the Patient Health Questionnaire-9 (PHQ-9).^{4,12,13}

A 2018 systematic review identified themes from qualitative research related to PAD patients' HRQoL using a framework analysis.⁴ The qualitative framework analysis was divided into six main groups: symptoms, impact on physical functioning, impact on social functioning, psychological impact, financial impact and process of care. When results of this qualitative analysis were mapped against the items/domains contained in 43 validated PROMs used in patients with PAD, the results revealed that neither the generic nor disease-specific PROMs cover the full spectrum of PAD or disease domains. However, the authors concluded that

Table 2 Summary of patient-related outcome measures (PROMs) used in peripheral arterial disease (PAD)

PROM	Use	Advantages	Disadvantages	Validity and applicability
Peripheral artery disease quality of life questionnaire (PADQOL)	PAD-specific QoL assessment	Highly sensitive and specific for PAD-related QoL	Limited to PAD-specific domains	Valid for assessing PAD impact; not comparable to generic PROMs
Vascular quality of life questionnaire (VascuQoL)	Measures QoL specific to vascular disease	Comprehensive for vascular symptoms	Less focus on mental health aspects	High validity in PAD; recommended as the optimal disease-specific PROM
Australian vascular quality of life index (AUSVIQOL)	Australian vascular QoL index	Localised for Australian PAD populations	Regional applicability limits global use	Valid in regional studies but less so internationally
Peripheral artery questionnaire (PAQ)	Measures physical activity in patients with PAD	Focuses on functional outcomes	Lacks broader QoL metrics	Applicable for evaluating mobility interventions in PAD
Walking impairment questionnaire (WIQ)	Walking impairment due to PAD	Simple, specific to walking-related limitations	Narrow scope, ignores psychological dimensions	Valid for physical assessments but not mental health
Intermittent claudication questionnaire (ICQ)	Intermittent claudication QoL	Specific to claudication symptoms	Excludes broader QoL dimensions	Limited to intermittent claudication patients; high specificity
Edinburgh Claudication Questionnaire	Identifies claudication symptoms	Easy to administer, focused	Does not assess QoL or mental health	Useful for symptom identification, lacks QoL data
EuroQoL-5D (EQ-5D-3L)	Generic QoL measure	Broadly applicable, cross-condition comparisons	Lacks sensitivity for PAD-specific impacts	Good validity for general populations; less specific to PAD
36-item short form (SF-36®)	Comprehensive generic QoL measure	Captures broad physical and mental health domains	Long and time-consuming	Highly validated but can burden patients in clinical settings
World Health Organization Quality of Life Assessment-100 (WHOQOL-100)	Generic QoL assessment	Global applicability, multidimensional	Time-intensive, less specific to PAD	Broad applicability; limited for PAD-specific concerns

NHP and VascuQoL can be considered the optimal generic and disease-specific PROM, respectively.⁴ Nevertheless, these findings indicate a possible gap in both clinical and research practices whereby solely relying on PROMs to wholly capture the experience of patients with PAD may be misaligned with patients' true needs.

Influence of PAD on mental health

The evidence linking PAD and mental health is limited within the current literature, which can be partly attributed to the lack of clinical infrastructure combining both physical and mental health in the holistic management of individuals with PAD, particularly in light of the aforementioned deficit in the screening tools used. The majority of evidence on this topic stems from cross-sectional studies using one or a combination of the above tools to measure HRQoL, disease burden and acceptance, depression, stress and anxiety and patient experience.^{15–27} The studies which looked at PROMs do not, in the main, take ACE into account, and are cross-sectional. This means that we have little evidence on causal relationships. Furthermore, we do not have detailed data which could guide the stratification of patients in terms of the likelihood of needing support nor the effectiveness of different approaches to the delivery of their healthcare.

A cross-sectional path analysis was recently conducted on a cohort of 1696 patients with PAD using a theory-based model.¹ The mean age of the cohort was 66.29±8.63 years and 67.6% (n=1141) were male. Risky alcohol consumption, defined by an AUDIT-C score of ≥4 in females and ≥5 in males, was reported by 29.1% of participants. Using the Fagerström test for nicotine dependence, 26.9% and 16.8% were identified as having either strong (5–6) or very strong (7–10) dependence on tobacco, respectively. That being said, it is important to note that the study used path analysis to account for potential confounding factors, including sociodemographic characteristics and baseline co-morbidities, which yielded a better fit between the goodness-of-fit indices and the observed data. The main analysis identified that walking difficulties due to PAD were linked to higher levels of depressive ($\beta=-0.36$, $p<0.001$) and anxiety symptoms ($\beta=-0.24$, $p<0.001$). Moreover, it was estimated that 5.5% and 2.7% of the patients experienced severe depressive and anxiety symptoms based on the PHQ-9 and GAD-7 surveys, respectively. Overall, the prevalence of depressive and anxiety symptoms of any severity stood at 48.3% and 35.5%, respectively, with female and younger patients being more susceptible. Walking impairment negatively impacted the physical QoL both directly ($\beta=0.60$, $p<0.001$) and

indirectly through depressive symptoms ($\beta = -0.16$, $p < 0.001$); it also had an indirect adverse effect on mental QoL, mediated through depressive ($\beta = -0.43$, $p < 0.001$) and anxiety symptoms ($\beta = -0.35$, $p < 0.001$). The authors described the involvement of addictive behaviours in the psychological sequela by reporting a significant association between depressive symptoms and tobacco use in their cohort, which also interplays with PAD pathogenesis.¹

The 2023 Scientific Statement released by the American Heart Association (AHA) tackled these issues in further depth.⁸ This statement was the result of an integrated PAD team collaboration involving both vascular surgeons and clinical psychologists along with other healthcare professionals. In addition to symptoms of depression, anxiety and stress, the statement also outlined the issue of addiction (opioids, alcohol, tobacco) secondary to PAD, giving examples of addictive opioid use in approximately 25% of the PAD population. The statement also acknowledged that addiction is more common in those also suffering from depression.

Furthermore, problematic substance use has been proven to be present in more than 60% of individuals with CLTI and is known to negatively influence revascularisation outcomes. The AHA also pointed out a correlation between increased risk of PAD and other mental health disorders such as post-traumatic stress disorder and attention-deficit/hyperactivity disorders. Other relevant manifestations of PAD include cognitive impairment and sleep disturbances. Lastly, the authors recognised the association of ACE with higher risks for cardiovascular diseases and premature mortality, and recommended the integration of ACE assessment into the holistic management of PAD.⁸

In a multicentre international prospective study of 1275 patients with PAD, 957 (75.1%) completed screening for mental health concerns on initial presentation to vascular clinics.¹⁵ Three hundred and thirty-six patients (35%) exhibited symptoms of depression, anxiety or perceived stress, of which 73 (7.6%) had two concerns and 40 (4.2%) showed all three. The Patient Health Questionnaire-8 (PHQ-8), Generalized Anxiety Disorder scale-2 (GAD-2) and Perceived Stress Scale-4 (PSS-4) were used to assess mental health concerns, and showed that stress was most commonly reported (28.7%), followed by symptoms of depression (14.1%) and anxiety (8.3%). Those exhibiting any psychological symptoms were more likely to be female, younger, of lower socioeconomic status, with less health and social support.¹⁵ Clinically, these patients were also more likely to have suffered from co-morbid neurological events, diabetes, coronary heart disease and previous depression. Nevertheless, a significant reduction in the above concerns was observed at the 12-month survey, with reported rates of stress, depressive symptoms and anxiety dropping to 17.5% ($p < 0.001$), 8.9% ($p = 0.02$) and 5.7% ($p < 0.001$), respectively. Despite this, the authors identified that a considerable percentage of patients screened positive for psychological symptoms for the first time at the 12-month follow-up: 42.3% for depression, 67.3% for anxiety and 46.7% for perceived stress. These individuals, who showed new psychological symptoms one

year after coming into the study, but not at enrolment, were more likely to have had a previous history of depression.¹⁵ This is important because it is rare evidence of a potential causal role of the PAD diagnosis in exacerbating psychological symptoms, especially in individuals who are vulnerable to depression and anxiety at clinical levels. This was a robust study and is further evidence for the inextricability of life experience and the importance of recognising that, especially amongst those with difficult life histories and current circumstances, their psychological well-being needs to be addressed alongside medical interventions.

A systematic review of 28 studies which focused on the incidence of depression associated with PAD reported a prevalence of depression or depressive symptoms ranging from 11% to 48% in 12 cross-sectional studies and from 3% to 36% in 16 longitudinal studies.¹⁶ Fifteen different scales and tools were used to assess for depression in the included studies including the Beck Depression Inventory (BDI), Cambridge Mental Disorders of the Elderly Examination (CAMDEX), Center for Epidemiologic Studies-Depression Scale (CES-D), Geriatric Depression Scale (Short-form or 15-item versions) (GDS), General Health Questionnaire-12 items (GHQ-12), General Health Survey (GHS), German National Health Interview and Examination Survey-Mental Health Supplement (GHS-MHS), Hospital Anxiety and Depression Scale-14 items (HADS-14), Hamilton Rating Scale for Depression-17 items (HAM-D-17), Munich-Composite International Diagnostic Interview (M-CIDI), Patient Health Questionnaire (PHQ; 9-item or 12-item versions), Dutch-Present State Examination (Dutch-PSE), Zung Self-Rated Depression Scale (ZSRDS) and ICD-9 codes related to depression.¹⁶ Depressed PAD patients were again more likely to be younger, female, African-American (compared with Caucasian) and to have more frequent and/or severe PAD symptoms and functional impairment than non-depressed patients. Most of the included studies met most, if not all, of the Newcastle-Ottawa Scale criteria for a methodologically rigorous study. However, nine of the scales solely relied on patient-reported measures of depression as the exclusive criteria for diagnosis without a clinician's verification, of which only six are considered well-established in this population. Hence, the study stressed the importance of using sensitive screening tools capable of detecting atypical symptoms that can manifest in some populations such as the elderly, which represents an area for further research and development.¹⁶

Bidirectional relationship between mental health burden and PAD

It is important to note, however, that the relationship between PAD and mental health is, as far as can be ascertained, complex and dynamic. On the one hand, psychological issues can exacerbate both the likelihood of physical disease and the ease of symptom management and, on the other, the presence of physical difficulties can cause or exacerbate low mood and anxiety, especially in those who are already vulnerable due to life experience or circumstances.

This interaction can, unless identified early through a collaborative multidisciplinary approach between vascular surgery and psychology teams, result in further harm to both the patient's physical and mental health.¹⁷

Ragazzo *et al*¹⁸ studied 113 patients with intermittent claudication. Using the BDI and BAI tools, 40% of patients were found to suffer from mild or moderate depression and 26.2% from anxiety of any severity. Patients with signs of depression were identified to have a shorter pain-free walking distance ($p=0.015$) and shorter total walking distance ($p=0.035$) than controls without depression signs. Furthermore, patients with moderate to severe depression reported significantly more barriers to physical activity than those with anxiety ($p<0.005$). However, anxiety alone did not have a significant effect on outcomes ($p>0.05$), although a degree of data overlap was observed with some patients being both anxious and depressed.¹⁸ Of note in this study, though, was the exclusion of patients with a previous history of depression or anxiety, in that they had previously received medication for mood. As we saw previously, it is likely that those with a history of struggling with mood would be vulnerable to exacerbation when faced with a new physical difficulty.

Aquarius *et al*¹³ undertook a single-centre cross-sectional study of 188 PAD patients focusing on patient-reported health burden and QoL. A similar trend to the above was seen, in that perceived stress was a significant predictor of a reduction in maximum walking distance ($p=0.001$) and poorer QoL ($p<0.001$). Stress was also identified to have a significant impact on the overall health of individuals with PAD ($p<0.001$), emphasising the importance of the bio-psycho-social model in this clinical context. In this study, stress was measured using the short 10-item version of the Perceived Stress Scale, health status using the RAND 36-Item Health Survey (RAND-36) and QoL using WHOQOL-100.¹³

Jelani *et al*¹⁹ analysed sex discrepancies in a cohort of 1243 patients with a higher incidence of moderate/severe depression (21.1% vs 12.9%; $p<0.001$) as well as mean depression score (5.6 ± 5.3 vs 4.2 ± 4.8 ; $p<0.001$) measured using the PHQ-8 in females with PAD. After stratification by sex and clinically relevant depressive symptoms (PHQ-8 ≥ 10), mean PHQ-8 scores among those with depressive symptoms were similar between men and women (14.2 ± 3.7 vs 14.1 ± 3.7). In this sex-adjusted model, both male and female patients with depressive symptoms were more likely to be younger and sedentary compared with their respective counterparts without depressive symptoms. Furthermore, there was a tendency to avoid care because of cost; however, this needs to be taken in the context that this study was set in health systems where private health insurance plays a significant role. Additionally, this analysis showed that those with depressive symptoms had worse health status at each follow-up point (all $p<0.0001$).¹⁹ Another systematic review followed a similar trend in its vascular outcomes, reporting a 20% increase in the incidence of major adverse limb events in depressed patients.²⁰

Clinical outcomes

The results of a study by Chyrek-Tomaszewska *et al*²¹ shed light on the critical relationship between depression and PAD revascularisation outcomes, which is an area with limited data. The PAD revascularisation group ($n=159$) experienced more frequent symptoms of depression and anxiety compared with healthy control individuals ($n=160$), measured using the HADS. The two groups were similar at baseline in terms of gender ($p=0.72$). Importantly, these symptoms were found to be associated with the severity of PAD based on ABPI measurements. A significant positive correlation was demonstrated between anxiety, depression symptoms and the intensity of walking pain. Multivariate analysis revealed that only amputations significantly increased anxiety severity, whilst depressive symptoms were influenced by multiple factors including previous revascularisation and amputation procedures as well as the severity of pain upon admission to hospital. A higher rate of severe depression was observed in those who underwent open surgical revascularisation compared with endovascular (10.5% vs 2.5%; $p=0.0003$).²¹ Importantly, a recent meta-analysis of five observational studies including a total of 119,123 patients, of whom 16.2% had depression or depressive symptoms, reported a 24% increase in mortality in this population compared with counterparts with no documented history of mental health conditions.²² In two of the five studies, depression was defined by an ICD-9 diagnosis code for Major Depressive Disorder or an equivalent, whilst the remainder used validated self-report screening tools including the GHQ-13, HADS and GDS. Overall, a moderate risk of bias was found using the Risk of Bias in Non-randomized Studies-of Interventions (ROBINS-I) instrument.²³

Welch *et al*²⁴ presented the relationship between PAD and mental health from a different perspective. In their study from June to August 2022, 37% of 104 individuals with PAD had at least mild depression on the PHQ-9. Meanwhile, 18% of the cohort had a documented history of depression, of whom 26% did not have a current antidepressant prescription. Moreover, 57% of those with a prescription still had an elevated PHQ-9 score despite the initiation of pharmacological treatment. These findings indicate the possible under-diagnosis and under-treatment of patients with PAD whose disease state is causing, or is associated with, psychological distress, with men being more likely to have unrecognised depression.²⁴ This should be a major healthcare concern. In their first assessment of 148 patients with PAD treated between July 2015 and October 2016, a similar trend of under-diagnosis had been seen, with 28.4% of patients screening positive for depression using GDS-SF, whereas the documented prevalence was only 3.3%. The authors also reported a significantly higher mortality rate within 6 months of revascularisation for depressed patients compared with counterparts with PAD but no documented history of mental health conditions (9.5% vs 0.9%). Interestingly, the baseline patient characteristics in both groups were similar. Conversely, despite the significant association between depression

and 6-month all-cause mortality on multivariate analysis, this was not the case for vascular reintervention, readmission or length of stay.²⁴

Patient activation and coping

A cross-sectional study of 212 patients closely explored disease acceptance and coping in vascular patients (n=104) and surgical patients (n=108).²⁵ The authors used the Acceptance of Illness Scale (AIS), which comprises five categories for coping ranging from 'very well' to 'very badly' and three categories for acceptance being 'low', 'average' and 'high'. Lower self-assessment scores for coping with disease were reported in the vascular group relative to surgical counterparts (very well: 13% vs 25%, $p=0.088$). Disease acceptance was also found to be significantly lower in vascular patients than in surgical patients (low: 34% vs 14%; average: 33% vs 36%; high: 32% vs 50%, $p=0.000$).²⁵ Connected to this, a systematic review of 14 qualitative studies encompassing 360 patients highlighted first-hand accounts of patients' experiences of living with PAD.²⁶ A key finding was the lack of patient understanding of their condition, which resulted in both delayed diagnosis and impaired adaptation once a diagnosis was made, which compounded the negative impacts of PAD on their QoL in different dimensions.²⁶ These studies showcase the importance of effective communication and patient education, as well as the direct impact they can have on the quality of care delivered and subsequent clinical outcomes.

A 2011 report using multivariate modelling showed that patient activation is directly and strongly connected to clinical outcomes.²⁷ This forms a pivotal component of the PAD treatment strategy and is a measure of patients' understanding, competence and willingness to take responsibility of their healthcare decisions. In the context of vascular surgery, Humphries *et al*²⁸ demonstrated variable activation rates reported by their cohort depending on disease type, length of symptoms and patient demographics using the 13-item Patient Activation Measure (PAM-13) survey. However, the authors observed higher levels of patient activation measures in their PAD population relative to other vascular diseases such as carotid, aneurysmal and venous disease, with CLTI patients being particularly activated (24% Level 1 activation, 34% Level 2 activation, 31% Level 3 activation, 34% Level 4 activation).²⁸ The evidence cited above demonstrates the role that mood plays in activation. Depression is associated with less walking, as is anxiety, perhaps due to fear of pain. Therefore, understanding the context, beliefs and cognitions of patients, as well as providing reward and encouragement for effort, especially for those with the most challenges, is an important aspect of medical management.

In relation to the early findings of the vulnerability conferred by pre-existing psychological conditions, it is important to consider the evidence on the earliest types of injury that can affect later disease presentation and progression – namely, ACE.²⁹ Felitti's group was the first to use a questionnaire to measure ACE and to identify the dose-response relationship between ACE and physical disease.³⁰

Since then, many studies have explored how ACE can affect the risk of developing chronic health conditions. This effect of toxic stress is direct on the one hand (increasing cortisol levels and chronic low-grade inflammation, for example) and indirect on the other, via the behaviours adopted to mitigate the psychological consequences of ACE (eg, problematic use of alcohol and non-prescription drugs, smoking and lack of motivation to exercise and over-eating, which can lead to obesity).³⁰ There is also evidence that these behaviours are themselves mediated by neurodevelopmental failure to thrive when such ACEs are present.³¹

In terms of predicting risk, Bertele *et al*³² found, in a thorough psychiatric and cardiac evaluation of 210 adults, that ACE predicted epicardial adipose tissue and that this effect was mediated by both depression and lack of physical activity. Sonu *et al*³³ analysed data, stratified by age, from nearly 90,000 adults recorded in the 2011–2012 Behavioural Risk Factor Surveillance System (BRFSS). They found that young adults with high ACE scores are at an increased risk of early-onset chronic disease, including cardiovascular disease. The adjusted incidence rate ratio (IRR) for cardiovascular disease between those with a null ACE score and those with a score of 4 or more was highest in the 18–34-year age group (IRR 2.57 (1.44–4.60)). The authors point out that earlier onset of risk factors for cardiovascular disease affects lifetime risk.³³

What are the consequences of ACE then, not only on the incidence of PAD but on its management? Neglect, abuse and chronic stress in childhood are also known to affect relationships in later life and, as we have seen, limit behaviours linked to self-care. Martin-Higarza *et al*³⁴ collected detailed data from a sample of 170 individuals and found lack of proactive coping, attachment difficulties and financial hardship in those with higher ACE scores. It is understandable, therefore, that patients with such vulnerabilities present to their clinicians as more anxious, more ambivalent about treatment and less proactive. Their relationship to help, given the attachment ambivalence, is also likely to make them either more needy of attention and reassurance or less reliable attenders, or indeed both.

Interventions

Evidence related to psychosocial interventions and their effect on PAD is very limited. A 2013 single-arm non-randomised clinical trial investigated the efficacy of a cognitive-behavioural self-help program.³⁵ A total of 13 patients with PAD and mild to moderate depressive symptoms at baseline, determined by a PHQ-9 score of ≤ 5 and ≤ 14 , were recruited from an outpatient vascular surgery clinic into the psychological programme. The intervention consisted of a workbook, a work programme and a computer-based programme with minimal coaching. The results of the pre-test, post-test and follow-up questionnaires showed a significant reduction in depressive symptoms, physical tension, negative thoughts and goal obstruction following the intervention ($p<0.01$).³⁵ Despite its small sample size, this trial represents a solid foundation

Table 3 Effectiveness of interventions for patients with peripheral arterial disease (PAD) and psychological concerns

Intervention type	Study reference	Population	Outcome measures	Findings
Cognitive-behavioural self-help program	Garnefski <i>et al</i> ³⁵	13 PAD patients	Reduction in depressive symptoms (PHQ-9)	Significant improvement in mood and reduced negative thoughts ($p<0.01$)
Supervised exercise therapy (SET) + cognitive behavioural therapy (CBT)	Smolderen <i>et al</i> ⁴¹	PAD patients with depression	QoL (VascuQoL), functional capacity	Improved adherence, reduced depressive symptoms, and enhanced mobility
Mindfulness-based therapy	Thomas <i>et al</i> ¹⁵	957 PAD patients	Stress, depression (PHQ-8)	Stress and depression decreased by 39% and 26%, respectively, over 12 months
Trauma-informed care	Hughes <i>et al</i> ¹⁰	Systematic review	ACE mitigation	Reduced psychological barriers to self-care

ACE, adverse childhood experience.

for future studies evaluating management strategies in this clinical scenario. In general, self-managed care interventions represented by lifestyle and behavioural changes such as smoking cessation, exercise engagement and healthy behaviours have been shown to have an overlapping positive impact on both PAD and mental health. Nevertheless, there is a lack of sufficient evidence supporting the role of dietary changes in this clinical context.^{4,35}

Based on the above evidence, it is suggested here that pilot programs to evaluate standard of care should address the co-morbid psychological needs of individuals with PAD. These would include a structured pathway for early recognition of mood changes with appropriate escalation and referral pathways to specialists, streamlining the trajectory for optimising both PAD and psychological outcomes.⁸ Importantly, activating the full potential of any of the above measures requires the active involvement of patients in their own care. However, ACEs represent a potential obstacle to patient activation, with patients' prior experiences influencing both their behaviours and how they engage in behaviour change. This is evident in several studies in the literature reporting significantly lower patient activation in patients with greater numbers of ACEs.^{36,37} Therefore, early identification of such individuals is likely to be of major importance so that more tailored and intensive approaches can be offered, taking into account the increased complexity and potential for re-traumatisation involved in such clinical scenarios.

Table 3 summarises available interventions aimed at improving psychological outcomes in PAD. Although evidence is sparse, cognitive-behavioural self-help programmes and supervised exercise therapy combined with cognitive behavioural therapy show promise. The study by Garnefski *et al*³⁵, despite a small sample size ($n=13$), demonstrated statistically significant improvements in mood ($p<0.01$). However, larger randomised trials are needed to confirm efficacy. Mindfulness interventions, particularly when integrated into vascular care clinics, yielded sustained reductions in depressive symptoms. These findings support a stepped care model, where brief scalable interventions can be delivered early in care pathways.

Vascular surgery and psychology: How can we work together?

Addressing well-being in patients with PAD must involve a multidisciplinary approach that targets both mental and physical elements. Research highlights several strategies that vascular surgeons and psychologists can use to improve outcomes in an integrated care model.³⁸ Vascular surgeons can lead the way to the optimisation of physical health in several ways other than revascularisation. For example, supervised exercise therapy, particularly walking programmes, have been shown to significantly improve functional capacity and quality of life.³⁹ However, studies investigating the effectiveness of supervised versus unsupervised exercise therapy do not stratify patients in terms of mood. We would suggest that, by measuring mood, it would be possible to focus more attention and encouragement on those with the least motivation and the greatest fear of pain.

Smoking cessation is critical, as well as optimising medical therapy with antithrombotic agents, lipid-lowering and other medications to manage PAD symptoms and treat risk factors (eg, hypertension, diabetes), which improve vascular health and reduce symptoms, which can also have a positive effect on mental health.^{8,40} Additionally, patient education and empowerment play a major role, as does educating patients about PAD, its symptoms and the benefits of lifestyle modifications; encouraging active participation in treatment plans to increase adherence and to reduce feelings of helplessness as described in the above studies. While, traditionally, physical and mental health services offer separate interventions, there is opportunity for using psychological models such as motivational interviewing, behavioural economics, cognitive behavioural therapy and mindfulness-based interventions within the exercise programmes offered in the clinic.^{8,41} Such simultaneous and collaborative efforts from psychology teams could also help to reduce the stigma that some patients can feel if they are referred by their physician to psychology.⁴²

Moreover, psychologists can promote health behavioural changes through techniques such as motivational interviewing and behavioural activation techniques, as well as addressing health

Table 4 Summary of risk factors for psychological concerns in patients with peripheral arterial disease (PAD)

Risk factor	Associated psychological concern	Impact on disease management	Study reference	Statistical significance
Female gender	Higher prevalence of depression	Poorer adherence to treatment	Jelani <i>et al.</i> ¹⁹	p<0.001
Adverse childhood experiences	Depression, anxiety	Reduced activation, poor self-care	Hughes <i>et al.</i> ¹⁰	OR 2.57 (CI 1.44 to 4.60)
Severe claudication	Depression, stress	Impaired mobility and reduced QoL	Rezvani <i>et al.</i> ¹	Depression: $\beta = -0.36$, p<0.001 Anxiety: $\beta = -0.24$, p<0.001
Low socioeconomic status	Stress, anxiety	Limited access to resources, lower support	Thomas <i>et al.</i> ¹⁵	Stress prevalence: 28.7%, p<0.001
Younger age	Depression	Higher psychological burden	Jelani <i>et al.</i> ¹⁹	Mean age for depressed: 64 vs 68, p<0.01
History of depression	Recurrent or delayed psychological symptoms	Reduced recovery, higher relapse risk	Thomas <i>et al.</i> ¹⁵	42.3% of new-onset depression at 12 months in those with history
Tobacco use	Depression	Increased PAD progression	Rezvani <i>et al.</i> ¹	Correlation between smoking and depression (significant, p value not specified)
Amputation/surgical treatment	Anxiety, depression	Increased distress and functional limitations	Chyrek-Tomaszewska <i>et al.</i> ²¹	Anxiety ↑ post-amputation (p<0.05). Depression ↑ after revascularisation (p=0.0003)

beliefs and maladaptive thoughts that may hinder lifestyle changes.⁴³ The aforementioned trial by Rezvani *et al.*¹ showed not only the significant correlation between PAD symptoms and depressive/anxiety symptoms, but also stressed that risky health behaviours should be approached by promoting behaviour change, which is typically delivered and/or supported by psychologists.¹ These personalised care plans tailor interventions to individual patient needs – for instance, prioritising mental health interventions in patients with severe depression while focusing on physical rehabilitation for those with mobility issues.

Stratifying patients with PAD who have mental health concerns is essential to ensure that those most in need receive appropriate care. A collaborative approach between vascular surgery and psychology teams can enhance patient outcomes through routine implementation of mental health screening of patients with PAD using an appropriate combination of aforementioned PROMs in addition to functional status evaluation, both of which should be

implemented periodically.^{8,15} This allows for timely adjustments to the care plan as needed. Furthermore, as seen in the above results, PAD patients who are female, younger, experiencing financial strain or lacking social support are at higher risk for mental health concerns, as are those with high ACE scores and a pre-morbid history of clinical depression and/or anxiety.^{1,15,16,19} Therefore, identifying these factors, summarised in Table 4, can help prioritise patients for comprehensive mental health evaluation alongside PAD management.¹⁵

Table 5 provides a stratification framework for clinicians to tailor interventions based on patient risk profiles. High-risk individuals, such as those with severe PAD symptoms and high PHQ-9 scores, may benefit from more intensive interventions including cognitive behavioural therapy and trauma-informed care. In contrast, those with moderate or transient symptoms may be managed with education and mindfulness practices. This triaging approach ensures that mental health resources are allocated efficiently and

Table 5 Example stratification framework for patients with peripheral arterial disease (PAD) and psychological concerns

Stratification criteria	Risk level	Screening tools	Proposed intervention
Severe walking impairment, PHQ-9 score >10	High	ABI, PHQ-9, GAD-7	Intensive psychological support, SET, CBT, mindfulness
Mild claudication, occasional stress	Moderate	ABI, PSS-4	Mindfulness, patient education, signposting to other services (eg, support groups)
Younger patients with ACE history	High	ACE Questionnaire, PROMs	Trauma-informed care, comprehensive multidisciplinary approach

ACE, adverse childhood experience; CBT, cognitive behavioural therapy; PROMs, patient-related outcome measures; SET, supervised exercise therapy.

Table 6 Proposed multidisciplinary care pathway for patients with peripheral arterial disease (PAD) and mental health concerns

Stage	Action	Responsible team	Outcome targeted
Initial assessment	Conduct PROMs screening (including ACE measures)	Vascular surgeon, psychologist	Identify PAD severity and mental health status
Stratification	Categorise risk (low, moderate, high)	Multidisciplinary team (vascular surgeon, nursing team, psychologist)	Tailored interventions
Intervention phase	SET, CBT, mindfulness training	Physiotherapists, psychologists	Improved physical function and mental health
Follow-up	Regular PROM and psychological assessments	Multidisciplinary team	Monitor progress and adjust care plan

ACE, adverse childhood experience; CBT, cognitive behavioural therapy; PROMs, patient-related outcome measures; SET, supervised exercise therapy.

that patients most in need receive timely psychological support.

Barriers to implementation within the NHS, including limited psychological service capacity, fragmented care pathways and stigma related to mental health, must be addressed to operationalise integrated care models for PAD.

In summary, a multidisciplinary approach integrating vascular surgery and psychology is pivotal in managing PAD patients with mental health concerns. Vascular interventions, paired with psychological support, can improve adherence to treatments like supervised exercise therapy and smoking cessation, while cognitive behavioural therapy can mitigate depression and anxiety. This stratified strategy addresses the bidirectional relationship between physical and mental health, optimising outcomes as proposed in Table 6.

Conclusion

The mechanisms linking PAD pathogenesis and psychological status are clearly complex. On the one hand, existing mental health difficulties raise the probability of the occurrence of PAD and make it more difficult for people to activate changes necessary for mitigation. In other words, they continue with the behaviours that increased the likelihood of incidence.

There is also evidence that perceived stress (in particular) and concomitant anxiety and depression, even if new, can impact management. A person-centred approach, which takes the patient’s context into account, is likely to yield cost savings in the long run by delaying and potentially reversing PAD-related damage. Future research efforts should focus on strategies for early identification and management of psychological concerns in PAD to tackle both incidence and progression, constituting a pivotal step towards optimising outcomes in PAD. The implementation of structured specialist pathways, including clinical health psychology input, is crucial for improving the standard of care delivered to patients with PAD. Finally, study quality across the included literature was variable, with most studies being observational and cross-sectional in design, limiting causal inference. While many employed validated psychological and quality of life measures, inconsistencies in methodological rigour, sample sizes and control

KEY MESSAGES

- Peripheral arterial disease (PAD) significantly impacts mental health, with high rates of stress, anxiety and depression contributing to diminished quality of life and poorer clinical outcomes.
- Adverse childhood experiences play a critical role in shaping vulnerability to both PAD and psychological disorders, underscoring the importance of trauma-informed care in this patient population.
- Integrating psychological therapies such as cognitive behavioural therapy and mindfulness into multidisciplinary PAD care can enhance treatment adherence, improve mental health and optimise patient outcomes.
- Current patient-reported outcome measures often fail to capture the full psychological dimensions of PAD, highlighting the need for validated tools tailored to this population.
- Standardised mental health screening protocols and individualised interventions are essential to addressing the holistic needs of patients with PAD, reducing the burden on individuals and healthcare systems.

of confounding factors were common. These limitations highlight the need for higher quality, longitudinal and interventional research to better understand and address the psychological needs of individuals with PAD.

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ORIGINAL RESEARCH

Surgical Site Infection in Major Lower Limb Amputation (SIMBA): an international multicentre audit: baseline unit survey

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Plain English Summary

Why we undertook the work: In 2022 over 3,000 people in the UK required an amputation of their leg. After amputation surgery there is a risk of wound infection. This can range from mild infections that can be treated with antibiotics to more serious problems including longer hospital stays, additional surgeries or even death. There are recommendations regarding prevention and treatment of wound infections; however, it remains unclear how effective these are and how closely hospitals follow this guidance.

What we did: We have designed an international audit: Surgical Site Infection in Major Lower Limb Amputation (SIMBA). Its aim is to evaluate infection rates, related complications and current care practices after amputation. As part of SIMBA, we conducted a survey to see how closely hospitals follow existing recommendations. It also looked to see which methods are most commonly used to prevent and treat wound infections.

What we found: We found that some practices were commonly used, such as using scans to plan surgery. However, there was significant variation in other areas. For example, not all hospitals routinely conduct pre-surgery assessments from specialists such as dieticians, psychologists and physiotherapists. Additionally, follow-up care, including rehabilitation and mental health support, varied widely between hospitals.

What this means: The results demonstrate that approaches to preventing wound infections after amputations vary and more specific evidence-based guidelines are needed. Better standardisation of practices could help to reduce infections and improve recovery for patients. More research focusing on amputation-specific guidelines could lead to better patient outcomes in the future.

Abstract

Introduction: Surgical site infection (SSI) is common after major lower limb amputation (MLLA) and is associated with significant morbidity and mortality. National and international guidelines and a best practice pathway aim to optimise care and prevent complications, but adherence is unknown.

Methods: Surgical Site Infection in Major Lower Limb Amputation (SIMBA) is an international, prospective, collaborative audit which compared current practice against national and international recommendations and evaluated equipoise regarding best practice. Each participating centre completed a baseline unit survey containing Likert scale questions regarding local MLLA pathways. Responses were compared with the Vascular Society of Great Britain and Ireland's best practice pathway, National Institute for Health and Care Excellence (NICE), Society of Vascular Surgery's Practice management guide and the European Journal of Vascular Surgery's Global Vascular Guidelines on the Management of Chronic Limb-Threatening Ischaemia guidelines.

Results: Forty centres (30 UK, 7 Europe, 2 Australasia and 1 Asia) completed the survey, yielding a response rate of 87% (40/46). MLLA was performed by vascular surgeons in all centres, with additional specialities also undertaking MLLA surgery including orthopaedic (n=10), plastic (n=4) and general surgery (n=3). Induction antibiotic prophylaxis was given in 32 (82.1%) of the centres. Prophylactic postoperative antibiotics were 'commonly' or 'always' given in 24 (61.5%) of the centres, typically comprising a 5-day intravenous course. Incise drapes were infrequently used (used 'never' for iodophor (39.5%, n=15) and non-iodophor

(44.7%, n=17) containing drapes). Routine follow-up was conducted in 27 centres (69.2%) and preoperative vascular imaging was 'commonly' or 'always' performed in 37 centres (92.5%). Preoperative assessment by physiotherapists and/or occupational therapists and diabetic specialists occurred 'commonly' or 'always' in 32 (82.1%) and 27 (71.1%) centres, respectively. Dietetic and psychological assessment only occurred 'commonly' or 'always' in 8 (21.6%) and 9 (25%) centres, respectively.

Conclusions: This audit highlights the variability in practice, underscoring the need for consensus on best practice. Future studies should focus on generating high quality evidence to refine recommendations and reinforce adherence to guidelines to reduce SSI and improve outcomes after MLLA.

Key words: major lower limb amputation, surgical site infection, chronic limb threatening ischaemia, wound breakdown

Introduction

Surgical site infections (SSIs) are a common complication following any surgical procedure, accounting for 20% of all hospital-associated infections.¹ The incidence of SSI following major lower limb amputation (MLLA) is particularly high, with a recent systematic review reporting an overall incidence of 7.2% and single-centre studies reporting rates up to 27%.² SSIs are a leading cause of in-hospital morbidity and mortality,³ and consequences of their development, including the substantial contribution to prolonged hospitalisation, result in SSIs being the costliest hospital-associated infection.¹ Furthermore, SSIs post MLLA increase the risk of stump dehiscence and need for revision amputations to the same or a higher level.² This may prevent a patient from independent ambulation,⁴ significantly affecting quality of life and negatively impacting mental health.⁵

The importance of this issue has been recognised by both clinicians and patients. The Priority Setting Partnership led by the Vascular Society of Great Britain and Ireland (VSBGI) in conjunction with the James Lind Alliance has highlighted improving wound healing and improving clinical outcomes after MLLA as two of the top 10 research priorities in amputation surgery.⁶ Furthermore, wound healing and stump infections have been highlighted in the core outcome set for MLLA.⁷ The VSBGI has established a best practice clinical care pathway designed to optimise quality of care and reduce complications after MLLA.⁸ The National Institute for Health and Care Excellence (NICE) have also published guidance relating to the prevention and treatment of SSI.³ However, the degree of adherence to these recommendations remains unclear. Various interventions, such as specialist dressings,⁹ negative pressure wound management systems¹⁰ and antimicrobial-coated sutures¹¹ have become increasingly available. Benefits have been demonstrated from prolonged prophylactic antibiotic courses to reduce the incidence of SSI in MLLA;^{12,13} however, aside from this, evidence of effective interventions to reduce the incidence of SSI in MLLA is sparse, and all adjuncts incur additional costs, contributing to variability in practice.

Surgical Site Infection in Major Lower Limb Amputation (SIMBA)

is an international collaborative audit comparing current practice against recommendations. It also aims to determine the incidence of SSIs and associated clinical sequelae, although these data are not part of this publication.¹⁴ The study consists of two parts: prospective data collection surrounding risk factors, interventions and outcome for patients undergoing MLLA, and an initial baseline unit survey completed once by each enrolled centre. This paper presents the results of the baseline unit survey. The primary aim of this survey was to assess adherence to published guidelines on reducing SSI. Secondary aims included assessing adherence to recommendations regarding optimising overall care and improving outcomes post MLLA, and evaluating equipoise regarding best practice for management of patients undergoing MLLA.

Methods

Study design

SIMBA is an international, prospective, collaborative audit designed to assess current clinical practice against established recommendations and to determine the incidence of SSI and associated clinical outcomes. A detailed protocol has been published in full.¹⁴ This audit is partially funded by the ROSSINI platform as part of the accelerator award scheme (Award ID: NIHR156728)¹⁵ and has been conducted in conjunction with the Birmingham Centre for Observational and Prospective Studies (BiCOPS) at the University of Birmingham. SIMBA is supported by the Vascular and Endovascular Research Network (VERN; <https://vascular-research.net/>), a multidisciplinary trainee-led vascular research collaborative.¹⁶

Centre enrolment began in October 2023, with data collection concluding on 1 May 2024. Any centre within the UK or internationally that provides emergency and/or elective MLLA under any speciality was eligible to participate. Centres were recruited through outreach by VERN using social media, email communications and professional networks. As part of the audit process, the lead consultant from each enrolled centre was required to complete a baseline unit survey detailing local pathways for managing patients undergoing MLLA.

Questionnaire development

Strategies for SSI prevention and management detailed within the NICE guidelines and recommendations for the care of those undergoing MLLA, including those within the VSGBI Best Practice clinical care pathway,⁸ the European Journal of Vascular Surgery Global Vascular Guidelines on the Management of Chronic Limb-Threatening Ischaemia¹⁷ and the Society of Vascular Surgery's Practice Management Guide,¹⁸ were identified and reviewed. Recommendations for preoperative, perioperative and

postoperative care were included. Based on these recommendations, a cross-sectional survey was created, including questions designed to assess centre compliance (Table 1). Additionally, questions were incorporated to explore variations in practice and areas of uncertainty to evaluate equipoise on best practice. Responses were collected using a Likert scale where possible, with a combination of multi-select and free-text options where required.

The survey underwent two rounds of internal validation by the

Table 1 Guideline adherence.

Guideline/recommendation (Grade of evidence where stated)	Recommending organisation				Relevant survey question	Percentage adherence
	NICE	EJVES	VSGBI	SVS		
Preoperative						
Patients should be assessed by the MDT prior to MLLA		X	X		7	42.5%*
Offer patients and carers clear, consistent information and advice through all stages of their care	X				35a	50%*
Be admitted under a named consultant in vascular surgery			X		14	92.3%*
Undergo diagnostic arterial imaging to determine revascularisation options			X	X	9	92.5%*
Have revascularisation options discussed at a vascular imaging MDT			X		11	75%*
Undergo assessment using TcPO2 to determine perfusion at a proposed amputation level				X	20	48.3%*
Involvement of clinical psychology				X	16a	25.0%*
Undergo assessment with OT/PT preoperatively (1C)		X	X		16b	82.1%*
Have nutritional assessment and receive dietician advice			X		16c	21.6%*
Have a member of diabetes team involved			X		16d	71.1%*
Have a venous thrombo-embolism risk assessment and prophylaxis as appropriate			X	X	18	97.4%*
Perioperative						
Antibiotic prophylaxis should not routinely be used for clean non-prosthetic uncomplicated surgery	X				21	17.9%
Do not use non-iodophor-impregnated incise drapes routinely for surgery	X				25	78.8%**
Do not use hair removal routinely	X				27	7.7%**
If hair has to be removed, use electric clippers	X				28	71.8%
Postoperative						
Antibiotic prophylaxis should not routinely be used for clean non-prosthetic uncomplicated surgery	X				36	15.4%**
Patients should be informed of the post-amputation care pathway		X			35b	50%*
Offer patients and carers information and advice about how to recognise a surgical site infection and who to contact if they are concerned	X				41	74.4%*
Day 1 postoperative review by acute pain team			X		33	61.5%*
Follow-up in clinic within a month after surgery				X	43	33.3%*
Outpatient review and rehabilitation follow-up with rehabilitation team (1C)		X	X	X	44	63.0%*
Referred to amputation support group				X	35d	36.8%*

* Percentage selecting 'commonly' or 'always'.

** Percentage selecting 'never' or 'rarely'.

EJVES, European Journal of Vascular and Endovascular Surgery; MDT, multidisciplinary team; NICE, National Institute for Health and Care Excellence; OT, occupational therapy; PT, physiotherapy; SVS, Society of Vascular Surgery; VSGBI, Vascular Societies of Great Britain and Ireland.

study management group. The survey was refined by consensus on major alterations (removing or adding questions) and minor alterations (wording or response modification). The first validation resulted in four major alterations (three questions added and one deleted) and five minor alterations, and the second yielded seven minor alterations.

The final survey included 29 questions; three were demographic questions, eight related to preoperative assessment and care, seven related to perioperative interventions and 11 assessed postoperative care and follow-up. The final version of the survey is provided in Appendix 1 online at www.jvsgbi.com.

Survey administration

The survey was built and published using the QualtricsXM Platform™ and was distributed via an email to the consultant leads for all centres enrolled in the SIMBA audit. Participants completed the survey by following the study URL link. Non-responding centres were followed up with reminder emails. Where duplicate responses were received from a single centre, the most complete response was retained; if all responses were equally complete, the first submitted response was kept.

Statistical analysis and reporting

Responses were exported to Microsoft Excel for cleaning and analysis. Non-response questionnaires were removed. Partially completed questionnaires were included. Dichotomous and Likert responses were reported as percentage of responses, and multiple selection questions were analysed to find a median or modal average. The Checklist for Reporting Of Survey Studies (CROSS)¹⁹ was followed during all steps of the study and a completed checklist is provided in Appendix 2 online at www.jvsgbi.com.

As many of the guidelines and recommendations selected as audit standard were UK based, sensitivity analysis was also performed using only the UK centres.

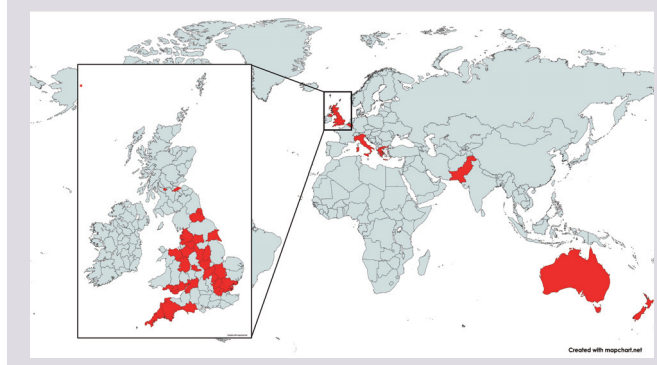
Results

Of the 46 SIMBA centres, 40 completed the survey giving an overall response rate of 87%. This included 30/34 in the UK (88%), 7/9 European centres (78%), 2/2 Australasian centres and 1/1 Asian centre (Figure 1).

In all centres MLLA was performed by vascular surgeons. In 30.0% (12/40) other specialties were also performing MLLA, including orthopaedic surgery (n=10), general surgery (n=4) and plastic surgery (n=3). Patients were 'commonly' or 'always' admitted under a named consultant in vascular or orthopaedic surgery in 92.3% (36/39) of centres.

Adherence to published guidelines and recommendations varied across participating centres (Table 1). The grade of evidence supporting these recommendations was rarely specified. A sensitivity analysis including only UK-based centres demonstrated broadly similar results (see Supplementary Table 1 - Appendix 3 online at www.jvsgbi.com).

Figure 1 Location of survey respondents (Ref. mapchart.net).



Adherence to SSI prevention and management guidelines

Antibiotic administration at the time of anaesthetic induction is routinely performed in 82.1% (32/39) of centres, with a median of two different antibiotics given intravenously. The most commonly used antibiotics are cephalosporins (13 centres) and metronidazole (13 centres) (see Figure 2a). Prophylactic postoperative antibiotics are 'commonly' or 'always' prescribed in 61.5% (24/39) of centres. The majority (22/24) administered exclusively intravenous antibiotics, whilst nine centres use either intravenous or oral routes and three centres routinely use oral antibiotics. Antibiotic choice varied between centres (see Figure 2b), with the most prevalent being penicillin (16/24), metronidazole (13/24) and cephalosporins (12/24) and the most common course duration ranging from 72 hours to 5 days. Adherence to the current NICE guidelines, which advise against the use of prophylactic antibiotics in clean, non-prosthetic, uncomplicated surgery, was low with 17.9% (7/39) of centres reporting they 'never' or 'rarely' administer antibiotics at induction and 15.4% (6/39) postoperatively.

Routine preoperative hair removal is 'commonly' or 'always' performed in (24/39) of centres, with 71.8% of these using electric clippers aligning with guideline recommendations. However, only 7.7% (3/39) of centres reported 'never' or 'rarely' performing hair removal, reflecting low adherence to guidance advising against routine hair removal. Just over half of the centres (60%, 20/32) 'commonly' or 'always' perform MLLA without incise drapes. When used, 78.8% of centres reported 'never' or 'rarely' using non-iodophor impregnated drapes, reflecting good adherence with guidelines (see Figure 3a and b).

Adherence to guidelines on providing information about SSI recognition and management was high, with 74.4% (29/39) selecting 'commonly' or 'always' done. In comparison, leaflets detailing the procedure itself and expected postoperative recovery are 'commonly' or 'always' provided in 50% of centres (19/38).

Adherence to best practice clinical care recommendations

Diagnostic imaging to assess revascularisation options are 'commonly' or 'always' performed in 92.5% (37/40) of centres and 75% (30/40) routinely discuss these cases in vascular

Figure 2 Antibiotics used prophylactically for patients undergoing major lower limb amputation (a) at induction of anaesthesia and (b) postoperatively.

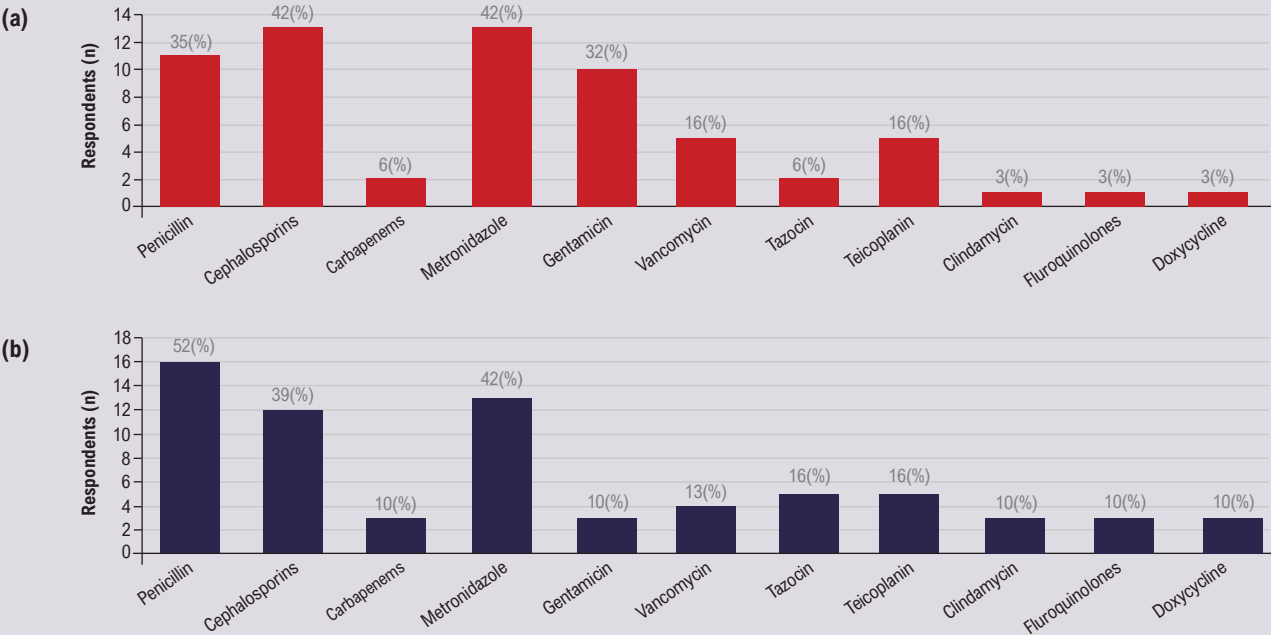
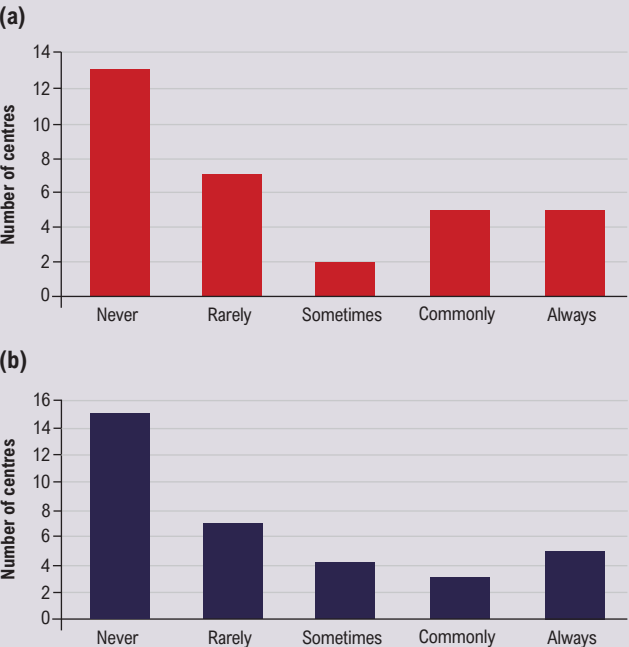
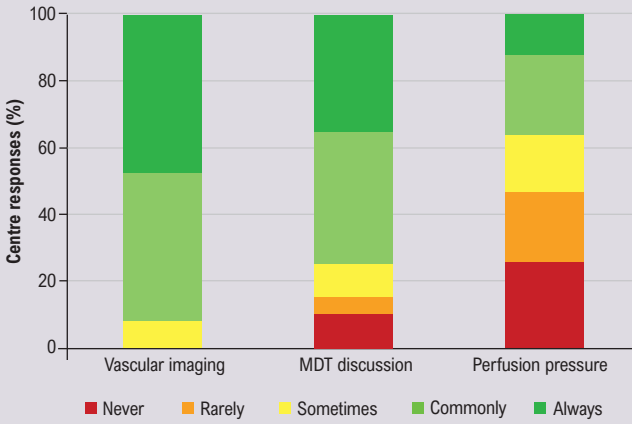


Figure 3 (a) Use of incise drapes and (b) use of iodophor-impregnated incise drapes.

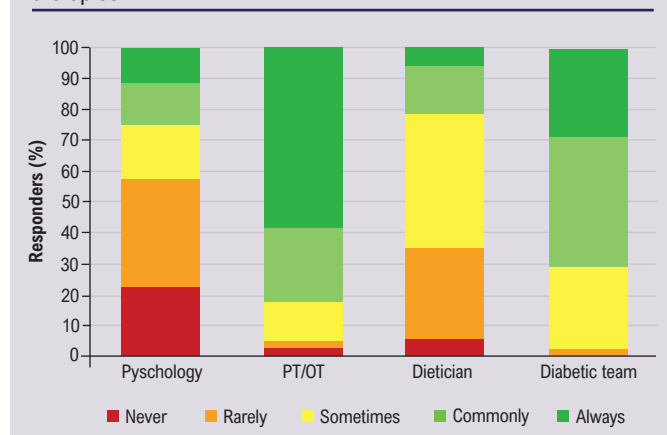


multidisciplinary meetings, demonstrating strong adherence to recommendations. In contrast, use of preoperative perfusion pressure measurements such as TcPO₂ are only ‘commonly’ or ‘always’ implemented in 48.3% (14/29) of centres (Figure 4).

Figure 4 Preoperative assessment of revascularisation options.



Routine preoperative assessment with occupational therapy and/or physiotherapy is ‘commonly’ or ‘always’ conducted in 82.1% (32/39) of centres and diabetic assessments are ‘commonly’ or ‘always’ undertaken in 71.1% (27/38), indicating good adherence to recommendations for multidisciplinary evaluation. However, adherence to guidelines recommending involvement of a dietician and clinical psychology were poor, with only 21.6% (8/37) and 25% (9/36) of centres selecting ‘commonly’ or ‘always’, respectively (Figure 5). Almost all centres (97.4%; 38/39) ‘commonly’ or ‘always’ implement thromboembolism risk assessment and prescribe prophylactic anticoagulation according to their local protocols.

Figure 5 Frequency of preoperative assessment by supportive therapies.

In 61.5% (24/29) of centres, patients routinely receive input from the acute pain team on the first postoperative day, indicating moderate adherence to pain management recommendations.

Routine follow-up after MLLA is provided in 69.2% (27/39) of centres. Where routine follow-up was implemented, all centres (27/27) offered face-to-face appointments, with seven also offering telephone follow-up and two using video consultations. Follow-up is most commonly provided in consultant surgeon-led clinics (23/27), with 14 of these centres also offering a nurse-led and/or rehabilitation clinic follow-up. In four centres, follow-up is conducted solely in nurse-led clinics or by rehabilitation/artificial limb application clinic only, with no surgeon involvement. Overall, 63.0% had outpatient follow-up with the rehabilitation team, showing moderate compliance with recommendations. Adherence was notably low regarding referral to external (peer-to-peer) support groups such as the Limbless Association, with only 36.8% 'commonly' or 'always' offering this service.

Evaluating equipoise

Several domains of post-MLLA care demonstrated considerable variability. Marked differences were seen in the use of postoperative antibiotics, with 61.5% (24/39) of centres reporting routine use whilst 15.4% (6/39) reported that they 'never' or 'rarely' prescribe them. Among these, administration routes also varied with 91.7% (22/24) using intravenous antibiotics exclusively, 12.5% (3/24) using oral only, and 37.5% (9/24) reporting that they used either intravenous or oral depending on the case. Duration also varied with 12.5% (3/24) giving antibiotics for <24 hours, 29.2% (7/24) for 24–48 hours, 25% (6/24) for 48–72 hours, 50% (12/24) for 72 hours to 5 days and 58.3% (14/24) for >5 days.

Surgical skin preparation techniques also differed. Single skin preparation was 'commonly' or 'always' applied in 60.5% (23/38) of centres and double skin preparation in 33.3% (13/39), demonstrating an area of clinical equipoise. Use on incise drapes also showed further disparity, with 40.6% (13/32) of centres always avoiding them whilst 31.3% (10/32) still used them 'commonly' or 'always'.

Routine outpatient follow-up after MLLA was offered in 69.2% (27/39) of centres. Among these, 33.3% (9/27) occurred within 4–6 weeks, 33.3% (9/27) within the first month and the remainder at other time points. Format also differed: 85.2% (23/27) offered consultant-led review, 63.0% (17/27) included rehabilitation-led follow-up and 33.3% (9/27) offered nurse-led care. Notably, nine centres provided consultant-only follow-up while three relied solely on rehabilitation teams without surgical input. These variations highlight differing models of postoperative care delivery across centres.

Discussion

This audit provides insights into the current clinical practices surrounding MLLA and highlights the variability in adherence to current guidelines aimed at reducing SSI. The findings demonstrate that vascular surgeons are the primary specialists performing MLLA, although a notable proportion of centres also involved other specialities such as orthopaedics, general surgery and plastic surgery. The variability in parent speciality may reflect differences in surgical techniques, indication for procedures, patient demographics and subsequently risk factors for SSI development,²⁰ likely contributing to variability in practice. However, this also raises important questions about the potential challenges in developing policies and/or best practice pathways to improve patient outcomes, particularly in the context of SSI prevention.

According to the 1964 wound classification, MLLA wounds are typically classed as 'clean',²¹ and therefore prophylactic antibiotics are not routinely recommended in the NICE guidelines. However, neither the guidelines nor this classification system account for the range of procedures, specialities, incision sites, patient cohorts and the subsequent variability in SSI risk.²² Many believe the increased risk of bacterial contamination secondary to ischaemic or infected tissue in MLLA warrants prophylactic antibiotic use,^{23,24} a consensus that seems in line with the survey results, with most centres (82.1%) administering induction antibiotics. Additionally, evidence suggests benefits of prophylactic postoperative antibiotics following MLLA,^{13,23} a practice also adopted in most centres (61.5%), although there was no clear consensus on duration of therapy. A recent randomised controlled trial¹³ published in 2022, three years after the 2019 NICE guidelines, demonstrated benefits of an extended 5-day course of antibiotic prophylaxis, highlighting how emerging evidence can surpass existing guidelines. It is important to consider that variation in antibiotic choice and administration route is expected due to differing local antimicrobial policies. This remains consistent with existing guidelines, which specify that, where antibiotics are indicated, selection should be guided by local antibiotic formularies, resistance patterns and microbiological tests where available.³ Given the risks of prolonged antibiotic use and antimicrobial resistance, it remains essential to balance antimicrobial stewardship with the prevention of infection.

The intraoperative practices and guideline adherence varied between centres. Hair removal was routinely performed in 61.5% of centres. However, the use of electric clippers, recommended over

razors to minimise micro-abrasions, was not universal, with 25.6% of centres still employing razors often, which may increase the risk of SSIs.²⁵ Current guidelines recommend using an alcohol-based solution of chlorhexidine but do not specify whether single versus double preparation should be employed. However, it is interesting to note the variability in local protocols, with 60.5% routinely using a single skin preparation and 33.3% often employing double skin preparation. There are some data from other surgical specialities demonstrating a reduction in bacterial colonisation with double preparation,²⁶ including a randomised controlled trial of patients undergoing total joint arthroplasty which suggests that double preparation reduces SSI rates;²⁷ however, these are not specific to MLLA. Some centres (21.1%) routinely use iodophor-containing incise drapes, which in other specialities have been shown to reduce SSIs;²⁸ however, no studies have focused on MLLA and many centres commonly or always perform MLLA without the use of incise drapes.

The survey demonstrated widespread use of diagnostic imaging (92.5%) and multidisciplinary team (MDT) discussions (75%) to evaluate revascularisation options and suitability prior to MLLA. This is encouraging as vascular optimisation, when appropriate, reduces the rate of MLLA.^{29,30} Furthermore, imaging review and MDT discussion aid in the complex decision of selecting the appropriate amputation level, balancing functional outcomes against the risk of postoperative ischaemic wound breakdown. Recommendations advocate pre-procedural imaging and perfusion assessments; however, no single test is accepted as the gold standard to predict wound healing³¹ and the decision is often primarily based on clinical judgement.³² Whilst angiography is widely implemented, preoperative perfusion pressures such as TcPO₂ are routinely used in less than half (48.3%) of centres, indicating a lack of standardisation. Perfusion pressures may be used to detect viable tissue for the amputation site. Studies suggest that TcPO₂ values of >40 mmHg are associated with a higher percentage of successful healing whereas values of <20 mmHg may indicate an increased risk of non-healing.³³ However, factors including limb oedema, cardiac output, smoking and pain can reduce accuracy, limiting its reliability as a sole determinant of amputation level. Consequently, there is no consensus regarding a specific threshold value. Despite this, the evidence suggests that perfusion pressures still provide valuable information.³² Additionally, emerging technologies such as machine learning algorithms may enhance risk prediction models by integrating patient risk factors and objective measurements. A recent pilot study demonstrated that machine learning incorporating multispectral wound imaging alongside patient risk factors improved the prediction for amputation wound healing.³¹ As these technologies evolve they may become an integral component of preoperative planning.

Occupational and physiotherapy assessments were widely implemented both preoperatively and postoperatively. Early assessment for rehabilitation can help prepare the patient physically and psychologically for rehabilitation,³⁴ and evidence has shown us

that early postoperative physiotherapy has a significant effect on function.³⁵ However, fewer centres routinely engaged dieticians (21.6%) and psychiatrists (25%) preoperatively. This finding is concerning as malnutrition and psychological distress are risk factors for poor post-surgical recovery and SSI development.^{36,37} Recent studies have highlighted the potential value of integrated approaches such as enhanced recovery after surgery (ERAS) collaborative models³⁸ and surgeon-physician co-management³⁹ to ensure optimal prehabilitation and perioperative management,⁴⁰ working towards better patient outcomes.

Follow-up varies significantly between centres, with almost one-third of centres (30.2%) not routinely providing routine follow-up after MLLA, which could lead to wound complications such as SSI and wound breakdown being under-diagnosed and therefore under-treated. Furthermore, less than half of centres routinely provide follow-up with a rehabilitation clinic (42.5%) or refer patients to external peer-to-peer support groups (36.8%) such as the Limbless Association. This lack of routine referral to support services may reflect under-appreciation of the role these resources play in long-term recovery and rehabilitation, given the significant physical and psychosocial impact MLLA often has. Greater integration of support services could improve patient outcomes and quality of life.⁴¹

Although this audit highlights significant variability in guideline adherence, it is important to note the limitations of the guidelines themselves. Some recommendations are outdated and others are derived from low-quality evidence,^{42,43} and recent trials have challenged existing guidelines such as the FALCON trial which questioned the superiority of chlorhexidine preparation in clean surgery.^{44,45} Notably, a recent study on diabetic foot disease reported similar findings, highlighting inconsistent adherence to guidelines and a lack of robust randomised controlled trial evidence supporting their foundation.⁴⁶ More critically, the SSI prevention and management guidelines are designed for broader surgical contexts and do not specifically address MLLA. As a result, their applicability and effectiveness in this cohort are uncertain, given the risk of SSI is multifactorial, influenced by patient comorbidities, procedural techniques and perioperative care beyond the scope of current recommendations. Moreover, there is a lack of high-quality evidence supporting the efficacy of intervention 'bundles' (combinations of individually effective interventions) in reducing SSI rates when implemented concurrently.⁴⁷ This audit also identified several areas of clinical equipoise, where significant variation in practice reflects a genuine lack of consensus of optimal management. Notably, the use of postoperative antibiotics showed great variability, with significant differences in route of administration and duration, ranging from 24 hours to >5 days. Similarly, intraoperative techniques such as single versus double skin preparation and the use of incise drapes showed substantial disparity between centres. Variability in preoperative MDT assessments and postoperative follow-up further reflected uncertainty in the holistic care aspect for those undergoing MLLA.

This highlights the need for robust procedure-specific evidence to guide best practice in MLLA. Current works, including the ROSSINI-Platform trial designed to evaluate SSI prevention strategies across surgical specialities including MLLA,⁴⁸ offer promising opportunities to continue addressing these evidence gaps. Furthermore, the European Society for Vascular Surgery is commissioning a Clinical Practice Guidelines specific for MLLA, set for publication in 2027.⁴⁹

Study limitations

There are some limitations to this audit. The survey responses were self-reported, which may introduce recall or social desirability bias and affect the accuracy of reported adherence. However, the main SIMBA study includes prospective data collection, which will help validate these findings against actual clinical practice. Additionally, the survey was limited to centres that participated in the SIMBA audit, with an overall response rate of 87%. Non-responders included four UK sites and two European sites. This may have introduced response bias, and the relatively small sample size and geographical concentration within the UK may limit the generalisability of these findings. There are also some limitations in the survey design. The survey was designed and internally validated by the SIMBA study management group, composed primarily of vascular surgeons and researchers, without external validation or wider multidisciplinary input, which may have enhanced its comprehensiveness and applicability. As a result, some terms – for example, 'MDT' – may have been interpreted inconsistently. Additionally, we did not collect data on the availability of specific services (eg, psychology or rehabilitation services), which limits our ability to determine whether the absence of routine assessment reflects a lack of access or other factors such as surgical urgency. Similarly, the survey did not include qualitative fields or free-text options to explore reasons for 'don't know' responses, which may reflect uncertainty or variation in terminology rather than true gaps in practice. Although some international guidelines were used, most recommendations assessed were based on UK-specific sources (eg, NICE and VSGBI), which may limit their applicability to international centres. Furthermore, while this audit provides a snapshot of current practice, it does not capture the real-time impact of these practices on SSI rates and patient outcomes. However, by evaluating adherence to established guidelines and identifying areas of clinical equipoise, this study highlights key areas for future research and focus points for future evidence-based guidelines tailored to this patient population.

Conclusion

This international multicentre audit highlights substantial variability in clinical practice and adherence to SSI prevention guidelines and best practice pathways in centres performing MLLA. Whilst there is good adherence to certain recommendations such as diagnostic imaging and multidisciplinary care, gaps remain, particularly in areas of preoperative nutritional and psychological evaluation,

KEY MESSAGES

- Surgical site infection is a common complication after amputation, potentially leading to prolonged hospital stays, revision amputations and even mortality.
- This survey revealed significant variation in practices including antibiotic use, preoperative assessments and postoperative care across 46 global centres.
- There is need for more tailored, evidence-based guidelines to reduce infection risk and improve patient outcomes following amputation.

intraoperative standardisation and postoperative support. However, given the lack of specificity of guidelines and the multifactorial nature of the risk of SSI, a more tailored evidence-based approach is needed. Future research should prioritise high-quality procedure-specific studies to evaluate the impact of different perioperative strategies on reducing the risk of SSI. This will facilitate the development of standardised care pathways, ultimately improving clinical outcomes for patients undergoing MLLA.

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ORIGINAL RESEARCH

Arterial assessment of the lower limb and foot: perceived benefits and disadvantages of current methods in contemporary practice

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Plain English Summary

Why we undertook the work: Many people have poor blood supply to the legs, which is known as peripheral arterial disease (PAD). This has a burden both for the patient and for healthcare services. It is important that assessments are used to make sure people have the right care at the right time. There are a range of tests used by healthcare professionals to assess and diagnose PAD. We wanted to explore what tests were used and what health practitioners thought about them. This was to help think about what devices might be useful in the future to help, or even to improve, PAD assessment.

What we did: An electronic survey was sent out to healthcare professionals asking them what assessments they used, how easy these were to complete, how long it took them and if there were any problems with completing them.

What we found: The survey was completed by 247 people. The largest group to complete the survey were podiatrists followed by community nurses, tissue viability nurses, vascular nurses, doctors and lymphoedema nurses. Manual assessments were most often used for measuring ankle and arm blood pressure to understand how healthy a patient's blood supply to the legs was. However, there were some difficulties in assessing patients. This was due to broken equipment, lack of equipment, lack of training or patient health issues. Patient health issues included being unable to lie flat, having very swollen lower legs, or the assessment causing pain, meaning it could not be completed.

What this means: Future technology to assess lower limb circulation could be improved. Alternative systems could be developed to improve assessment of the circulation in patients with PAD.

Abstract

Background: Peripheral artery disease (PAD) is a subtype of atherosclerotic cardiovascular disease, most commonly affecting arteries of the lower limb. PAD brings a significant burden to healthcare systems. This paper presents the results of a cross-sectional survey investigating current practices and perceptions surrounding vascular assessment performed by healthcare practitioners in community and acute care. An online survey using several social media channels, professional societies and personal networks was distributed for a nominal period of 3 months.

Methods: Responses were received from 247 practitioners working in community and hospital settings across Great Britain and Northern Ireland. The largest group were podiatrists followed by community nurses, tissue viability nurses, vascular nurses and doctors. Practitioners frequently undertook assessments at multiple locations. Taking vascular assessments were part of their daily (n=151, 61%) or weekly (n=62, 25%) role. For the remainder, assessments were made less regularly; monthly (n=23, 9%) or rarely (n=10, 4%). Several systems were in use for vascular assessment, the majority manually operated.

Results: Across the range of instrumentation used, numerous equipment issues were reported. Of 390 stated problems, Doppler probe malfunction/casing breakage (n=160, 41%) was the most common followed by flat batteries (n=134, 34%), problems with arm and ankle cuffs (n=54, 14%) and burst toe pressure cuffs (n=24, 6%). Other issues included loose wires, faulty electronics, tubing detachment from cuffs and loss of waveform. Practitioners frequently employed multiple methods of vascular assessment. Of the 247 respondents, ankle-brachial pressure index was used by the majority (n=194, 79%), whilst toe pressure measurements for

calculating toe-brachial pressure index were used by 109 (44%). Numerous barriers were identified in performing assessments: lack of time, lack of equipment, lack of training and lack of confidence. Participants also reported patient-based barriers including lack of patient mobility to lie supine, lower limb oedema and discomfort during assessment. It may be prudent for future technologies to consider alternative assessment methods to prevent limitations of assessment on those with swollen, calcified and broken friable tissue and for those who are unable to lie in a supine position without experiencing discomfort and pain.

Conclusion: Based on the results of this work, there is justification to pursue development of novel technologies which, in the future, would make it easier for healthcare practitioners to assess lower limb and foot circulation with ease, greater accuracy and at lower cost to the NHS.

Key words: vascular assessment, ankle-brachial pressure index, toe-brachial pressure index, training, time constraints

Introduction

Cardiovascular disease (CVD) is now a major public health concern and World Health Organisation (WHO) sustainable development goal (SDG).¹ As a non-communicable disease, the SDG target is mortality reduction and prevention of disease burden (SDG 3.4.1).² Arterial disease outside the brain or heart is referred to as peripheral artery disease (PAD), a subtype of atherosclerotic CVD, most commonly affecting arteries of the lower limb.³

Considering the significant burden that PAD brings to healthcare systems in both higher income countries and lower to middle income countries, efforts to meet WHO SDG 3.4 will only be achieved with prompt diagnosis. However, given that the spectrum of disease is wide, including people who are symptomatic and asymptomatic,⁴ there are reported concerns about the reliability, availability and use of current devices and methods for vascular assessment in PAD, especially in those patients with end-stage disease, chronic limb threatening ischaemia.⁵

PAD diagnosis is made upon a full lower limb vascular assessment including assessment of distal pulse and measurement of arterial pressure combined with symptom presentation.⁶ A common method of assessing arterial pressure is the calculation of the ankle-brachial pressure index (ABPI). This involves taking systolic pressure at the ankle (posterior tibial and dorsalis pedis) and dividing the reading by the highest systolic brachial pressure. Differences are reported as a ratio. In addition, more recent practice also extends to measurement of toe pressures and the corresponding toe-brachial pressure index (TBPI). Now, with the appearance of automated systems on the market, an understanding of contemporary measurement methods, techniques, instrumentation and procedures in use across Great Britain and Northern Ireland is warranted. The aim of the study therefore was to undertake an online survey seeking to better understand current practice as well as possibilities for technology development for those involved in the care of patients with lower limb circulatory disease.

Methods

This work was undertaken as part of a larger study funded by the

Medical Research Council (MRC). Institutional ethics approval was obtained before commencing the study.

Study design and target audience

A cross-sectional survey was carried out to investigate current practices and perceptions surrounding vascular assessment performed by professional healthcare practitioners in community and acute care.

Questionnaire development

All authors contributed to the design of the questionnaire by drawing on their collective professional experiences in nursing, medicine, podiatry, community and acute care vascular assessment. The goal was to capture quantitative and qualitative data on a wide range of practice, knowledge levels and challenges encountered in everyday clinical settings. The questionnaire was distributed using free online software, Google Forms, chosen for its user-friendly interface and easy distribution.

Consent and confidentiality

Before accessing the survey questions, participants were presented with an information page outlining the study purpose, the voluntary nature of participation, and assurances regarding data confidentiality. Informed consent was implied by the participant decisions to proceed with the survey and by agreeing to an explicit statement of consent. No personal identifiers were collected. All responses were automatically anonymised upon submission.

Survey distribution and data collection

The survey link was distributed via several channels:

- Email invitations to professional societies including the Society of Tissue Viability, Society of Vascular Nurses as well as individual/collective contacts identified by the research team (eg, the Sheffield-wide community nursing teams and NHS vascular nurses).
- Announcements by specialist publisher Wounds UK (survey posted 19 September 2024) or newsletters where possible through established professional connections as well as social

- media streams such as ‘X’ (formerly known as Twitter) and closed Facebook groups related to peripheral artery disease or lower limb wounds.
- Personal networks of the co-authors (in collaboration with colleagues) – for example, podiatrists working within high-risk areas within the NHS – to further extend the reach.
 - A time-limited window for data collection (nominally 3 months) was set to complete the questionnaire.

Data management and analysis

Submitted responses were stored securely in a password-protected online university repository. Upon closure of the survey, responses were exported to an Excel™ spreadsheet. All analyses were conducted at an aggregate level to maintain anonymity. Not all survey questions were answered by every individual. Open-ended survey responses such as those focused on barriers to vascular assessment and the role of PAD assessment were individually analysed by all the researchers with conceptual coding⁷ before being drawn together and consensus reached upon the data findings. Group level results are reported as well as anonymous quotations considered helpful to clarify content.

To balance accuracy with readability, percentages have been rounded to the nearest whole number where appropriate. Values of 0.5 and above have been rounded up, while those of 0.4 and below have been rounded down. As a result, percentage totals may not always equal exactly 100%.

Results

Respondents

The survey was open from 17 September to 12 November 2024. During the first 10 days 168 responses were received, followed by a further 79 over the remaining 47 days, resulting in a total of 247 completed questionnaires. Of these, 245 respondents provided location data. The majority were based in England (n=216, 88%), with 13 responses each from Wales and Scotland (5% each), and three from Northern Ireland (1%).

Practitioners

Of the 247 healthcare respondents working across community and hospital settings, the largest group were podiatrists (n=115, 47%). Others included community nurses (n=49, 20%), tissue viability nurses (n=29, 12%), vascular nurses (n=28, 11%) and doctors (physicians and surgeons) (n=17, 7%). Lymphoedema nurses also participated (n=4, 2%). An additional five (2%) selected the ‘other’ category, which included roles such as vascular scientist, exercise physiologist and assistant practitioner.

Time working as a healthcare professional ranged from 1 to >40 years. Of the 246 who provided service data, 56 (23%) had 1–9 years of experience and an almost equal number (n=62, 25%) had been practising for 10–19 years. A further 70 (28%) reported 20–29 years of experience, while 46 (19%) had worked for 30–39 years. Twelve (5%) had been practising for ≥40 years.

Among the 244 who provided educational information, the majority held a graduate level qualification (n=215, 88%). Of these, 84 (39%) had obtained a Master's degree or Doctorate. The remaining respondents were educated to Diploma level or held other forms of certification (n=29, 12%).

Of the 246 who provided working sector data, the majority were employed exclusively within the NHS (n=195, 79%). A further group worked solely in the private sector (n=12, 5%) and the remainder combined NHS roles with other activities such as education, research or private practice.

Assessment locations

Practitioners frequently undertook assessments at multiple locations. The most frequently reported location was clinic-based practice (n=211, 85%), followed by domiciliary or community settings (n=138, 56%) as well as hospital wards (n=99, 40%). Less common settings included in a University, General Practice surgery or nursing home (n=3, 1%). Of the 247 respondents, 246 indicated that performing vascular assessments was a regular component of their professional responsibilities, with 151 (61%) undertaking them daily and 62 (25%) on a weekly basis. A smaller proportion reported conducting assessments less frequently, either monthly (n=23, 9%) or rarely (n=10, 4%). Several systems were in use for vascular assessment, the majority manually operated but automated systems were being used in everyday practice (Table 1).

Huntleigh (Huntleigh Healthcare Ltd, Cardiff, UK) equipment

Table 1 247 individuals reported using 1111 manual and automated systems in their vascular assessment.

Manual equipment	Frequency of responses
Arm and ankle blood pressure cuff	203
Toe pressure cuff	130
Manual sphygmomanometer	162
Handheld Doppler without visual waveform	170
Handheld Doppler with visual waveform	138
Handheld Doppler with toe pressure function	99
Stethoscope	97
Automated equipment	Frequency of responses
Automated MEDI/MESI	34
Automated ankle-brachial index machine	30
Photoplethysmography probe (PPG)	23
Automated toe pressure unit	18
TcPO ₂ machine	4
Duplex scan/ABPI/TBPI	3
MEDI/MESI (mediUK Ltd).	
ABPI, ankle-brachial pressure index; TBPI, toe-brachial pressure index;	
TcPO ₂ , transcutaneous oxygen pressure.	

Table 2 Manufacturer, company base and number of types of equipment used as stated by respondents; 24 respondents did not specify the make of device used.

Device manufacturer	Equipment type	Company details
Huntleigh (n=214)	Vascular assessment Doppler probe and cuffs	Huntleigh Healthcare Ltd, Cardiff, UK
mediUK (n=7)	MESI automated pressure (ankle, brachial, toe) systems	mediUK Ltd, Surrey, UK
Perimed (n=2)	Laser Doppler vascular diagnostics	AB Vascular Diagnostics, Sweden
Hadeco (n=2)	Mini Doppler	Medisch Vakhandel, Netherlands
BlueDop (n=2)	ABPI screening (ankle cuffless technology)	London, UK
Diaped (n=2)	Vascular Doppler	OvilCare, London, UK
Hi Dop (n=2)	Vascular Doppler	Ana Wiz Ltd, Surrey, UK,
Welch Allyn (n=1)	Blood pressure systems	Medisave UK Ltd, Dorset, UK
Falcon Pro (n=1)	Complete vascular physiological system	Viasonix, Ra'anana, Israel
V Scan Air (n=1)	Handheld ultrasound system	GE Healthcare, Buckinghamshire, UK
Podium (n=1)	Vascular diagnostics and diabetic foot health	Thermatrix, Abercynon, UK
Bistos (n=1)	Ultrasound Doppler system	Gyeonggi-do, Korea
Moor Instruments (n=2)	MediCap, TcPO ₂	Moor Instruments, Axminster, UK
UltraTec (n=1)	Vascular Doppler	Chepstow, UK
Systoe (n=1)	Automated toe pressure measurement using PPG	PMS (Instruments) Ltd, Wokingham, UK

PPG, photoplethysmography probe; TcPO₂, transcutaneous oxygen pressure.

was the most common supplier of vascular devices (including arm and ankle pressure cuffs), although practitioners reported using more than one type of vascular assessment device (eg, manual and automated systems) (Table 2).

Multiple devices are in use in current practice for arterial pressures at the ankle, toe and arm, either manually or by automated systems. Photoplethysmography (PPG) was used in vascular assessment practice, most frequently by podiatrists. More advanced diagnostic systems such as duplex ultrasound was used by consultant podiatrist/clinicians, Perimed AB vascular diagnostics (Sweden) by podiatrists and a vascular scientist. Falcon (Viasonix, Ra'anana, Israel) was used by vascular nurses. Medicap (Moor Instruments, Axminster, UK) transcutaneous oxygen monitoring was used by podiatrists and a doctor.

Across the range of instrumentation/devices used, numerous equipment-related issues were reported, totalling 390 problems from the majority of respondents (n=202). The most frequently cited issue was Doppler probe malfunction or casing breakage (n=160, 41%), followed by flat batteries (n=134, 34%), problems with arm

and ankle cuffs (n=54, 14%) and burst toe pressure cuffs (n=24, 6%). An additional 18 (5%) included loose wires, faulty electronics, tubing detachment from cuffs and loss of waveform.

Pressure measurements

Of the 246 who provided data on brachial pressure measurement, the majority (n=192, 78%) reported using the highest value obtained from the right and left arm readings in practice. A smaller group (n=12, 5%) used the right arm for right-sided ABPIs and the left arm for left-sided ABPIs. Among the remaining respondents (n=4, 2%), alternative methods were used such as selecting the easiest arm to access or adapting to patient-specific factors (for example, when a cannula was in situ). Thirty-eight participants (15%) either did not measure brachial pressure or did not provide a response to the question.

Ankle-brachial pressure (ABP) and calculation of index (ABPI)

Of the 246 who described their vascular assessment practice, 37 (15%) reported not including an ABPI calculation in their assessments. Of the remaining 209 who did include ABPI, the majority (n=170, 81%) reported always taking measurements from both legs. A further group did so only sometimes (n=31, 15%), while a small number measured the leg suspected of disease only (n=8, 4%). Doppler signals (sounds and waveforms) are key to ABPI and TBPI assessment, and headphones can enhance auditory signal detection. Fourteen (6%) reported using headphones regularly and 56 (23%) used them sometimes. However, the majority (n=177, 72%) reported never using headphones in their practice.

The time required to complete ABP measurements and to calculate ABPI varied among respondents. Of 201 practitioners who reported the duration of their assessments, the majority (n=114, 57%) indicated it took less than 20 minutes. A further 42 (21%) reported durations of 20 to <30 minutes while 45 (22%) stated that the procedure took 30 minutes to >1 hour. Most (n=132, 65%) considered that they had sufficient time to complete ABPI, whilst the remainder reported either not having enough time or expressed a preference for more time to carry out the procedure.

Practitioner views on the ease of completing ABPI assessments were divided. Of the 208 who answered this question, 102 (49%) reported finding the procedure easy, while a similar number (n=100, 48%) described it as sometimes difficult. A small number (n=6, 3%) found ABPI assessments either difficult or very difficult. Reported challenges included difficulty finding pulses, patient discomfort, limited time or lack of staffing, and lack of experience. With regard to calculation of the index, almost all respondents (n=209, 98%) reported feeling confident to undertake the calculation.

Toe-brachial pressure (TBP) and calculation of index (TBPI)

Compared with the number of practitioners performing ABPI as part of their vascular assessment, far fewer reported including toe pressure measurements or calculating the TBPI. For the 132 who

provided data on time taken, 102 (77%) completed pressure measurements and TBPI calculation in <20 minutes, including 38 who reported taking ≤5 minutes. The remaining 30 (23%) reported durations ranging from 20 to 60 minutes. When asked whether there was enough time to perform a TBPI in the same appointment after completing an ABPI, the majority (n=158, 65%) reported that they either did not have sufficient time or would prefer more time. By contrast, 35% indicated that they had enough time to complete both ABPI and TBPI.

For the 136 respondents who commented on the ease of performing TBPI measurements, 51 (38%) found the assessment easy. However, 73 (54%) found it sometimes difficult, while eight (6%) described it as difficult and four (3%) as very difficult. Of 225 respondents who provided data on patient positioning during ABPI and TBPI assessments, nearly all (n=222, 99%) reported being able to help patients achieve the correct position. Of these, 11 (5%) stated they could do so always, 148 (66%) mostly and 63 (28%) sometimes. Only three (1%) indicated that they had difficulty positioning their patients appropriately for the assessments.

Vascular assessment barriers

When given the opportunity to report perceived barriers to performing vascular assessments through an open-ended question, 242 provided feedback, generating 628 unique responses. Of these, 77 (32%) reported no barriers to assessment. Among the remaining 165 (68%), 13 distinct themes emerged. The most often cited barriers included time constraints or lack of service capacity (n=202), insufficient experience, knowledge or training to perform the tests (n=179), malfunctioning or unavailable equipment (n=79) and lack of managerial support (n=24). Additional themes included low patient engagement, lack of clinical support and limited professional interest in vascular assessment.

Diagnostic cut-offs for PAD

A variety of index test thresholds were in use in practice for both ABPI and TBPI. For ABPI, the most widely used was a threshold of >0.7 to ≤0.8 and, for TBPI, >0.6 to ≤7 (Table 3).

PAD screening

For the 184 who answered this question, the vast majority (n=172, 93%) believed that vascular assessments have a role in the preventative screening of PAD. Only 12 (7%) disagreed. Those in support of preventative screening highlighted benefits such as early detection of disease, the potential to prevent progression and the opportunity to manage risk factors proactively. Common themes included: “it would help detect disease earlier”, “prevent disease progression, because time is very important in PAD”, and “it would encourage early management and control of risk factors”. Others emphasised broader public health benefits, suggesting that the general public should be screened, and noting that “if PAD can be detected earlier, I believe treatment can be cheaper, with better prognosis” and “GPs should have capacity to perform ABPI”.

Table 3 Diagnostic cut-off values for ABPI and TBPI (104 responses received for ABPI; 64 responses received for TBPI).

ABPI	n	TBPI	n
0.9< ABPI ≤1	1		
0.8< ABPI ≤0.9	22	0.8< TBPI ≤0.9	1
0.7< ABPI ≤0.8	26	0.7< TBPI ≤0.8	0
0.6< ABPI ≤0.7	7	0.6< TBPI ≤0.7	30
0.5< ABPI ≤0.6	8	0.5< TBPI ≤0.6	7
ABPI ≤0.5	12	TBPI ≤0.5	4
ABPI 1.3	1	TBPI 1.3	1
Unsure	7	Unsure	7
Written response*	20	Written response*	14

*No numerical range given, typically a description – for example, “Results used in conjunction with clinical assessment”, “It’s not that simple!”, “I would be guided by our lower limb policy and the whole assessment, not just the numbers”.

General perspectives from participants

Assessment opportunities and timing

There were areas of good supportive practices with respondents saying that they ran PAD triage clinics to detect early PAD, redirecting referrals from vascular surgeons to podiatry leg community-based services. “We have 60-minute appointments for these people +30 min administration time to cover assessment, diagnosis, breaking news, education about long term conditions and negotiation about BMI and lifestyle changes. Another stated, “All patients receive ABPI assessment within two weeks of admission to caseload”. On the other hand, there were comments indicating that respondents were concerned about lack of experience and time availability to be able to undertake the assessments, “Time and experience is the factor that holds back good assessments” and “A thorough assessment is not possible in the community, with the lack of equipment, time constraints and lack of exposure given, to be confident and competent in then relaying our findings with any confidence!”

Perceptions of equipment

“The kit falling apart is a disaster....”. Better functioning equipment goes in tandem with concerns for space and staff: “We need more resources i.e. better functioning equipment, clinic space, well trained staff” as well as a lack of equipment: “We use very basic vascular assessment” and “We have equipment but limited ABPI and TBPI machines”

Training, skill, experience and confidence in understanding results

A common theme was that there needs to be an increase in access to education about the assessments and for upskilling of staff to ensure confidence in the interpretation of results.

"The assessment itself is clear on what is required. The challenge lies with (a) interpretation of the results for clinicians who are not as skilled and/or do not feel competent in their assessment, and (b) patient impact and their presentation".

"It is something that we can get comfortable with and better at with time and practice, there is sadly a lack of support with some of the technicalities with the equipment".

"There needs to be major education".

Clear guidance on when to refer to vascular services

It was thought that the ideal situation would be to have the assessments completed more frequently and regularly for patients with none or very minor symptoms, almost similar to screening, rather than assessments happening because the patients have advanced disease, but currently this was not feasible due to lack of education, skills and time constraints.

Many respondents felt the main problem was delayed referrals to the assessment service with concerns that, due to GP collectives, patients with lower limb wounds are referred to the acute sector: *"Primary care practitioners no longer deal with wound care/active wounds, never mind prevention. Who is going to fund a program for preventative screening for PAD?! Great idea but unrealistic".*

Responses highlighted concerns surrounding those patients who are housebound: *"My patients are all housebound, not able to get ongoing clinical support when there is doubt or a problem in doing test or interpreting results".*

Who should be undertaking assessments

Many respondents were keen for all practice staff to be educated in taking the assessments: *"Would benefit from all staff in the treatment rooms being able to do toe pressures"* and respondents who worked in podiatry settings stated: *"ABPI needs to be encouraged to be performed routinely by all podiatry staff band 5+ not just specialist podiatrists"*. Some respondents believed it was a simple process in a very easy patient but, if trying to make good referrals, accuracy and context was needed. As such, the assessment should be undertaken by a qualified podiatrist and should not be treated as a simple technical role for assistants. Others thought the role of specialists was key to good quality tests: *"In secondary care the vascular scientist performs these tests and has a huge amount of learning background and training to achieve reliable readings"*.

Emerging and automated systems for vascular assessment

New technologies used in vascular assessment arising primarily from research suggest that there is good support for their use in disease prognosis *"TcPO₂ has been a game changer - we can assess chances of healing before toe amputation so know if we need to look at vascular intervention first. Saving money by reducing need for unnecessary imaging"*. There was also support for the newer automated pressure systems but with recognition of

the need for systems validation. *"We also use automated assessments (MESI and BlueDop) but in a research capacity as there is a lack of data on the validity of these devices"* *"We would love to use blue dop or automated systems if safe"*.

Follow-up monitoring

Continued monitoring was identified as a concern with a lack of time and staff capable of undertaking follow-up. Respondents stated that when they needed to refer to vascular (eg, due to unclear results and for safe compression) it could take a long time for patients to be seen and in the meantime ulcers and oedema were worsening. *"In our lymphoedema clinic all new patients get a vascular assessment including ABPI or TBPI, but for ongoing monitoring purposes we would do the vascular assessment without the ABPI/TBPI; eg, the problems come on discharge, because we don't have anyone to refer to for repeat vascular assessments"*.

Discussion

In this survey we have attempted to understand the perspectives and experiences of frontline healthcare professionals in contemporary vascular assessment practice. Both positive and negative responses help towards healthcare improvement as well as facilitating the drive for MedTech development if there are technology gaps to close. A wide audience involved in all aspects of vascular assessment was reached whether practice was based in hospital, community or clinics. Linking with professional networks and societies focused on wound healing and vascular disease, 247 respondents submitted survey information about their day-to-day practice in under 2 months. With the survey design used, respondents were at liberty to provide information as a mix of discrete options as well as open-ended responses. This meant that response numbers varied between questions.

ABPI was by far the most common method for vascular assessment, with just over half taking toe pressure measurements for calculation of TBPI. Use of these assessment techniques is higher than those identified previously in UK-based studies. For example, 26% of 260 podiatrists were reported to perform ABPI and just 6% TBPI.⁸ A slightly higher percentage of activity was reported, with 32% of 307 podiatrists completing ABPI and a similar number (6%) completing TBPI.⁹ It is possible that, by moving from a single profession audience (podiatry) to a broader group of vascular practitioners, a wider perspective has been achieved where assessments are being performed involving ABPI and TBPI in day-to-day vascular care and treatment, than for podiatry where the nature of the specialty differs.

The higher rates of ABPI and TBPI assessments reported in the current survey may indicate a shift in practice consequent on publication of research (as well as national guideline recommendations for vascular assessment) after the previous surveys had been completed and published. Emphasis, particularly on the importance of ABPI in PAD assessment,¹⁰ may have resulted in greater recognition of the guidance translated to practice.

Non-invasive simple methods for disease detection in clinical practice are attractive, but tests need to be sufficiently reliable to prevent missed diagnoses. ABPI, as an index test for PAD with a threshold of <0.9 , is recommended as the best predictor.¹¹ This threshold has been used to distinguish positive (<0.90) and negative (≥ 0.90) ABPI test results.¹² When referring to guidelines, clinicians use this threshold in practice. However, false negative and false positive test results do occur.¹³ This is recognised as a confounder to test accuracy, especially when used for lower limb PAD in patients with medial artery calcification at the ankle arising from incompressible tibial vessels. This is a common finding in patients with diabetes who present with symptoms of PAD and foot ulcers,^{14–16} making ABPI a significant limitation when used for vascular assessment in diabetic patients. With increasing rates of diabetes in the community,^{17,18} diagnostic accuracy is key to early intervention and treatment. Of concern here is diagnostic performance of ABPI against gold standard angiography, with sensitivity for PAD diagnosis ranging widely.¹⁹ For example, a high level of specificity (83.3–99.0%) for an ABPI ≤ 0.90 was reported, but with a wide range of sensitivity (15–79%).²⁰ Low sensitivity, especially in older people and those with diabetes, was also noted.²⁰ Some confusion may exist about the relationship between guidelines for PAD diagnosis and venous disease, where ABPI is used as a safety check for strong compression therapy.²¹ Safe compression is indicated when ABPI is >0.8 in venous disease and is the mainstay of treatment in those with venous leg ulcers. This subtle detail in knowledge of the respective ABPI thresholds could sometimes be misinterpreted by lower limb clinicians, especially those in the leg ulcer management field. For those with end-stage PAD presenting as chronic limb threatening ischaemia, it has been noted that partial compression of the vessel may underestimate the severity of the disease.²² In a large series of nearly 6,000 patients undergoing revascularisation, 21% had a 'normal' ABPI and 53% had a mild reduction in ABPI only, indicating a 'disconnect' in the utility of ABPI in certain populations of patients.²²

Whilst expert consensus recommends toe pressures and TBPI for its advantages over ABPI²³ in the presence of heavily calcified tibial vessels, there still lacks an agreement on the threshold.²⁴ Furthermore, a threshold for TBPI (and toe pressure) to confirm diagnosis does not exist.⁵ Even so, just over half of respondents were using TBPI in their practice with the majority using a threshold of 0.7, where TBPI ≥ 0.7 indicates that diagnosis of PAD is less likely.²⁴

Whilst the greater number of respondents in the survey measure ABPI and/or TBPI manually, a smaller group have adopted automated monitoring, despite recommendations that such systems to detect PAD in people with leg ulcers should be used only in the context of research.^{25,26} This may be due to previous evidence of poor diagnostic precision comparing manual with automated systems for measuring ABPI (sensitivity 75%, specificity 67%).²⁷

Focusing on barriers to performing vascular assessments, 628

open comments were received. Thematic analysis of the open questions identified barriers falling into 14 themes, of which four were key – namely, lack of time, lack of equipment, lack of experience training and confidence. The lower percentage of practitioners completing TBPI assessment may reflect a lack of training and confidence with toe pressure assessment. Comments from participants repeatedly reported upon TBPI being a 'faff' or 'fiddly'. Less experienced clinicians reported uncertainty in the assembly of the equipment and lack of confidence with interpreting the readings. There was a clear commentary on the necessity for additional training to enhance skills to help provide confidence on correct equipment use. In a systematic review, ABPI education was explored.²⁸ It was concluded that training requires time, mentorship and feedback on all stages of the ABPI procedure. To date, there is no standardised training to close these training gaps, suggesting that some patients may be receiving suboptimal assessment, falling short of recommendations and guidance by national and international health agencies.^{24,29} This background is mirrored to an extent by the issues arising in this survey, where lack of training, lack of confidence and a recognition of the need to upskill staff was repeatedly identified as an area of concern.

Focusing on patient-based barriers to performing vascular assessments, open responses identified key themes – namely, lack of patient mobility to lie supine, limb oedema and discomfort during assessment. These findings are comparable to those identified in a study exploring PPG versus ABPI assessment in patients with PAD.³⁰ The feedback from this survey identified factors such as inability to lie flat as a barrier to ABPI assessment and discomfort or pain on cuff inflation at the ankle. It is clear that neither ABPI nor TBPI is suitable for all patients, at all times, who require assessment for PAD. Newer technologies may be more suitable. However, results from the current survey identify little use of alternative technologies that do not rely on cuff inflation, with only 23 respondents using PPG for example. It may be prudent for future technologies to consider alternative assessment methods to prevent limitation of assessment on those with swollen, calcified and broken friable tissue and for those who are unable to lie in a supine position without experiencing discomfort and pain.

Conclusion

This national survey has provided an important insight into the current practices, experiences and challenges associated with lower limb vascular assessment in clinical practice across Great Britain and Northern Ireland. The findings demonstrate a clear commitment by healthcare professionals to the detection and diagnosis of PAD, with high levels of engagement in ABPI assessments and, to a lesser extent, TBPI measurements. Despite improvements compared with earlier surveys, particularly in the uptake of ABPI and TBPI, significant barriers persist. These include limitations in time, equipment availability, clinician training and confidence, and patient-specific factors such as discomfort, immobility and advanced disease presentation.

KEY MESSAGES

- This study demonstrates the commitment by healthcare professionals to the detection and diagnosis of peripheral artery disease.
- Healthcare professionals report limitations in time, equipment availability, training opportunities and broken/non-functioning equipment hampers their assessment practice.
- Wide variations in ABPI and TBPI thresholds mark limitations of current assessment practices, demonstrating the need for improved diagnostic accuracy.
- Practitioners are interested in new and emerging technologies for future vascular assessment practice.

Notably, the variation in diagnostic thresholds used in practice, along with confusion between national guidelines, indicates a need for clearer and more unified clinical guidance. This, combined with persistent uncertainty around TBPI thresholds and limitations of ABPI in certain populations, underscores the necessity for improved diagnostic accuracy through both enhanced clinician education and the development of validated user-friendly technologies.

The limited adoption of emerging and automated technologies, despite practitioner interest, further highlights a critical area for future development. This includes the potential value of technologies not dependent on cuff inflation and more adaptable to the needs of patients with complex presentations. If PAD is to be diagnosed earlier and more accurately, particularly in community settings, investment in both workforce training and technology is essential. Ultimately, achieving the WHO sustainable development goal² of reducing mortality from non-communicable diseases will require a coordinated response that addresses systemic barriers, improves diagnostic reliability and enables equitable access to high-quality vascular assessment across all care settings.

Conflict of Interest: None.

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ORIGINAL RESEARCH

Outcome measurement for vascular amputee patients: a scoping survey of UK clinical practice

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Plain English Summary

Why we undertook the work: Using appropriate physical assessment tests with patients who have undergone an amputation due to vascular disease is important to patients and healthcare professionals. They are used to assist with setting patient goals and monitoring how a patient is progressing when they are undergoing treatment or rehabilitation. At the moment it is not known which physical assessment test is most useful to use with patients who do not walk or use a prosthetic limb.

What we did: Before starting the research we obtained ethical approval from the University of Leicester. We carried out a survey with healthcare professionals who currently work in the UK and used an online platform to run the survey. We asked healthcare professionals what kind of physical assessment tests they are using at the moment with patients, and how useful they find them.

What we found: Over half of the healthcare professionals who responded to the survey had over 10 years of experience working with amputees. Healthcare professionals stated that they more commonly used physical assessment tests to assess walking (89%) and less than half used assessment tests with patients who do not walk (45%). Healthcare professionals stated the assessment tests for patients do not walk are not useful when treating patients.

What this means: At the moment the available physical assessment tests are not being used frequently with the majority of patients who do not use a prosthetic limb for walking after an amputation due to vascular disease. Therefore, this study may support the development of a new physical assessment test that would be useful for patients and healthcare professionals to assist with setting patient goals and providing treatment or rehabilitation to these patients.

Abstract

Objective: Currently it is unknown whether Physical Performance Based Outcome Measures (PerBOMs) are used in clinical practice with patients who have undergone an amputation due to peripheral arterial disease. This study aims to explore the clinical use and usefulness for healthcare professionals (HCPs) and to look at the types of rehabilitation interventions being provided to amputees.

Methods: An anonymised scoping survey published online at <https://www.onlinesurveys.ac.uk> was used. The survey consisted of 17 questions, and all data collected were non-identifiable. Ethical approval was obtained from the University of Leicester ethics committee. Statistical analysis was completed with descriptive statistics.

Results: A total of 125 HCPs responded, of which more than half had ≥ 10 years' experience working with vascular amputees (51.2%). Timed Up and Go was the most used ambulatory PerBOM by HCPs (89%) and the Basic Ambulatory Mobility Scale (45%) was the most commonly used non-ambulatory PerBOM. PerBOMs were least used before amputation (15%) and were used most frequently 6 months after amputation (59%). HCPs rated PerBOMs for ambulatory patients as being of greater usefulness than non-ambulatory PerBOMs. The most common rehabilitation interventions for non-ambulatory amputees include transfer practice (85.5%) and wheelchair training (69.6%); few provided group exercise therapy (23.2%).

Conclusions: Ambulatory PerBOMs are well known and used more frequently than non-ambulatory PerBOMs. PerBOMs for vascular amputees are not used within clinical practice due to the limited number and inadequate options of PerBOMs for non-ambulatory vascular

amputees. Further research is needed in understanding the limited clinical use of existing PerBOMs. Pending further research, a new PerBOM for non-ambulatory patients may be supported to assess the physical function of amputees throughout the patient journey of vascular amputees and for goal setting in the short and longer term.

Key words: vascular amputation, non-ambulatory, physical performance, function

Introduction

Peripheral arterial disease (PAD) and/or diabetes is the largest cause of major amputation.¹ Individuals who have undergone an amputation due to vascular disease ('vascular amputees') often have multiple comorbidities, are older, frail,² have decreased physical function and live with disability following their amputation.^{3,4} Vascular amputees often do not wear a prosthesis for ambulation for several reasons. Factors affecting successful prosthetic wear include patients experiencing reduced physical function pre-amputation,⁵ multiple co-morbidities,⁶ altered cognitive function⁷ and potential problems with their contralateral limb^{8,9} if a unilateral amputee. This often leads to an inability to wear a prosthetic limb or unsuccessful prosthetic rehabilitation.^{7,10} In this paper patients who do not use a prosthetic limb for walking following an amputation due to vascular disease will be referred to as 'non-ambulatory vascular amputees'.

Vascular amputees live with disability and require appropriate assessment of their physical function for holistic clinical management and rehabilitation with Physical Performance Based Outcome Measures (PerBOMs) throughout their patient journey and as their PAD develops.¹¹ Using appropriate PerBOMs within clinical practice can support healthcare practitioners (HCPs) to set patient goals and monitor progression whilst receiving treatment and rehabilitation.

At present there is little guidance on which PerBOMs are best to use with the vascular amputee population. A comprehensive list of all PerBOMs that have been validated and clinimetric properties assessed with the vascular amputee population has been produced in a systematic review of all previous literature.¹² This paper identifies that only four PerBOMs are suitable for the non-ambulatory amputee population: Amputee no Prosthesis (AMPnoPro),¹³ Transfemoral Fitting Predictor (TFP),¹⁴ One Leg Balance Test (OLBT)¹⁵ and Basic Amputee Mobility Score (BAMS).¹⁶ However, it is unknown which of these validated outcome measures are being used within clinical practice in the UK and which PerBOMs clinicians find useful. It would be important to determine whether there is a mismatch between published research and current clinical practice.¹⁷

Primarily, this survey aims to explore the current use of outcome measures in clinical practice with vascular amputees in order to inform clinicians which PerBOMs are most useful clinically and for future research projects developing PerBOMs for non-ambulatory vascular amputees.

Secondly, this survey aims to explore variation in existing rehabilitation services for non-ambulatory vascular amputees and the type of rehabilitation interventions being delivered to this patient population.

Methods

This paper was written in accordance with the CHERRIES checklist.¹⁸ An anonymous scoping survey was produced with the aid of a list of all PerBOMs from a systematic review.¹² Ethical approval was sought and granted from the University of Leicester ethics committee (reference: 27972-aea19-Is:cardiovascularsciences).

The survey topics and questions were designed and refined with key stakeholders who identified themes and questions relevant to this patient population. Key stakeholders consisted of HCPs working with vascular amputees and researchers. The initial version was piloted to a convenience sample of HCPs and researchers. Changes were suggested and made to the survey questions and format prior to publishing the survey online. Due to the exploratory nature of this scoping survey, the survey was not validated prior to circulation.

All participants completed the survey online at <https://www.onlinesurveys.ac.uk>, where the responses were automatically captured by the website. All data collected were non-identifiable; each responder was provided with a unique study ID number. The data were stored in the University of Leicester secure research file store on University of Leicester password-protected computers in locked offices.

Seventeen questions were produced for the survey. The list of online questions is shown in Appendix 1 online at www.jvsgbi.com. Adaptive questioning including conditionally displayed questions based on the responses was used (Appendix 2 online at www.jvsgbi.com) to reduce the number of questions and complexity of the survey. To reduce missing data or incomplete survey responses, all questions that appeared to the participant were mandatory. Some questions provided a 'not applicable' answer to limit non-response. Participants were able to use the back button to change their answers.

The sample was distributed to a convenience sample of HCPs through email networks including local and national networks. Further convenience sampling methodology was used by distributing the survey through national email networks including the British Association of Chartered Physiotherapists in limb Absence

Rehabilitation (BACPAR) and the British Association of Orthotists and Prosthetists (BAPO) membership lists. The survey was also advertised on X (formerly Twitter). Details of the study including the purpose of the study, approximate length of time to complete the survey and data storage information were included as a Participant Information Sheet (PIS) attached to the survey (Appendix 3 online at www.jvsgbi.com). Participation was completely voluntary, as described on the website and PIS. Informed consent on the first page of the survey was provided by participants before completing the scoping survey. Data were collected between 1 January 2021 and 30 April 2021.

Data analysis

Descriptive statistics and figures exploring participant characteristics and PerBOM use were produced using Microsoft Excel. Subgroup analysis for vascular physiotherapists only was completed with descriptive statistics as this group was the largest cohort of HCP participants. Due to the exploratory nature of the survey, statistical analysis was limited to descriptive statistics.

Results

Participant characteristics

The survey was completed by 125 participants. The website initial participant information page had a view rate count of 860. Fifty-five individuals started the survey and abandoned it. Incomplete responses were not recorded. The survey was completed by a range of HCPs including vascular physiotherapists, prosthetists, vascular specialist doctors, occupational therapists, vascular nurses and other HCPs (Table 1). Vascular physiotherapists accounted for more than half of the participants and were the largest group of HCPs, and vascular nurses made up the smallest group of participants (n=4). Sixty-four (51.2%) of the participants had more than 10 years' experience working with vascular

amputees and only five (4.0%) had less than 1 year experience.

Information on the participants' location of work was also obtained (Table 1). The largest number of participants (n=72, 57.6%) worked in an acute hospital inpatient setting and the smallest number of participants (n=7, 5.6%) worked in a community hospital or domiciliary setting. Vascular physiotherapists worked in the largest range of different settings while vascular specialist doctors and vascular specialist nurses both primarily worked in inpatient or outpatient acute hospital settings. The majority of prosthetist responders worked in prosthetic rehabilitation centres, with limited numbers in other clinical areas.

Use of outcome measures

The participants were familiar with different types of PerBOMs including Patient Reported Outcome Measures (PROMs), PerBOMs and Clinically Reported Outcome Measures (CROMs) (Figure 1). Overall, the highest number of participants selected familiarity with PROMs (n=102), with slightly fewer participants selecting CROMs (n=98) and PerBOMs (n=94). For all professional groups except prosthetists and physiotherapists, PROMs were the most familiar type of outcome measure.

We also explored how often participants used PerBOMs in clinical practice in this survey (Figure 2): 39 (33%) stated that they 'never use' PerBOMs in their clinical practice, 25 (21%) and 24 (20%) stated using PerBOMs 'sometimes' or 'most of the time', and 33 (27%) stated that they 'always' used PerBOMs.

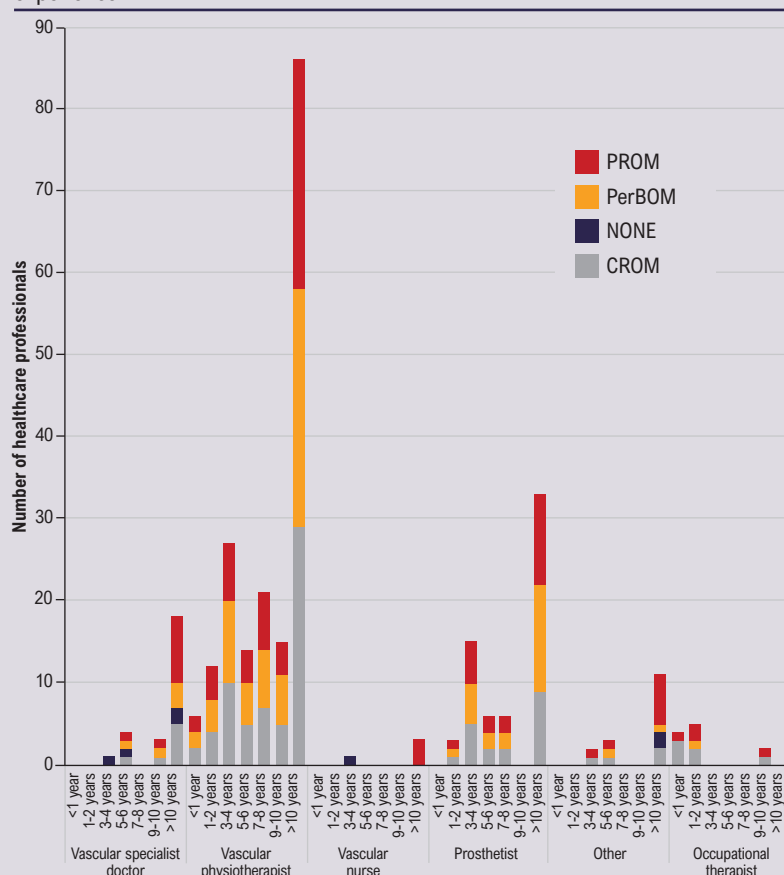
Eighty-two participants, the majority of which were vascular physiotherapists and prosthetists, identified using PerBOMs 'sometimes', 'most of the time' or 'always'. These 82 participants proceeded to continue with questions regarding PerBOM rating and evaluation due to the conditional questioning method of displaying questions in the survey.

Of the previously identified PerBOMs, participants were requested to identify which of them are being used clinically in

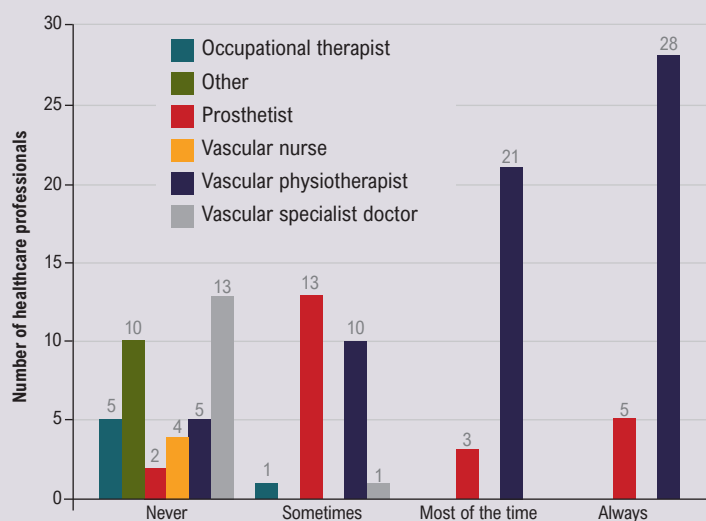
Table 1 Participant demographics categorised by professional role, work setting and years of experience.

	Acute hospital inpatient (%)	Prosthetics rehabilitation centre (%)	Acute hospital outpatients (%)	Community hospital (%)	Domiciliary (home visits) (%)	Other (%)	<1 year (%)	1–2 years (%)	3–4 years (%)	5–6 years (%)	7–8 years (%)	9–10 years (%)	>10 years (%)
Occupational therapist	3 (2.4)	1 (0.8)	1 (0.8)		3 (2.4)		3 (2.4)	2 (1.6)				1 (0.8)	
Other	10 (8.0)	1 (0.8)	9 (7.2)	2 (1.6)	2 (1.6)	2 (1.6)			1 (0.8)	2 (1.6)		1 (0.8)	9 (8.0)
Prosthetist	1 (0.8)	20 (16.0)	3 (2.4)			1 (0.8)		1 (0.8)	5 (4.0)	2 (1.6)	2 (1.6)		13 (10.4)
Vascular nurse	4 (3.2)		3 (2.4)						1 (0.8)				3 (2.4)
Vascular physiotherapist	39 (31.2)	29 (23.2)	14 (11.2)	5 (4.0)	2 (1.6)	3 (2.4)	2 (1.6)	5 (4.0)	10 (8.0)	5 (4.0)	7 (5.6)	6 (4.8)	29 (23.2)
Vascular specialist doctor	15 (12.0)		10 (8.0)						1 (0.8)	3 (2.4)		1 (0.8)	10 (8.0)
Total	72 (57.6)	51 (40.8)	40 (32.0)	7 (5.6)	7 (5.6)	6 (4.8)	5 (4.0)	8 (6.4)	18 (14.4)	12 (9.6)	9 (7.2)	9 (7.2)	64 (51.2)

Total number of participants in survey: n=125 (% in parentheses).

Figure 1 Familiarity with outcome measures by professional role and years of experience.

PROM, Patient Reported Outcome Measures; PerBOM, Performance Based Outcome Measure; CROM, Clinically Reported Outcome Measure. Total PROM, n=101; PerBOM, n=94; CROM, n=98; NONE, n=7. Total number of participants n=121.

Figure 2 Use of Physical Performance Based Outcome Measures by profession.

Total number in each group: never, n=39; sometimes, n=25; most of the time, n=24; always, n=33. Total number of participants n=121.

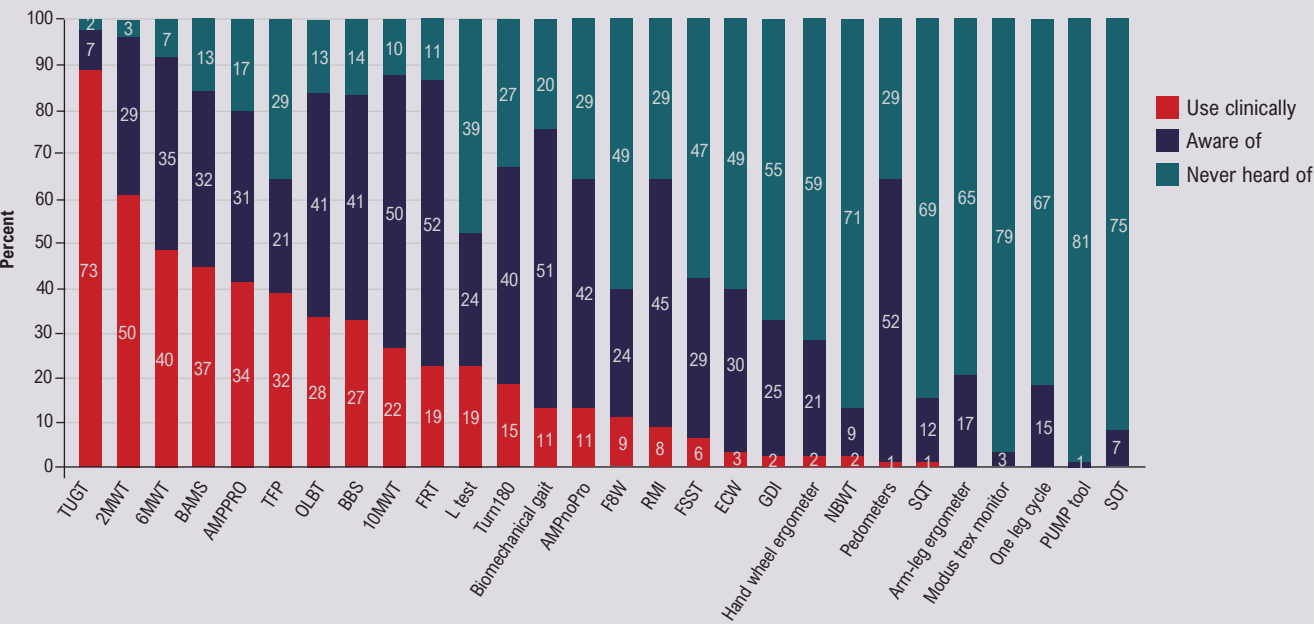
practice (Figure 3). Timed Up and Go (TUGT) was the most used PerBOM identified (89%). Other commonly used ambulatory PerBOMs include the 2 Minute Walk Test (2MWT), 6 Minute Walk Test (6MWT) and the Berg Balance Scale (BBS). The most commonly used non-ambulatory PerBOM was the Basic Amputee Mobility Score (BAMS) with 37 (45%) participants using this PerBOM clinically and 32 (39%) being aware of this PerBOM but not using it clinically. Other non-ambulatory PerBOMs include the Transfemoral Fitting Predictor (TFP) used clinically by 32 (39%) participants and the One Leg Balance Test (OLBT) used clinically by 28 (34%). Only 26% of participants were aware of the TFP and over a third (35%) had never heard of this PerBOM. The Amputee Mobility Predictor no Prosthesis (AMPnoPro) is the least commonly used clinically non-ambulatory PerBOM; 31 (51%) participants were aware of it but did not use it clinically. The least commonly used PerBOMs include the arm-leg ergometer, Modus trex monitor, one leg cycle test, PUMP tool and Sensory Organisation Test (SOT), all of which (except the PUMP tool) are digitally-enabled PerBOMs.

Participants ranked the PerBOMs on their usefulness out of 10, where 1 is least useful and 10 is very useful. Seventy-two participants in total scored the TUGT. The box and whisker diagram in Figure 4 shows a skew towards a higher score of between 7 and 10 for the TUGT, 2MWT and 6MWT. Minimum values varied, with a score of 2 for TUGT, 5 for the 2MWT and 3 for 6MWT. The BBS, with a median value of 7, was rated by 39 HCP participants. All four ambulatory PerBOMs had an interquartile range of around 3.

The BAMS (n=43), TFP (n=40) and OLBT (n=41) non-ambulatory measures have a similar spread of data with maximum values of 10 and minimum values of 1 and 2. Interquartile range (IQR) varied, with BAMS IQR of 4, TFP IQR of 2 and OLBT IQR of around 4. The TFP was scored by 40 participants and had an overall higher median score than all other non-ambulatory PerBOMs. The AMPnoPro (n=23) had a wide spread of data, with the largest IQR of 5.

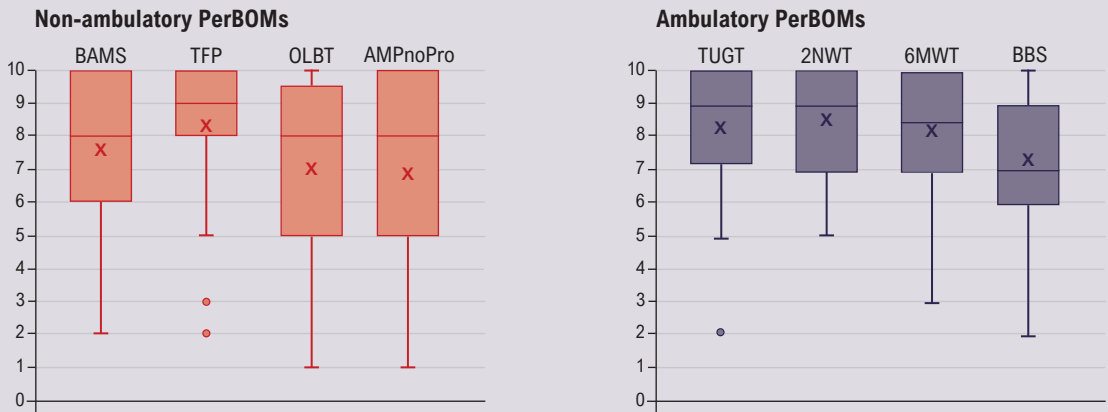
PerBOM use (Figure 5) at different timepoints was identified. PerBOMs were used less frequently before amputation and in the early stages after amputation at 0–7 days and were used most frequently at >6 months and 1–3 months after amputation.

Figure 3 Physical Performance Based Outcome Measures (PerBOMs) used by healthcare professionals in clinical practice.



TUGT, Timed Up and Go Test; 2MWT, 2 Minute Walk Test; 6MWT, 6 Minute Walk Test; 10MWT, 10 Meter Walk Test; BAMS, Basic Amputee Mobility Score; AMPPro, Amputee Mobility Predictor Prosthesis; TFP, Transfemoral Fitting Predictor; OLBT, One Leg Balance Test; BBS, Berg Balance Scale; 10MWT, 10 Meter Walk Test; FRT, Functional Reach Test; Turn 180, 180 degree turn test; AMPnoPro, Amputee Mobility Predictor no Prosthesis; F8W, Figure of 8 Walk test; RMI, Rivermead Mobility Index; FSST, Four Square Step Test; ECW, Energy Cost of Walking; GDI, Gait Deviation Index; NBWT, Narrow Beam Walking Test; SQT, Step Quick Turn test; PUMP tool, Prosthetic Use for Mobility Prognosis tool; SOT, Sensory Organisation Test. Number of participants n=121.

Figure 4 Scored rating on the usefulness of each individual Performance Based Outcome Measure (PerBOM) (1–10).

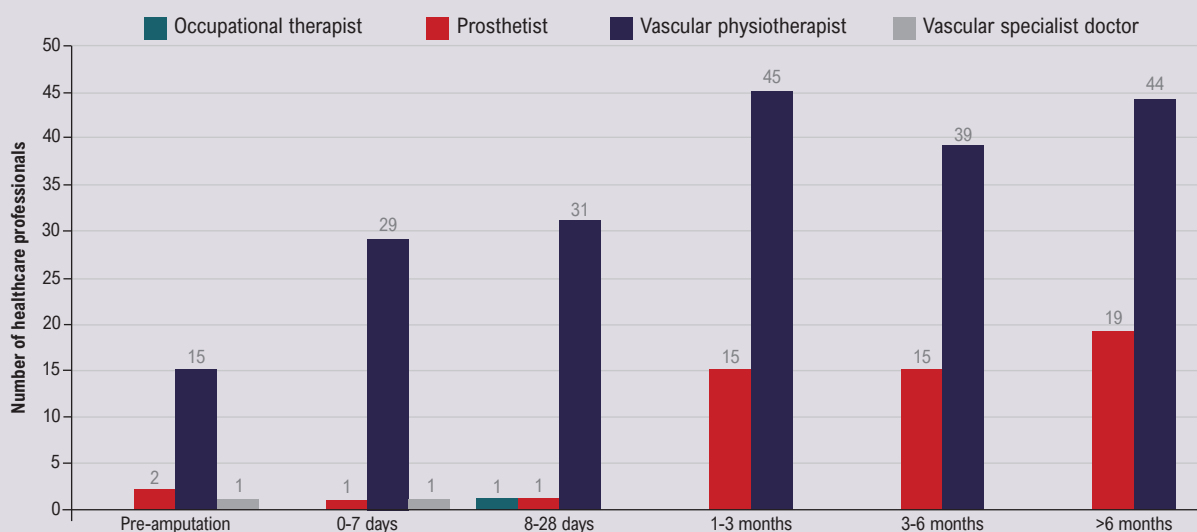


2MWT, 2 Minute Walk Test; 6MWT, 6 Minute Walk Test; AMPnoPro, Amputee Mobility Predictor no Prosthesis; BAMS, Basic Amputee Mobility Score; BBS, Berg Balance Scale; OLBT, One Leg Balance Test; TUGT, Timed Up and Go Test. Number of participants: 2MWT, n=57; 6MWT, n=48; AMPnoPro, n=23; BAMS, n=43; BBS, n=39; TUGT, n=72; TFP, n=40; OLBT, n=41.

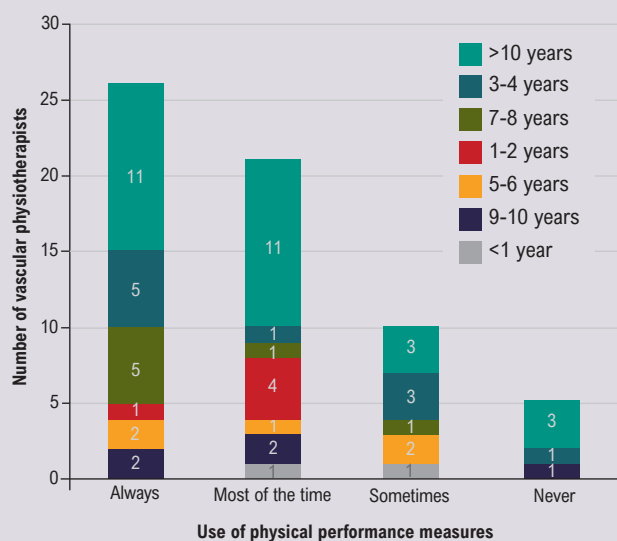
Vascular physiotherapists

Vascular physiotherapists were the largest group of HCPs in this study, so a sub-analysis was made for this group of participants (n=64). The frequency of use of PerBOMs by vascular physiotherapists has been categorised by years of clinical experience (Figure 6) and work location (Figure 7).

Around half of the participants had >10 years of experience (n=28). The largest number of participants (n=26) selected that they ‘always’ used PerBOMs in clinical practice, equal numbers of highly experienced vascular physiotherapists with either >10 years or 9–10 years of experience stated that they either use PerBOMs ‘always’ or ‘most of the time’, while the smallest number of

Figure 5 Timepoints of using Performance Based Outcome Measures (PerBOMs) in clinical practice.

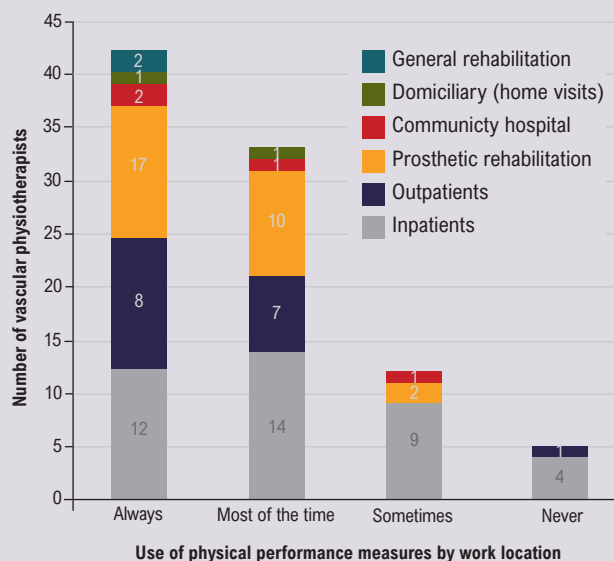
Total number of participants for pre-amputation n=18, 0-7 days, n=31; 8-28 days, n=33; 1-3 months, n=60; 3-6 months, n=54; >6 months, n=63. Total number of participants n=82. Categories not plotted on graph for the number of participants for 'other', n=0; number of participants for 'vascular nurse', n=0.

Figure 6 Vascular physiotherapists' frequency of use of Performance Based Outcome Measures (PerBOMs) in clinical practice. Sub-categorised by years of clinical experience of vascular physiotherapists.

Number of participants for always, n=26; most of the time, n=21; never, n=5; sometimes, n=10. Total number of vascular physiotherapists: n=62; <1 year, n=2; 1-2 years, n=5; 3-4 years, n=10; 5-6 years, n=5; 7-8 years, n=7; 9-10 years, n=5; >10 years, n=28. Legend ordered by decreasing frequency (n).

participants (n=5) stated that they 'never' used PerBOMs.

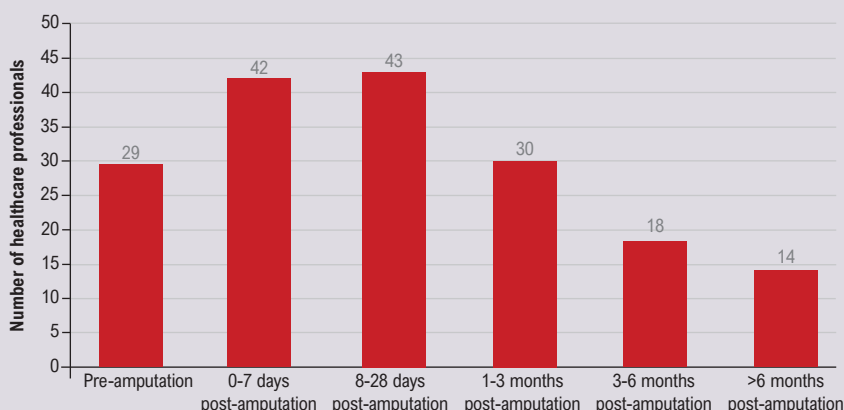
Vascular physiotherapists have varying clinical roles in clinical practice and therefore they were able to answer that they work in more than one work location (Figure 7). The majority of vascular physiotherapists worked in the inpatient hospital setting (n=39) and

Figure 7 Vascular physiotherapists' frequency of use of Performance Based Outcome Measures (PerBOMs) in clinical practice based on work location.

Total number of vascular physiotherapists, n=62; inpatients, n=39; outpatients, n=16; prosthetic rehabilitation, n=29; community hospital, n=4; domiciliary home visits, n=2; general rehabilitation, n=2.

the smallest number of participants worked in a general rehabilitation or home visit domiciliary setting (n=2). Participants who worked in a prosthetic rehabilitation setting were more likely to use PerBOMs; PerBOMs were used 'always' (n=17) and 'most of the time' (n=10) in clinical practice, with only minimal numbers

Figure 8 Rehabilitation during the patient journey at different timepoints. Total number of participants n=69.



using them 'sometimes' (n=2) and no participants 'never' using them.

However, participants who worked in an acute hospital inpatient setting demonstrated varying use of PerBOMs, with no trends towards increased or decreased frequency of use of PerBOMs in clinical practice. Additionally, around 10% of participants who worked in an acute hospital inpatient setting never used PerBOMs in clinical practice (n=4).

Rehabilitation

Rehabilitation for patients who have undergone an amputation due to vascular disease who are ambulatory and non-ambulatory is described in Appendix 4 online at www.jvsgbi.com. Few HCPs provide pre-habilitation to non-ambulatory patients (n=23) and ambulatory patients (m=26), whilst general rehabilitation is most frequently provided in total for ambulatory and non-ambulatory patients. Similar numbers of participants provided prosthetic rehabilitation, specialist amputee rehabilitation and general rehabilitation (n=54–55) to ambulatory patients.

Rehabilitation for non-ambulatory patients who have undergone an amputation at different timepoints was also explored in the survey (Figure 8). The survey identifies that rehabilitation for non-ambulatory patients is most frequently provided by HCPs at 0–7 days (n=42) and 8–28 days (n=43) after amputation. Pre-habilitation was provided by HCPs less frequently (n=29). However, the fewest HCPs provide rehabilitation to non-ambulatory patients in the longer term after amputation at 3–6 months (n=18) and >6 months after amputation (n=14).

Discussion

A range of different HCPs have completed the scoping survey, with vascular physiotherapists making up the majority of the participant cohort. This is possible to be representative of the HCPs who are using PerBOMs in clinical practice, as physiotherapists have been using PerBOMs in clinical practice to prove clinical effectiveness since the 1990s.^{19,20} A large variety of HCPs completed the scoping survey, including many vascular specialist doctors and prosthetists. This represents a large range of HCPs who are involved in the clinical management and care of patients.

Previous evidence states that there are often issues with the use of PerBOMs in clinical practice when there is a lack of physiotherapist knowledge and experience of using outcome measures.²¹ Data in this survey suggest that PerBOMs are likely to be used by physiotherapists at all stages of clinical experience. This demonstrates that there was no relationship between the use of PerBOMs in clinical practice for vascular physiotherapists

and the number of years in clinical practice, therefore indicating that clinical uptake of available PerBOMs may be due to other factors.

Work location did appear to have an influence on whether PerBOMs were used (Figure 7) as vascular physiotherapists who worked within an acute inpatient setting reported using outcome measures at varying rates. In comparison, those who worked in prosthetic rehabilitation more frequently used PerBOMs 'always' and 'most of the time'. This could be expected from the busy acute hospital setting where there is little prosthetic or walking rehabilitation. Furthermore, staff are often limited on time in the acute hospital inpatient setting,²² with particular focus on patient discharge destination. This finding differs from previous work which suggested that physiotherapists were likely to use PerBOMs in all clinical settings.²⁰

Additionally, few participants worked in a community hospital or completed domiciliary visits. Due to lack of responders in these clinical areas, we are unable to obtain representative data on them.

Previous evidence evaluating PerBOMs for this patient population is limited. A previously published systematic review recommends the AMPnoPro, TFP, OLBT and BAMS for use in clinical practice for non-ambulatory amputees.¹² Based on the tasks involved, the BAMS¹⁶ would be most suited clinically for patients early after amputation in the acute inpatient hospital setting. However, despite the fact that BAMS is reportedly the most used non-ambulatory PerBOM, it is only used clinically by less than half of HCPs with non-ambulatory patients. Furthermore, although a third of participants were aware of this PerBOM, it was not chosen to be used clinically.

The notion that PerBOMs for non-ambulatory patients are unlikely to be used in clinical practice is also emphasised, with participants using PerBOMs least frequently at timepoints before amputation and 0–7 days after amputation, when patients would be non-ambulatory before and immediately after surgery.

For non-ambulatory PerBOMs the one with the highest median usefulness score is the TFP. However, the number of participants rating the TFP was around a third less than the number of

participants rating the TUGT, the most commonly scored ambulatory PerBOM. Although the TFP was found to be relatively useful, this should be interpreted with caution as fewer participants rated the non-ambulatory PerBOMs compared with the ambulatory PerBOMs. There is a clear disparity between the current validated outcome measures¹² and current clinical practice. This study suggests this variation could be explained by HCPs reporting limited usefulness of these outcome measures. Future research may focus on an investigation into the reasons for limited PerBOM use with non-ambulatory amputee patients. Development of a suitable, meaningful and clinically relevant new PerBOM is suggested, which may support the management of non-ambulatory patients.

The findings of this study suggest that participants were more likely to use PerBOMs if they worked in a prosthetic rehabilitation centre with ambulatory patients who are undergoing prosthetic rehabilitation. These data are supported by the high frequency of clinical use of ambulatory PerBOMs reported by participants. The TUGT is overall the most reportedly used PerBOM by HCPs, and is used clinically by the majority of participants. Furthermore, most participants who did not use this PerBOM clinically were aware of it, suggesting it is a recommended PerBOM in clinical practice.

The ambulatory PerBOM most frequently used by participants, rated by the largest number of participants ($n=72$) and with the highest score of usefulness, is the TUGT. This score may be the most reliable score of usefulness of the PerBOM ratings due to the largest number of participants rating it. Additionally, the 2MWT ($n=57$) had a similar median usefulness score, therefore demonstrating that both PerBOMs are useful for HCPs. The 6MWT ($n=48$) also had a high usefulness score, but the BBS provided more mixed results, indicating that HCPs in prosthetic rehabilitation centres use the available PerBOMs regularly and find them clinically relevant for patients who have the goal of ambulation or are currently ambulating. Overall, more participants provided a rehabilitation intervention to ambulatory patients who had an amputation than to non-ambulatory patients. In the early stages after amputation, wheelchair rehabilitation is the most common rehabilitation intervention provided to the non-ambulatory patient. Moreover, the data suggest that there are limited rehabilitation services for non-ambulatory patients. Future research may focus on exploring new rehabilitation interventions or services for this underserved population of patients.

Strengths and limitations

This is the first anonymous scoping survey study to explore the current use of PerBOMs by HCPs working with patients who have undergone an amputation due to vascular disease. This study builds on previous research, which has identified all PerBOMs for patients who have undergone an amputation due to vascular disease. Additional strengths include using conditional questioning, which has enabled individuals who were most appropriate to be directed to the correct questions in the survey. This is likely to have

KEY MESSAGES

- Outcome measures are used frequently with vascular amputee patients who are ambulatory with a prosthetic limb
- Limited use and usefulness of outcome measures with the non-ambulatory vascular amputee patient population
- A new clinically relevant and meaningful physical performance measure is needed for the non-ambulatory vascular amputee

improved the completion rate and ensured that the survey length was as short as possible for participants.

The limitations of this study include the small study cohort, with 125 responses despite 860 initial views from the first page. Furthermore, this is a voluntary research study using convenience sampling methodology and therefore, due to sampling methodology, there is a self-selection bias towards research-interested HCPs and a bias towards physiotherapy HCPs in this study. However, despite the broad distribution of this survey to different groups of HCPs and 860 views on the survey's first page, the small numbers limit the generalisability of this study. These small numbers of participants also reduce the reliability of the results from the subgroup analysis. It could be that, although physiotherapists were the largest professional group within this study, it may be a reflection of the specialist expertise of HCPs who work with this patient cohort and use outcome measures within their clinical practice.

Conclusion

Ambulatory PerBOMs including the TUGT and 2MWT are commonly used in clinical practice and are found to be useful by HCPs. Non-ambulatory PerBOMs including the TFP are less used in clinical practice. Future research may focus on exploring the reasons for the underuse of current PerBOMs with the non-ambulatory patient population. Pending further research and evidence, there may be a clinical need for the development of a meaningful PerBOM for vascular amputees that can be used throughout the patient journey.

Conflict of Interest: None.

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PROTOCOL

Validation of the Clinical Frailty Scale in vascular surgery: a protocol

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Plain English Summary

Why we are undertaking this work: We have an ageing population in the UK. This means many people having surgery for vascular diseases are older, with a greater number of long-term health problems. This can affect their ability to care for themselves and others, to do things which are important to them, and to manage new or worsening health problems. This situation is called frailty. Having frailty may increase the risk of complications after surgical treatments, including a higher chance of death. If we can accurately assess frailty in patients having vascular surgery, this may lead to better understanding of their risks during and after an operation. This would help patients and doctors to make decisions about surgery and plan their care to reduce the chance of problems after surgery.

What we will do: The Rockwood Clinical Frailty Scale (CFS) is a tool which is used to screen people for frailty. However, we do not know if it can identify frailty in people with vascular diseases because this has not been specifically tested before. Some people with vascular disease are more likely to have problems with moving around and doing daily activities. We aim to find out if the CFS is good at detecting features of frailty in people undergoing vascular surgery. We also want to know how frailty affects the risk of complications after a vascular operation. We are planning to run a study looking at everyone who had a vascular operation between 3 August 2022 and 31 December 2023 at one hospital. This period has been carefully calculated to ensure we collect information on enough patients to answer the question. We will compare their CFS score against two other scores to assess frailty. The first is the electronic frailty index. This is currently used by all GPs in the UK. The second is the National Vascular Registry frailty level. By comparing the scores, we want to see which one is better at finding out who has frailty. We want to look at the association between these scoring systems and the presence of frailty on how well patients recover following treatment. This includes the complications they have and whether they survive their surgery. This will help us to support patients with frailty so that they have better results following their surgery.

What this means: This article outlines the steps we plan to follow to test whether the CFS is a good measure of frailty in patients having vascular surgery. When we have completed the research, the results will be shared with doctors and patients.

Abstract

Introduction: Frailty is a complex, dynamic and multifactorial syndrome. It is common in patients with vascular disease due to increased age and comorbidities. Identifying those with frailty preoperatively can help inform decisions about major interventional treatments and tailor postoperative care. This study aims to validate the Rockwood Clinical Frailty Scale (CFS) in patients undergoing major vascular surgery and determine whether the CFS can predict postoperative outcomes.

Methods: Validation study of the CFS as a measure of frailty in patients undergoing major vascular surgery in a single-centre retrospective cohort study. Consecutive patients undergoing major vascular surgery at one tertiary vascular centre between 3 August 2022 and 31 December 2023 will be included. The electronic Frailty Index will be used as the reference standard, against which the CFS will be assessed. Diagnostic accuracy will be compared in each of the following patient groups: major lower limb amputation, aortic aneurysm repair, lower limb revascularisation and carotid endarterectomy. Prognostication will explore the ability of CFS to predict mortality, complications, length of stay and discharge destination. A sample

size of 97 patients per subgroup will be required for an estimated sensitivity of 90% and specificity of 85%, based on local prevalence of documented frailty scores.

Conclusion: This study aims to validate the CFS in vascular patients and assess the ability of the CFS to predict postoperative outcomes. This will help to inform shared decision making and postoperative care.

Key words: vascular surgery, frailty, clinical frailty score, validation, protocol

Introduction

As life expectancy increases, so does the prevalence of older patients and age-related health conditions. Frailty is one such condition which has become increasingly recognised as a clinical syndrome, distinct from chronological age, disability and comorbidity.¹⁻³ A complex, dynamic and multifactorial syndrome, frailty may be theoretically defined as 'a state of increased vulnerability, resulting from age-associated declines in reserve and function across multiple physiological systems, such that the ability to cope with every day or acute stressors is compromised'.³⁻⁵ In the UK, increasing frailty in the community is associated with higher rates of adverse events such as falls, hospitalisation and institutionalisation, and death.⁶⁻⁹ Since frailty may be considered a measure of reduced physiological reserve,¹⁰ its severity has implications for patient response to medical and surgical therapy¹¹ and risk associated with therapeutic interventions.¹¹ Therefore, at the individual level, frailty can impact shared decision making and development of patient-centred care plans,^{7,8} while the effect of frailty on health economics and resource distribution^{8,12} may be felt by society.

Although the above definition is broadly accepted in theory, a single unified approach to assessing and quantifying frailty in a clinical setting remains elusive.^{13,14} The following operational models are some of the most commonly used and studied: frailty as an accumulation of deficits, such as the frailty index² (FI); frailty as a phenotype of low energetics, for example, Fried's frailty phenotype;³ frailty as derived from medical, nutritional, functional and psychological assessments, for example using Comprehensive Geriatric Assessment (CGA);¹⁵ frailty as a clinical judgement of function, such as using the Rockwood Clinical Frailty Scale (CFS).¹⁰

The plethora of available scales and scoring systems likely reflects uncertainty in the underlying components and pathophysiology that comprise frailty,¹⁰ leaving clinicians and policymakers alike without a clear directive of which assessment tool to use. Moreover, not all frailty measurements have been robustly validated, and many are used in a modified form rather than the original validated version,¹³ or used in populations other than those in which the tools were originally validated.¹⁶ For many specialties, the clinical value of frailty assessment depends on its validity in prognostication: is frailty an independent predictor of adverse outcomes?¹⁶⁻¹⁸ If frailty simply correlates with related factors such as chronological age¹⁹ or comorbidity burden,²⁰ then

time spent performing a designated frailty assessment could be better spent elsewhere.

Most patients who require major vascular surgery are chronologically and physiologically older: the majority are aged 65 or over²¹⁻²³ and have significant comorbidities such as diabetes, hypertension, cardiac disease, respiratory disease and a history of smoking.^{21,22} Moreover, frailty in these patients is becoming increasingly recognised as a preoperative risk factor which can impact postoperative recovery and is thus collected in the UK National Vascular Registry (NVR) quality improvement audit.²² There is potential for the use of frailty scores in prognostication for patients undergoing major vascular surgery,^{11,16} but the tools used need to be validated for use in a vascular cohort.²⁴

This study aims to explore whether the CFS, mapped onto the NVR four levels of frailty, is a valid method of quantifying frailty in patients who are undergoing major vascular surgery. The CFS is a rapid method of frailty assessment, making it ideal for use in acute and busy settings.¹¹ Clinicians consider comorbidity, cognitive impairment and disability to form a judgement of a patient's frailty status, based on pictures and descriptions of each level of frailty.¹⁰ This scoring system has been validated for identifying frailty in adults aged 65 or older in the UK,²⁵⁻²⁷ but has yet to be convincingly validated as a tool for identifying frailty itself within the cohort of inpatients with vascular disease. Previous studies have demonstrated that the CFS has a high specificity for identifying frailty in vascular outpatients and therefore could be useful in assessing frailty.^{28,29} These findings could be extrapolated to imply that the CFS is a valid measure of frailty in vascular inpatients; however, the studies done so far outside the clinic setting appear to consider the CFS as a prognostic factor only,³⁰⁻³² rather than seeking to evaluate the CFS against another measure of frailty. This study seeks to evaluate the evidence to determine whether the CFS measures and assesses frailty in the population of vascular inpatients.

Since 2019 the NVR has recommended that commonly used formal frailty assessments, including the CFS, may allow patients to be categorised as:

1. Not frail: well or managing well, routinely walking
2. Mild frailty: evident slowing such as difficulty walking outside
3. Moderate frailty: need help with some personal care or keeping house
4. Severe frailty: completely dependent for personal care.³³

The CFS allows clinicians to stratify patients by frailty level: if the CFS provides a consistently accurate estimate of the extent of frailty in patients with vascular disease, we aim to then explore whether frailty has an independent prognostic value for adverse outcomes in patients undergoing major vascular surgery.

Objectives

To validate the Clinical Frailty Scale (CFS) and NVR four levels of frailty in patients undergoing major vascular surgery and explore the prognostic value of CFS in predicting adverse events.

Outcomes

1. Sensitivity and specificity of CFS (and subsequently the NVR four levels of frailty) in diagnosing frailty in patients undergoing major vascular surgery. The electronic frailty index (eFI) will be the reference standard. This is a scoring system that uses the cumulative model of frailty: the patient's score is the fraction of deficits they are recorded as having from a list of 36 pre-specified diagnoses, deficits and disabilities. Conversely, the CFS is based on the phenotype model of frailty and describes differing degrees of physical performance^{10,34} based on standardised pictures and descriptions.
2. Risk associated with different CFS degrees of frailty in developing adverse events after major vascular surgery.
3. Assess the differences in frailty between groups of patients undergoing different vascular surgical procedures.

Methods

The study will be reported with reference to the Standards for Reporting Diagnostic accuracy studies (STARD) 2015 reporting guidance.³⁵

Study design

This is a single-centre validation study of the CFS frailty assessment tool in patients undergoing major vascular surgery.

Patient population

Consecutive patients admitted under the vascular services at a tertiary care centre from 3 August 2022 to 31 December 2023 will be included. This period has been calculated to ensure sufficient patients may be included for each subgroup, based on the volume of each type of surgery performed at the reference centre.

Only patients who undergo a major vascular surgery, as reportable to the NVR,²¹ will be included. This includes any patients undergoing major lower limb amputation (MLLA), for example, for chronic limb threatening ischaemia (CLTI) or diabetes-related foot complications; patients with abdominal aortic aneurysms (AAA) who undergo repair (open/endovascular); those presenting with CLTI or acute limb ischaemia (ALI) undergoing lower limb revascularisation (open/endovascular including angioplasty/hybrid); and patients with carotid disease undergoing revascularisation (open/endovascular).

Index test

We will compare the performance of a phenotype model of frailty assessment with the cumulative model of frailty assessment. The CFS will be validated in patients undergoing major vascular surgery. This is the preferred method of assessing frailty in the Centre for Perioperative Care guidelines,³⁶ and has previously been validated in hospital inpatients aged >65 years^{25,27,37} and in the outpatient setting for vascular patients;²⁸ however, there have been questions raised over the tool's applicability in those with lower limb ischaemia.³⁸

Reference standard

The eFI will be the reference standard. This tool is applied to all people over 65 years old to identify those at risk of being moderately or severely frail in the community setting.^{6,39} The eFI score is calculated as a fraction of 36 deficits determined from around 2000 GP read codes. This tool is used as a method of screening the community population, with the aim of identifying people who may benefit most from additional interventions^{6,40,41} to enable them to live well with frailty. As this tool is applied to everyone aged >65 years in England, all included patients aged >65 years should have an eFI in their records, and we will use this tool as the reference standard. For those patients aged <65 years, the eFI will be manually calculated from the GP read codes.

Data collection

Baseline data collection will include patient demographics, biochemical tests (haemoglobin, estimated glomerular filtration rate), comorbidities, American Society of Anaesthesiologists (ASA) grade and indication for the operation. The CFS is assigned prospectively, ahead of any surgical intervention, and all other data will be collected retrospectively.

Operative data will include the type of operation undertaken and the type of anaesthetic used.

Postoperative data will include admission to the intensive care unit (ICU), length of ICU stay, length of inpatient stay, input from dieticians and therapists (occupational, physical and speech and language); return to theatre, Clavien–Dindo classification of inpatient complications;^{42,43} discharge equipment and discharge destination.

Outcome data will be assessed at 30 days and 1 year, including re-admission, return to theatre, major adverse limb events (MALE, defined as amputation of the index limb, or major re-intervention such as new bypass graft; graft revision; angioplasty, thrombectomy)^{44–46} and major adverse cardiovascular events (MACE) defined as myocardial infarction, stroke and death (any cause).^{44–46}

Reference standard

The eFI score will be collected for all consecutive patients admitted under the vascular services and will be extracted from GP records or calculated using the eFI guidance note (Table 1) when the GP

Table 1 List of 36 electronic frailty index (eFI) deficit states⁶

Deficit: Disease state	Deficit: Abnormal laboratory value
1. Arthritis	21. Anaemia and haematinic deficiency
2. Atrial fibrillation	
3. Cerebrovascular disease	Deficit: Symptoms/signs
4. Chronic kidney disease	22. Dizziness
5. Diabetes	23. Dyspnoea
6. Foot problems	24. Falls
7. Fragility fracture	25. Memory and cognitive problems
8. Heart failure	26. Polypharmacy ⁹
9. Heart valve disease	27. Sleep disturbance
10. Hypertension	28. Urinary incontinence
11. Hypotension/syncope	29. Weight loss and anorexia
12. Ischaemic heart disease	
13. Osteoporosis	Deficit: Disability
14. Parkinsonism and tremor	30. Activity limitation
15. Peptic ulcer	31. Hearing impairment
16. Peripheral vascular disease	32. Housebound
17. Respiratory disease	33. Mobility and transfer problems
18. Skin ulcer	34. Requirement for care
19. Thyroid disease	35. Social vulnerability
20. Urinary system disease	36. Visual impairment

score is not available. This is calculated as follows: eFI = number of deficits/36 (total number of deficits).

Index test

The CFS will be extracted from the hospital medical records. The CFS is recorded contemporaneously on admission to the vascular ward by the clerking doctor: either a foundation trainee, vascular registrar, consultant vascular surgeon or vascular physician. Consistency is achieved by training all clerking doctors in how to calculate the CFS, highlighting that the score should reflect a patient's pre-morbid state or baseline function.⁴⁷

It is recommended that a comprehensive history is taken about the patient's usual function at least two weeks prior to acute illness onset, such that the CFS recorded reflects their baseline function and not their status whilst acutely unwell. Assessment of frailty should consider direct patient history, observation of the patient plus collateral history from the patient's relatives. However, if the patient is dying, they will always be classified as CFS 9, and not by their baseline function.⁴⁸

Reliability

To examine inter-rater reliability, CFS scores assigned by resident doctors during initial assessment will be compared to a blinded assessment made by a consultant vascular physician (geriatrician). To examine intra-rater reliability, clinicians who assess the CFS will be asked to repeat the frailty assessment at least 24 hours after initial assessment. All reliability data will be collected as a separate prospective sub-study, with new patients.

Analysis

Data analysis

Descriptive statistics reporting the mean, median, standard

Table 2 Comparative cut-off levels for different levels of frailty (mild, moderate or severe) as measured by the NVR, CFS or eFI frailty assessment tools.

NVR category ³³	eFI ⁶	Rockwood CFS ¹⁰
1. Fit	0–0.12	1, 2
2. Mild frailty	0.13–0.24	3, 4, 5
3. Moderate frailty	0.25–0.36	6
4. Severe frailty	≥0.37	7, 8, 9

CFS, Clinical Frailty Scale; eFI, electronic frailty index; NVR, National

deviation and interquartile range will be reported for continuous data where appropriate. Categorical data will be reported as counts, frequencies and percentages. Data will be tested for normality. Data that are not normally distributed will be analysed using non-parametric tests. A p value of <0.05 will be interpreted as statistically significant.

Diagnostic accuracy

The frailty scores will be interpreted as in Table 2.

The following cut-off points will be explored:

- Not frail (NVR 1 and 2) versus Frail (NVR 3 and 4)
- Not frail (NVR 1) versus Frail (NVR 2, 3, 4)³³

Convergent validity will be used to assess validity of the CFS. For the CFS to be valid in patients undergoing major vascular surgery, it should agree with the eFI in more than 75% of cases and there should be a correlation of >0.5 between CFS and eFI. This will be tested using Spearman rank correlation. Analysis will be completed for all included patients and then explored across each of the four major patient cohorts – namely, those undergoing MLLA; repair of AAA; lower limb revascularisation; and carotid endarterectomy (CEA).

The diagnostic accuracy of CFS in identifying frailty compared with eFI will be explored by varying the test positivity cut-off point and constructing a receiver operator curve for each test positivity cut-off.

The sensitivity and specificity of CFS will be compared with eFI in a contingency table.

Reliability will be determined by test–retest correlation analysis from initial assessment score and second assessment score. This process will be repeated for inter-rater reliability with test–retest correlation analysis between blinded CFS scores allocated to the same patient.

Prognostication

If the CFS is shown to be an accurate way of diagnosing frailty in patients undergoing major vascular surgery, the role of CFS in predicting important patient outcomes will be explored. If CFS is not an accurate tool to diagnose frailty, eFI will be analysed for prognostication.

Table 3 Expected values used in sample size calculations and results of sample size calculations using these values^{52,53}

(a)		(b)	
Quantity	Value (%)	n values	Participants
Expected sensitivity	90	Sample size for sensitivity	87
Expected specificity	85	Sample size for specificity	82
Disease prevalence	40	Final sample size with 10% dropout	97
Precision ($\pm$ expected)	10		
Confidence level	95		
Expected dropout rate	10		

A multivariate logistic regression model will be used to explore whether each of eFI, CFS and NVR categories are independently correlated with adverse outcomes. Patient outcomes will include mortality, ICU admission, MALE, MACE, length of stay and discharge destination.

Subgroup analysis

For AAA and lower limb revascularisation, a subgroup analysis will be performed to examine the validity and prognostication of CFS/eFI. In patients undergoing AAA repair, the subgroups will be rupture versus not rupture; infrarenal versus juxta-renal/suprarenal repair; and open versus endovascular repair. In patients undergoing lower limb revascularisation the subgroups will be indication for revascularisation (ischaemia, aneurysm, trauma, etc) and type of revascularisation. Ischaemia will be further subcategorised into acute limb ischaemia, intermittent claudication and CLTI.

Sample size

The local prevalence of frailty is taken to be 43%, based on a recent trust frailty audit.⁴⁹ An expected sensitivity of 90% and specificity of 85% have been estimated from other patient groups in the literature,^{50,51} since no studies have clearly established the sensitivity and specificity of CFS for identifying frailty in vascular patients. A 10% dropout rate (missing data) has been included in the sample size calculations as it is possible that not all patients will be assessed for frailty preoperatively. From the values shown in Table 3a,^{52,53} 97 patients will be required (Table 3b). For subgroup validity, this means 97 patients will be required per type of procedure (MLLA, AAA repair, lower limb revascularisation and CEA), giving a total sample size of 388 to determine the diagnostic validity of CFS compared with eFI across each vascular patient subgroup.

Ethics

The project was submitted as an audit to Hull University Teaching Hospital NHS Trust and has received local approval: 2022.111 Re-audit of the Prevalence of Frailty and the Impact on Surgical Management and Resource Use, for Vascular Inpatients Using the

National Vascular Registry (NVR) Frailty Classifications. Based on the UKRI decision tool, this study does not need independent NHS Research Ethics Committee (REC) approval. Data collected will be handled according to Good Clinical Practice guidelines, General Data Protection Regulation 2018 and information governance policies. Only study team members will have access to the data. All data will be anonymised. The study will not involve a change to routine patient care.

Dissemination of results

The results will be presented at local and national meetings and submitted to a peer review journal. A lay summary will be produced for patients and the public.

Discussion

Although there have been many studies of frailty in patients undergoing major vascular surgery,¹¹ there is no standardised approach to frailty assessment in these patients. The CFS is a rapid method of frailty screening which may have prognostication value but is yet to be convincingly validated in the population of vascular patients. This study will contribute to the growing field of frailty literature by validating the CFS and NVR four levels of frailty in vascular patients. It will also improve on existing data by validating these methods of frailty assessment in each subpopulation of the vascular cohort: patients undergoing MLLA, AAA repair, lower limb revascularisation and CEA. If the CFS is valid, this study may also offer insights into the prognostic value of frailty assessment, identifying whether baseline preoperative frailty is an independent risk factor for adverse outcomes in patients undergoing major vascular surgery.

The study is based in a large tertiary vascular centre in the North of England which has a catchment population of over 1.25 million people.⁵⁴ This will result in a diverse cohort of patients in terms of socioeconomic status, ethnic diversity and health status, so is likely to be generalisable to other settings in the UK. The method of validating frailty will consider different operations, indications and use an existing validating tool to assess frailty in the diverse vascular population. The study will also assess the reliability of CFS using a range of assessors with different experience of assessing frailty using CFS.

Potential caveats are: the results will only be applicable to patients who actually undergo surgery; external validity of the results may be limited as the data will be collected from a single centre; and potential biases from missing data due to the retrospective validation methods.

This protocol outlines a comprehensive validation study of CFS in patients undergoing vascular procedures reportable to the NVR. The results will provide key insights into the performance of some of the commonest frailty tools used in different populations of vascular patients. This information is vital when integrating frailty assessments into treatment decision making in future practice.

KEY MESSAGES

- Frailty is a complex, dynamic and multifactorial syndrome with implications for adverse health events.
- Frailty assessment in patients undergoing major vascular surgery needs to be validated for accuracy and prognostication.
- This protocol outlines the methods by which we aim to validate the Clinical Frailty Scale (CFS) for assessment of frailty in patients undergoing major vascular surgery, and any prognostication value the CFS may offer.

Conflict of Interest: None. We would like to declare that Professor Ian Chetter, who is a co-author of this protocol, also serves as Editor-in-Chief for *JVSGBI*.

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CLINICAL AUDIT

An audit of Global Vascular Guidelines implementation at two large teaching hospitals in differing healthcare settings

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Plain English Summary

Why we undertook the work: Chronic limb-threatening ischaemia (CLTI) is a serious illness where blood flow to the legs is very poor. This can cause pain, wounds that don't heal, and even lead to leg amputation. In 2019, experts made a set of guidelines called the Global Vascular Guidelines to help doctors treat CLTI better. We wanted to see if hospitals are following these guidelines.

What we did: We looked at the care given to patients with CLTI over one month in two big hospitals—one in London, UK and one in Colombo, Sri Lanka. We checked if doctors followed the guidelines, including how they checked patients' feet, if they used scoring tools, and if they did scans to look at blood flow.

What we found: Both hospitals did well with scans to check blood flow. But foot checks were often not done properly, especially for patients staying in hospital. Most doctors also did not use the scoring tools to tell how bad the illness was. The London hospital followed the guidelines better in its foot clinic, likely because trained podiatrists (foot experts) were involved.

What this means: Even well-equipped hospitals can find it hard to follow all the guidelines. Simple steps like training junior doctors, using checklists and having the right tools (like monofilaments for foot tests) could help; however, this is beyond the scope of this audit. Hospitals everywhere need support to follow these guidelines better and improve care for people with CLTI.

Abstract

Objective: The Global Vascular Guidelines on the Management of Chronic Limb-Threatening Ischemia provide a framework for assessment and management of patients with chronic limb-threatening ischaemia (CLTI). This audit describes compliance with Global Vascular Guidelines (GVG) standards across two teaching hospitals in different healthcare settings.

Design: This is a prospective, cross-sectional, clinical audit conducted over a 1-month period.

Methods: All new CLTI patients admitted or seen in the outpatient podiatry clinic at Guy's and St Thomas' Hospital (GSTT) and the National Hospital of Sri Lanka (NHSL) between 1 May 2024 and 31 May 2024 were included. Data were collected regarding clinical assessment, scoring system and imaging utilisation according to recommendations set out in the GVG. Statistical significance was analysed with Fisher's exact test using SPSS.

Results: 65 inpatients were included (GSTT: 38; NHSL: 27) and 49 outpatients (GSTT: 21; NHSL: 28). Among the inpatients, GVG-compliant medical history was recorded in 57 (88%) cases (GSTT: 32 (84%); NHSL: 25 (93%), $p=0.311$). GVG-compliant foot examination was completed in 10 (15%) patients (GSTT: 10 (26%); NHSL: 0 (0%), $p=0.004$). Use of non-invasive imaging was consistent between groups. Among the outpatients, GVG-compliant foot examinations were performed in all 21 outpatients at GSTT (100%) but in none of the 28 outpatients at NHSL (0%, $p<0.001$). Limb severity scoring systems were used for all outpatients seen at GSTT (21/21, 100%), whereas only 5 of 28 outpatients at NHSL (18%) had scoring systems documented ($p<0.001$). Non-invasive imaging utilisation was comparable between the two institutions for outpatients.

Conclusions: Implementation of the GVG is challenging, with even large teaching hospital centres failing to meet all the recommendations for assessment of patients with CLTI.

Commonly missing parameters relate to examination and scoring systems. Further work is needed to understand the barriers to implementation and address these. This was a single cycle audit and further work has not been conducted to recycle this audit.

Key words: vascular, Global Vascular Guidelines, chronic limb-threatening ischaemia, international, audit

Introduction

Chronic limb-threatening ischaemia (CLTI) is the most severe form of peripheral arterial disease, associated with high rates of morbidity, mortality, and limb loss.¹ CLTI creates significant costs to healthcare systems across the globe. Between 2020 and 2021 alone, the financial burden of non-elective amputations cost the National Health Service (NHS) over £115 million.² Therefore, minimising these risks and resource utilisation is highly desirable. The Global Vascular Guidelines (GVG) were published in 2019 and provide a comprehensive evidence-based framework for the assessment and management of CLTI to improve patient outcomes.³ Effective implementation of clinical guidelines raises the standard of care, reduces expenses as well as inconsistent practices and decreases the risk of avoidable errors and adverse events.⁴ Additionally, guideline-based care has been shown to improve patient outcomes across various medical specialties.⁵⁻⁹

Currently, literature evaluating the global rates of compliance with GVG is scarce. In a single-centre study in Japan, patients with CLTI who received distal bypass revascularisation in line with GVG recommendations showed satisfactory outcomes in terms of limb salvage, graft patency, wound healing and survival. These results support the real-world effectiveness of GVG bypass recommendations as an initial revascularisation strategy.¹⁰ However, guideline adherence can be challenging due to variations in healthcare infrastructure, resources, variations in clinician practice and availability of locally designed guidelines.¹¹ As a result, many low- and middle-income countries depend on guidelines developed in high-income settings despite lacking the multidisciplinary teams and specialist equipment required for effective implementation.^{12,13} Based on this context, the authors propose that implementing the GVG in non-high-income countries may be particularly challenging due to resource limitations. To date, no studies have evaluated compliance of healthcare institutions with GVG best practices.

This study audits compliance with GVG recommendations across two large teaching hospitals in contrasting healthcare settings: Guy's and St Thomas' Hospital (GSTT) in London and the National Hospital of Sri Lanka (NHSL) in Colombo. By assessing differences and similarities, this audit aims to identify areas for improvement and strategies to enhance guideline implementation globally.

Methods

Study design and setting

A single-cycle, prospective, cross-sectional, clinical audit was

conducted over a one-month period from 1 May to 31 May 2024 at two large teaching hospitals: GSTT in London and NHSL in Colombo, Sri Lanka.

Participants

The audit included all acutely admitted inpatients with a diagnosis of CLTI or those managed on an outpatient basis in podiatry clinics at both institutions during the study period. No formal sample size calculation was undertaken as this was an observational audit of routine clinical practice over a defined period. As this was a prospective audit including all eligible patients within the study period, no formal power calculation was performed. As per the GVG, the diagnosis of CLTI was defined as a clinical syndrome characterised by the presence of peripheral arterial disease in conjunction with rest pain, gangrene or lower limb ulceration of more than 2 weeks' duration.³

Ethics and approvals

The audit received a GSTT service-level approval (audit number: 15955) and underwent local organisational audit approval at NHSL. All data collection was based solely on the documentation in the patient record systems.

Data collection procedures

A proforma was designed to ensure uniform record keeping across both institutions (Figure 1). All inpatient data were collected from the initial admission clerking note in compliance with institutional protocols for maintaining patient confidentiality.

Assessors

In Sri Lanka, all assessments were performed by vascular surgeons ranging from registrars to consultants. In the UK, inpatient and outpatient assessments were conducted by vascular surgery consultants and middle-grade doctors, with specialist podiatry staff leading outpatient foot assessments. Equipment provided in GSTT included handheld Doppler machines on specialist vascular wards in the inpatient setting and ankle-brachial pressure index (ABPI) and toe-brachial pressure index (TBPI) equipment in the outpatient setting along with monofilament probes in both settings. This equipment was not always available in outlying wards or the Emergency Department. At NHSL this included access to Doppler machines in the inpatient setting but limited specialist equipment in the outpatient setting, with no access to ABPI or TBPI equipment or monofilaments and limited access to Doppler machines.

Figure 1 Audit proforma.**Assessment of patients with Chronic Limb Threatening Ischaemia (CLTI) and Diabetes Mellitus (DM)****Initials:****Age:****MRN:****NHS #:****Type of patient (i.e. inpatient/outpatient):****If inpatient:**

Source of referral: GP / ED / Community Podiatrist / Referring hospital / Other

Date of admission: ____/____/____

Time of admission: ____:____

DM status: Type 1 / Type 2 / No DM

Laterality of ulcer: Right / Left / Bilateral

Duration of ulcer: ____ weeks ____ months ____ years

Previous treatment for ulcer: Yes / No

Details: _____

Inflammatory markers and vital signs on admission:

o CRP: _____

o WCC: _____

o NEWS score: _____

o Vital signs: Pulse ____ BP ____ O2 Sats ____ Temp ____ RR ____

Time to first antibiotic dose on admission: ____ hours ____ mins

Time to surgical debridement from admission: ____ hours ____ mins

If outpatient:

Date seen in GSTT foot clinic: ____/____/____

Provider: Podiatry / Podiatry + Diabetes / MDM clinic

Source of referral: GP / ED / Community Podiatrist / Other

Date first seen in podiatry (prior to GSTT foot clinic): ____/____/____

Referral to vascular surgery: ____/____/____

Date first seen by Vascular team: ____/____/____

DM status: Type 1 / Type 2 / No DM

Laterality of ulcer: Right / Left / Bilateral

Duration of ulcer: ____ weeks ____ months ____ years

Previous treatment for ulcer: Yes / No

Details: _____

Domain for assessment	Parameter	Yes	No
Diagnosis and limb staging	Detailed history including:		
	- symptoms		
	- past medical history		
	- cardiovascular risk factors		
	Complete cardiovascular physical examination		
	Smoking status		
	Examination of foot including:		
	- pedal pulses		
	- probe to bone		
	- assessment of neuropathy		
Medical management	Measure ankle pressure (AP) and ankle-brachial index (ABI)		
	Measure toe pressure (TP) and toe-brachial index (TBI)		
	Use of lower extremity CLTI staging system (i.e. Wiffl/Sinbad etc.)		
	Non-invasive vascular imaging (i.e. Duplex/CT Angio)		
	Treatment with antiplatelet agent		
	Control of hypertension SBP < 140, DBP < 90		
	Smoking cessation intervention (i.e. pharmacotherapy/counselling/behavior modification)		
	Metformin use as a 1st choice hypoglycaemic agent for Type 2 DM		
	Use of moderate- or high-intensity statin therapy		

Table 1 Global Vascular Guideline recommendations audited with corresponding level of evidence.³

Global Vascular Guidelines domain	Level of evidence
Clinical history	C = Low
Use of staging system (eg, Wiffl classification system)	C = Low
Perform a detailed history	Good practice statement
Complete cardiovascular examination	Good practice statement
Complete examination of the foot	Good practice statement
ABPI measurement	B = Moderate
TBPI measurement	B = Moderate
Non-invasive imaging	B = Moderate
Antiplatelet agent	A = High
Statin	A = High
Control hypertension	B = Moderate
Metformin as primary hypoglycaemic agent	A = High

Levels of evidence per Global Vascular Guidelines classification: A = high quality evidence, B = moderate quality evidence, C = expert opinion/consensus.

ABPI, ankle-brachial pressure index; TBPI, toe-brachial pressure index; Wiffl, Wound, Ischemia, and foot Infection.

evidence, 'B' moderate, 'C' low, and 'good practice statement' reflects expert consensus without formal grading.

Data collection focused on clinical assessment, scoring systems and non-invasive imaging use. First, the documentation of medical history was reviewed to confirm whether presenting symptoms (eg, rest pain and tissue loss), past medical history (such as diabetes, hypertension and renal disease) and atherosclerosis risk factors (including smoking and hyperlipidaemia) were recorded. For detailed history and foot assessment, the documentation was considered compliant only if all parameters listed in the proforma were documented (as per best medical practice recommendations of the GVG). Second, foot examination practices were audited to assess the documentation of pedal pulses, neuropathy testing and ulcer probing (where applicable) to evaluate depth, infection or exposure of underlying structures. Third, the use of limb severity scoring systems, such as the Wound, Ischemia, and foot Infection (Wiffl) classification, was examined to determine their role in disease severity assessment and management decisions. Finally, compliance with recommendations for non-invasive imaging including duplex ultrasonography and computed tomography (CT) angiography was evaluated to assess vascular disease extent.

Data sources and management

Demographic data including patient age and sex were recorded. At GSTT, data were extracted from electronic medical records while, at NHSL, patient records were reviewed from paper-based documentation. All data were collected by trained clinicians familiar with the audit framework. To ensure reliability, 10% of the patient

Variables and outcome measures

The audit assessed compliance with key recommendations across multiple GVG domains, including diagnosis and limb staging. For clarity and to facilitate interpretation of compliance, the exact GVG recommendations audited, along with their corresponding level of evidence, are summarised in Table 1. Levels of evidence were extracted directly from the GVG, where 'A' denotes high-quality

records were randomly selected for cross-checking by a second reviewer.

Missing data

Missing data were documented as 'not recorded' and excluded from percentage compliance calculations for that specific parameter, but included in denominators for overall compliance where appropriate. This was handled by one of the doctors overseeing this project.

Statistical analysis

Data were analysed using SPSS statistical software. Categorical variables were summarised as frequencies and compared between GSTT and NHSL using the two-tailed Fisher's exact test, as several variables had small cell counts that did not meet the assumptions for the χ^2 test. The Fisher's exact test was applied to all categorical comparisons to ensure consistency across analyses. Continuous variables such as patient age were reported as medians with interquartile ranges (IQR). Statistical significance was set at $p < 0.05$.

Results

A total of 65 inpatients (GSTT: 38; NHSL: 27) and 49 outpatients (GSTT: 21; NHSL: 28) were included in this audit. Median ages for inpatients were 7.5 years older at GSTT than at NHSL, while outpatient median ages were 16.5 years older at GSTT than NHSL (see Table 2).

For inpatients, GVG-compliant medical histories including symptoms, past medical history and risk factors were recorded for the vast majority of patients. The compliance rates were similar between GSTT and NHSL.

GVG-compliant foot examination including pedal pulse

assessment, neuropathy testing and probing of ulcers were poorly completed for inpatients at both GSTT and NHSL. Despite this, there was still a significant disparity observed between the two institutions, with no patients at NHSL having these investigations. At GSTT, the commonly missed parameters were neuropathy assessment (documented in 11 patients) and ulcer probing (documented in 10 cases). Whilst GVG-compliant foot examination was poorly performed at both centres, documentation of pedal pulses alone was significantly higher at NHSL than at GSTT, whereby all inpatients at NHSL had pedal pulses assessed. GSTT performed complete cardiovascular examinations considerably less often for inpatients than NHSL.

The use of limb severity scoring systems such as Wiffl classification was low across both institutions, although significantly lower in GSTT than NHSL. Non-invasive imaging, including duplex ultrasound or other vascular imaging modalities, was consistently high at both hospitals. All NHSL patients received duplex ultrasonography as the modality of choice (see Table 3).

Among the 49 outpatients, significant differences in adherence to GVG recommendations were also observed (see Table 4). GVG-compliant foot examinations including documentation of pedal pulses, neuropathy assessment and ulcer probing were performed in all GSTT outpatients but in none of the outpatients at NHSL. Significant differences were also observed in performance of complete cardiovascular examination in the outpatient setting whereby no GSTT outpatients had this performed; this was only performed in the minority of NHSL outpatients.

Limb severity scoring systems were used for all outpatients seen at GSTT whereas only a small minority at NHSL had scoring systems documented. The scoring system preferentially used in the GSTT outpatient setting was the Site, Ischaemia, Neuropathy, Bacterial infection, and Depth (SINBAD) classification.

Table 2 Demographic and clinical characteristics of inpatients and outpatients

Variable	GSTT inpatients	NHSL inpatients	GSTT outpatients	NHSL outpatients
Median age (years)	69.5 (62–75.8)	60.6 (57.5–69.5)	67 (62–74)	50.5 (44–61)
Male (%)	78	Data not recorded	64	Data not recorded
Smokers (%)	33	48	2	43
Diabetes type 1 (%)	6	0	5	4
Diabetes type 2 (%)	62	100	77	96
No diabetes (%)	32	0	18	0
Left-sided ulcers (%)	49	52	42	36
Right-sided ulcers (%)	37	33	50	57
Bilateral ulcers (%)	2	15	8	7
No ulcers (%)	12	0	0	0

Data are presented as median (IQR) or % of study population.

GSTT, Guy's & St Thomas' Trust; NHSL, National Hospital of Sri Lanka.

Table 3 Compliance with Global Vascular Guidelines (inpatients).

Global Vascular Guidelines parameter	GSTT	NHSL	P value
Detailed medical history recorded (%)	84	93	0.45
Complete cardiovascular exam (%)	24	93	<0.001
Smoking status recorded (%)	71	48	0.075
Complete foot examination (%)	26	0	0.004
ABPI or TBPI measured (%)	0	0	1.0
CLTI staging system used (%)	11	33	0.031
Non-invasive imaging performed (%)	95	100	0.51
Treatment with antiplatelets (%)	97	100	1.0
Controlled hypertension (%)	95	100	1.0
Metformin for type 2 DM (%)	100	100	1.0
Statin use (%)	92	100	0.13

Data are presented as % of study population.

ABPI, ankle-brachial pressure index; CLTI, chronic limb-threatening ischaemia; DM, diabetes mellitus; GSTT, Guy's & St Thomas' Trust; NHSL, National Hospital of Sri Lanka; TBPI, toe-brachial pressure index.

Table 4 Compliance with Global Vascular Guidelines (outpatients).

Global Vascular Guidelines parameter	GSTT	NHSL	P value
Detailed medical history recorded (%)	10	89	<0.001
Complete cardiovascular exam (%)	0	43	<0.001
Smoking status recorded (%)	10	43	0.013
Complete foot examination (%)	100	0	<0.001
ABPI or TBPI measured (%)	0	0	1.0
CLTI staging system used (%)	100	18	<0.001
Non-invasive imaging performed (%)	71	68	1.0
Treatment with antiplatelets (%)	71	100	0.004
Controlled hypertension (%)	71	100	0.004
Metformin for type 2 DM (%)	76	100	0.018
Statin use (%)	86	100	0.072

Data are presented as % of study population.

ABPI, ankle-brachial pressure index; CLTI, chronic limb-threatening ischaemia; DM, diabetes mellitus; GSTT, Guy's & St Thomas' Trust; NHSL, National Hospital of Sri Lanka; TBPI, toe-brachial pressure index.

Non-invasive imaging utilisation was comparable between the two institutions for outpatients; however, both were considerably less common than their inpatient counterparts.

Consistently, across inpatient and outpatient groups, NHSL pharmacologically reduced modifiable risk factors in all patients through the prescription of antihypertensives, statins and diabetes medication. This was also successfully performed for the majority of inpatients at GSTT, but considerably less in the outpatient setting.

In the inpatient setting, overall compliance with GVG was comparable but equally suboptimal (GSTT 63.2%; NHSL 69.8%). In the outpatient setting, the findings were similar (GSTT 54.1%; NHSL 60.1%).

Discussion

Various challenges in global implementation of clinical practice guidelines have been highlighted in the literature. Key obstacles include technological and attitudinal barriers, time constraints and lack of motivation, scepticism about validity and applicability, differences in professional practices, resource shortages and inconsistencies in staff training, all of which hinder widespread adoption and adherence to these guidelines.^{14–18}

Challenges specific to vascular surgery have also been discussed in the literature. The lack of training in specialised techniques such as endovascular surgery are a key barrier to implementing vascular clinical guidelines in low- and middle-income countries.¹⁹ The limited availability of reputable training fellowships intensifies competition between newly qualified vascular surgeons and experienced practitioners already established in the field; however, these obstacles, although very relevant, were not applicable to the implementation of the assessment element of the guidelines.¹⁹ The impact of vascular disease is further exacerbated by the unavailability of essential surgical equipment combined with restricted access to surgeons.^{20,21}

This audit highlights significant challenges in the implementation of the GVG at two major teaching hospitals operating in contrasting healthcare settings: GSTT in London and NHSL in Colombo. Despite the vast differences in their healthcare environments, neither institution demonstrated full compliance with GVG standards, underscoring universal barriers to their implementation.

A notable observation was the poor adherence to guideline-directed foot examinations, particularly among inpatients at both institutions. At NHSL in particular, despite consistent documentation of pedal pulses, crucial elements such as neuropathy assessments and ulcer probing were omitted across both inpatient and outpatient settings. It is possible that providing simple and cost-effective tools like monofilaments and ulcer probes in the inpatient setting could improve disease severity assessment and support clinical decision-making; however, specific auditing of availability of equipment was not carried out as this was beyond the scope of this audit. In contrast, GSTT excelled in outpatient foot evaluations, achieving 100% compliance in that parameter. The success of this service may be linked to the specialised expertise of the podiatry team leading it, rather than rotational medical staff who face challenges in maintaining protocolised institutional care due to the need for ongoing training.²² Additionally, the use of a standardised proforma for outpatient pedal assessments – a method known to improve documentation consistency and enhance patient outcomes – likely contributed to its effectiveness.²³ The disparity between the hospitals could stem from differences in healthcare infrastructure (ie, availability of an electronic patient

record system at GSTT providing ease of documentation), training and resources (lack of monofilaments compromises complete clinical evaluation of neuropathy), but this is beyond the scope of this study to further investigate. Although consultant-led ward rounds at GSTT emphasised pedal pulse assessments, initial patient evaluations on admission were often conducted by junior residents. There could be several barriers to complete examination by junior residents such as lack of confidence in their foot examination skills due to inadequate training or failure to complete assessments because of competing clinical demands or practical barriers faced during overnight admissions such as removal and re-application of dressings. Data were not collected in this study to identify the root causes for a lack of compliance. At NHSL clinicians appeared to depend more on thorough clinical examination and pedal pulse assessment compared with GSTT.

Another striking finding was the minimal use of the Wifl limb severity scoring system at both institutions. This system is integral to the GVG framework, providing a structured approach to stratifying disease severity and estimating the risk of major limb amputation, need of revascularisation and even time to wound healing.³ Despite its importance, both institutions failed to meet this GVG recommendation. The 'ischaemia' component of the Wifl score is determined using haemodynamic measurements including the ABPI or TBPI.²⁴ However, neither hospital demonstrated use of the necessary equipment to conduct these assessments in the inpatient setting, highlighting that resource limitations can persist even in high-income healthcare systems. Interestingly, despite its availability in the outpatient setting in GSTT, the guidance for ABPI and TBPI was poorly adhered to, suggesting that access to equipment may not be the most important factor driving its use. Addressing this gap in guideline implementation would require not only the provision of appropriate diagnostic tools but also structured clinician training and institutional backing to ensure integration into routine practice.^{15,20}

Notably, GSTT achieved full compliance in using a scoring system within the outpatient podiatry service. However, their chosen system was the SINBAD classification – the most commonly used diabetic foot ulcer tool in the UK – known for its simplicity as it requires no specialised equipment.²⁵ Despite its widespread use, the Wifl classification offers superior outcomes compared to SINBAD, including more accurate predictions of one-year amputation risk and ulcer healing times. Consequently, broader adoption of the Wifl system could lead to improved patient outcomes and informed shared decision-making in both high- and low-to-middle-income healthcare settings.²⁵

Non-invasive imaging, a cornerstone of CLTI assessment, was one area where both hospitals demonstrated high compliance. Nearly all GSTT inpatients (except for those deemed for palliation, $n=2$) and all NHSL inpatients underwent non-invasive imaging studies, reflecting the prioritisation of diagnostic vascular assessment in both settings. The parity in imaging utilisation suggests that this aspect of the GVG may be more feasible to

implement universally, even in resource-constrained environments like NHSL. Of note, in the absence of contraindications, the routine non-invasive imaging modality at NHSL was duplex ultrasonography whereas the GSTT patient cohort tended to undergo CT angiography as the investigation of choice. Identification of vascular anatomy through imaging is crucial for planning revascularisation strategies. While duplex ultrasonography remains a valuable diagnostic tool, its limitations have been highlighted in previous studies.²⁶ Conversely, CT angiography is often favoured for surgical planning due to its ease of use and the comprehensive anatomical detail provided by cross-sectional imaging, but it may not be readily available in a low-income setting due to increased financial costs.²⁷

Another challenge of translating comprehensive guidelines like the GVG into real-world practice is the presence of national guidelines that may differ from those proposed globally. In the UK the management of CLTI follows the National Institute for Health and Care Excellence (NICE) guidelines which, while aligned with the GVG in many aspects, differ in certain domains.²⁸ For example, the use of CLTI staging systems is not outlined in the guidance and therefore may not be included in routine clinical practice across the UK. However, given the well-documented prognostic value of the Wifl system, integrating this staging tool into routine care could offer long-term benefits in patient management.^{3,24,25}

A further issue, particularly evident at NHSL, was physical access to a vascular surgeon. Due to limited resources, many CLTI patients were forced to travel for hours to attend their appointments and had to rely on relatives or public transportation. Although not directly measured in this audit, inability to access a vascular unit may cause diagnostic and treatment setbacks, causing substantial delays in revascularisation of CLTI patients. Risks of postoperative major amputations and in-hospital death are associated with delayed presentation and management.²⁹ It has also been shown that a presentation delay of 2 weeks is an independent predictor of major limb amputations.³⁰ Therefore, healthcare infrastructure remains a key component for best patient outcomes.

It is notable that several high-evidence recommendations such as antiplatelet therapy and statin use achieved high compliance in both settings, whereas lower-evidence or good practice recommendations such as detailed foot examination or staging system use showed marked variation. This pattern suggests that the strength of evidence underpinning a recommendation may influence its prioritisation in clinical practice, an observation consistent with previous literature on guideline adoption.

While the strengths of this study include the comprehensive quality of the data from two vascular units with tertiary referral practices and wide inpatient and outpatient coverage, it has several limitations. It is an audit based on figures over a short period of time. Additionally, it lacks follow-up data to assess one-year major limb amputation rates, mortality and time to healing of ulcers. Finally, it is unclear whether the observed low rates of compliance with the GVG recommendations affect patient outcomes.

KEY MESSAGES

- Both high-resource (UK) and resource-limited (Sri Lanka) centres showed suboptimal adherence to key Global Vascular Guidelines (GVG) recommendations, particularly for foot examination and use of severity scoring systems.
- Wifl, recommended by GVG for limb staging, was rarely used; however, the alternative scoring systems not requiring specialist equipment were used more frequently.
- Duplex ultrasonography and CT angiography were consistently used at both centres, showing that this guideline element is feasible even in resource-constrained environments.

Moving forward, tailored interventions are essential to improve GVG adherence. Both high-resource and resource-limited healthcare systems may benefit from simplified protocols that prioritise fundamental high-impact components of the guidelines. For instance, ensuring the availability of bedside equipment for comprehensive foot examinations (eg, monofilaments for neuropathy assessment, TBPI machines) and promoting the use of limb severity scoring tools could significantly enhance guideline adherence and long-term outcomes without requiring substantial resource investment. High-resource settings like GSTT must address documentation gaps, recognise the need for clinical training of junior residents and explore opportunities to integrate guideline components (ie, scoring systems) into standardised electronic health records and workflows.

Conclusion

The implementation of the GVG remains suboptimal in both resource-limited and resource-rich healthcare settings. While each setting presents unique barriers, common deficiencies – particularly in foot examination and scoring system utilisation – highlight the need for enhanced resources and education, streamlined workflows and context-specific adaptations of the guidelines. Addressing these challenges will be essential to improving CLTI outcomes globally and ensuring equitable access to evidence-based care.

Conflict of Interest: None.

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Ethics and approvals: The audit received a GSTT service-level approval (audit number: 15955) and underwent local organisational audit approval at NHS. All data collection was based solely on the documentation in the patient record systems.

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CLINICAL AUDIT

An audit of glycaemic control and impact on surgical outcomes among inpatients with critical limb-threatening ischaemia (CLTI)

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Plain English Summary

Why we undertook the work: Many people in hospital with severe lower limb circulation problems (CLTI) also have poorly controlled blood sugar. When blood sugar isn't well managed, wounds are slower to heal. High blood sugar after surgery increases the risk of serious problems with the affected limb, including possible amputation.

What we did: We reviewed hospital patients with CLTI over a 6-week period to see how well their blood sugar was controlled and how this affected outcomes. The review took place at one specialist vascular centre and included all such patients admitted during that time. We compared their blood sugar control against national guidelines and used statistical analysis to see if it was linked to outcomes after treatment.

What we found: Out of the hospital patients with CLTI, a small proportion had well-controlled blood sugars, while most had poor control. Patients with good blood sugar control healed better, had fewer amputations, and experienced fewer serious complications. Poor blood sugar control was strongly linked to worse healing and higher risk of amputation, even after accounting for other health factors. All deaths occurred in patients with poor blood sugar control.

What this means: This audit shows that even in a specialist diabetic foot centre, many patients have poor blood sugar control, which continues to worsen outcomes. Practical strategies and care pathways are needed to improve blood sugar management across all settings for this high-risk group of patients.

Abstract

Background: Diabetes mellitus is a key risk factor for peripheral arterial disease (PAD), with poor glycaemic control in diabetic patients linked to foot ulceration, delayed wound healing and an increased need for surgery and amputations. Most UK vascular centres have specialist multidisciplinary diabetes foot clinics to address this. Despite these efforts, diabetic foot complications, often associated with PAD, remain prevalent. We conducted an audit of inpatients with critical limb-threatening ischaemia (CLTI) to assess their glycaemic control and correlate it with limb-related outcomes.

Methods: Data were collected from a single tertiary vascular centre with focus on inpatients with CLTI over a 6-week period from 2 January 2023 to 12 February 2023, including all admitted patients during this time frame. Glycaemic control was audited against national guidelines. A multivariate analysis examined the relationship between HbA_{1c}/blood glucose levels and post-procedural outcomes, adjusting for age, body mass index (BMI) and sepsis status, with glycaemic control categorised according to National Institute of Health Care and Excellence (NICE) guidelines.

Results: Of 236 inpatients, 120 with CLTI had blood glucose or HbA_{1c} data available. The cohort was mostly male (70.3%), with a median age of 70 years. Among them, 92 patients (76.6%) had type 2 diabetes, four patients (3.3%) had type 1 diabetes and 24 (20%) were not diabetic. Median HbA_{1c} and glucose levels were 8.7% and 10.7 mmol/L, respectively. Based on NICE guidelines, 54 patients (45%) were well controlled (Group 1) and 66 patients (55%) were poorly controlled (Group 2). Foot outcomes were linked to diabetes control: primary healing was higher in Group 1 (42.5%) than in Group 2 (18.1%) ($p=0.002$). Group 1 had fewer minor amputations (11% vs 24%, $p=0.002$) and major adverse events (major amputation and

death) (12.9% vs 33.3%, $p=0.002$). Multivariate analysis when adjusted for age, C-reactive protein and BMI along with the glycaemic status showed poor glycaemic control was significantly associated with poorer wound healing and amputations ($p<0.01$), but not with unplanned surgeries ($p>0.05$). Five deaths occurred, all in poorly controlled patients.

Conclusion: Many vascular inpatients with CLTI with or without diabetes have inadequate glycaemic control, which is associated with adverse outcomes. This audit highlights that, despite a well-established multidisciplinary diabetic foot service in a tertiary centre and known associations between poor glycaemic control and adverse outcomes, diabetes management remains suboptimal and continues to affect patient outcomes. There is a need for actionable pathways to improve glycaemic control across care settings for this high-risk population.

Key words: diabetes, peripheral artery disease, hyperglycaemia, critical limb-threatening ischaemia, diabetic foot infection

Introduction

Chronic limb-threatening ischaemia (CLTI) is the most severe presentation of peripheral arterial disease (PAD) and affects 1% of the population in the UK.¹ PAD is a common disease among patients with diabetes mellitus,² and the relative risk of PAD increases with increasing duration and severity of diabetes.³ As diabetes is a major driver of the disease severity by acting at the molecular and cellular level,⁴ many patients with CLTI are found to have poorly controlled diabetes with elevated blood glucose levels and HbA_{1c}. Postoperative hyperglycaemia is associated with adverse events after lower extremity vascular procedures in patients with and without diabetes including infection, increased hospital utilisation (need for further procedures) and mortality.⁵ Studies have shown that, in patients with diabetes and CLTI, HbA_{1c} levels of >6.8–8% are associated with major amputations.^{6,7} The cost of treating CLTI in patients with diabetes is higher than the health system treatment costs of either coronary artery disease or cerebrovascular disease,^{8,9} and these increased costs may be associated with higher rates of hospital admissions, procedures, medication costs and complications seen in this group.^{8,9} The National Institute for Health and Care Excellence (NICE) has issued guidelines for perioperative diabetes control, setting an HbA_{1c} target of 48 mmol/mol (6.5%) in patients with both type 1 and 2 diabetes, and a blood glucose target of 9 mmol/L in type 1 and 8.5 mmol/L in type 2 diabetes. This is based on clear evidence of poorer outcomes after surgery for patients with poor diabetic control.^{5–7}

The primary aim of this study is to evaluate the adequacy of glycaemic control in CLTI patients admitted to a tertiary vascular unit. In addition, we considered patient access to a specialist diabetes review when needed. Our secondary aim was to assess any potential correlation between glycaemic control and impact on postoperative outcomes.

Methods

Study design

This was a retrospective audit of inpatients in a single-centre tertiary level vascular unit. Patients presenting with CLTI, regardless

of their diabetes status (as per global vascular guidelines 2019) over a 6-week period from 2 January 2023 to 12 February 2023, all admitted patients during this timeframe, were included in the study.

Data gathered included patient demographics, presenting complaint and the intervention proposed, blood glucose pre- and post-intervention, HbA_{1c} values, sepsis status (C-reactive protein, CRP), body mass index (BMI), inpatient diabetes team review and post-procedural outcomes. The post-surgical outcomes in CLTI patients were categorised as primary wound healing, need for further unplanned operation, minor amputation, major amputation and death. Glycaemic control definitions were taken from the NICE guidelines as follows: diabetic patients: HbA_{1c} <48 mmol/mol (6.5%) and blood glucose levels <8.5 mmol/L; non-diabetic patients: HbA_{1c} <42 mmol/mol (6%) and blood glucose levels 7.8 mmol/L.

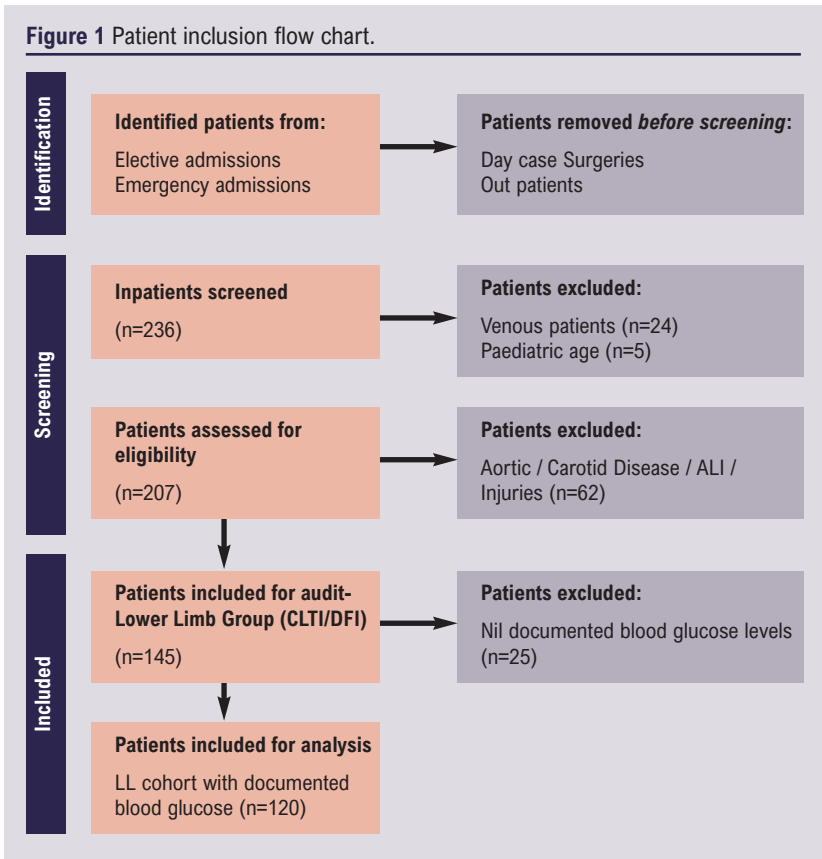
Statistical analysis

Data analysis was performed using descriptive statistics and multivariate analysis. Blood glucose levels and HbA_{1c} levels are presented as mean and medians, and categorical/quantitative variables such as age, glycaemic control, CRP, BMI and post-procedural outcomes are presented as counts and/or absolute numbers and analysed with a multinomial logistic regression model using R software. P values <0.05 are considered as statistically significant.

Results

From 3 January 2023 to 12 February 2023, a total of 236 patients were admitted as inpatients to the vascular unit at St Thomas' Hospital. One hundred and forty-five patients were identified with CLTI, the majority of which were diabetic (69%). Of these, 25 patients (17%) did not have blood glucose measurements available and therefore were excluded. Five (11%) non-diabetic patients had available HbA_{1c} levels and 24 (53%) non-diabetic patients with blood glucose levels were included in the analysis. A final number of 120 patients were included in the study (see Figure 1).

In the study group the median age was 70 years (range 38–92) and 85 (70.3%) patients were male. Ninety-six patients (80%) were



known to be diabetic, of which four had type 1 diabetes and 92 patients had type 2. Twenty-four patients (20%) were not diabetic but had blood glucose and/or HbA_{1c} levels available.

Fifty-four patients (45%) had well controlled blood glucose (<8.5 mmol/L) (Group 1), of which 32 (59%) were known to have diabetes and 22 (41%) were not diabetic. The median blood glucose level in this group was 6.5 mmol/L (range 4–8 mmol/L).

Sixty-six patients (55%) had poorly controlled blood glucose (>8.5 mmol/L) (Group 2), of which 64 (97%) were known to be diabetic and two (3%) were not known to be diabetic. The median blood glucose level in this group was 12.8 mmol/L (range 2.1–27.4 mmol/L) (see Table 1).

Table 1 Diabetes control categorisation amongst inpatients with chronic limb-threatening ischaemia (CLTI).

Group	Definition	Number (N=120)	Percentage (%)
Non-diabetic patients	Blood glucose level <7.8 mmol/L	22	18.3
Non-diabetics with deranged blood glucose	Blood glucose level >7.8 mmol/L	2	1.6
Well controlled diabetic patients	Blood glucose level <8.5 mmol/L	32	26.6
Poorly controlled diabetic patients	Blood glucose level >8.5 mmol/L	64	53.3

Eighty-seven patients had documented HbA_{1c} readings. Of these, 24 (27.5%) patients had well controlled HbA_{1c} (<6.5%, 48 mmol/mol) including 20 diabetic patients and four patients without diabetes. The median HbA_{1c} was 5.7%, 39 mmol/mol (range 5–6.4%). Sixty-three patients (72.4%) had poorly controlled HbA_{1c} levels (>6.5%, 48 mmol/mol) including 62 diabetic patients and one patient without diabetes. The median HbA_{1c} level for this group was 8.6%, 69 mmol/mol (range 6.2–16%).

There were 45 patients with CLTI who were not known to be diabetic. Of these, 24 patients had data available, of which two (8.3%) had poorly controlled blood glucose levels (>7.8 mmol/L) and one had an elevated HbA_{1c} level of 46 mmol/mol (6.2%).

The median HbA_{1c} in the group known to have diabetes for whom data were available (n=87) was 56.8 mmol/mol (7.7%), which was higher than the NICE recommendation of 48 mmol/mol (6.5%). The mean HbA_{1c} for the good control group was 66 mmol/mol (8.2%) and for the poor control group was 75 mmol/mol (9.0%) (p=0.05). Further analysis of the relationship between sepsis (CRP) and glycaemic control was conducted and showed that the mean CRP level in the poor glycaemic control

group was higher than in the good glycaemic control group (110.52 mg/L vs 74.59 mg/L; p=0.01).

Among the group with poorly controlled sugar levels (66 patients), 18 patients (27.2%) were reviewed as inpatients by the diabetes team. Two patients (3.7%) with well controlled sugar levels were reviewed by the diabetes team as inpatients.

Univariate analysis showed that outcomes were correlated significantly with glycaemic control, with primary wound healing achieved in 42.5% (23/54) of patients with good glycaemic control and only 18.1% (12/66) of patients with poor glycaemic control (p=0.002). Further unplanned surgery was required in 35.1% (19/54) of patients with good glycaemic control and in 22.7% (15/66) of patients with poor glycaemic control (p=0.002). Minor amputations were more frequently observed in patients with poor glycaemic control (17/66 patients, 25.7%) compared with those who had well controlled sugars (5/54 patients, 9.2%; p=0.002; Table 2).

Major adverse limb events, defined as major limb amputation or further revascularisation of the index limb, were more common in the group with poor glycaemic control (17/66, 25.7%) than in the well controlled group (7/54, 12.9%; p=0.002) (see Table 3).

There were five (7.8%) deaths in this cohort, all of whom had poorly controlled diabetes (see Figure 2).

A multinomial logistic regression model analysed the relationship between glycaemic control and clinical outcomes, adjusting for age, CRP and BMI. In this regression model, poor

Table 2 Post-procedural outcomes categorised based on glycaemic control.

Post-surgical outcomes	Well controlled group (N=54)	Poorly controlled group (N=66)
Good primary healing	23 (42.5%)	12 (18.1%)
Further unplanned surgery	19 (35.1%)	15 (22.7%)
Minor amputation	5 (9.2%)	17 (25.7%)
Major amputation and/or death	7 (12.9%)	22 (33.3%)
Major adverse limb events	7 (12.9%)	17 (25.7%)

Table 3 Univariate analysis of glycaemic control with surgical outcomes adjusting for other variables.

Characteristics	Good control (Group 1) (N=54)	Poor control (Group 2) (N=66)	P value
Age (years)	68.83 (12.90)	68.02 (11.27)	0.6
Sex			0.8
Male	37 (69%)	48 (73%)	
HbA _{1c} (%)	8.21 (2.48)	9.05 (2.32)	0.050
CRP (mg/L)	74.59 (80.91)	110.52 (98.49)	0.014
BMI (kg/m ²)	25.28 (4.85)	26.40 (4.76)	0.094
Outcomes			0.002
Good healing	23 (42.5%)	12 (18.1%)	
FUS	19 (35.1%)	15 (22.7%)	
Minor amputation	5 (9.2%)	17 (25.7%)	
MAE	7 (12.9%)	22 (33.3%)	

Categorical data represented as n (%) and continuous data represented as mean (SD). BMI, body mass index; CRP, C-reactive protein; FUS, further unplanned surgery; MAE, major adverse events.

Table 4 Multivariate analysis showing relation between glycaemic control and surgical outcomes adjusting for other variables in patients with chronic limb-threatening ischaemia (CLTI).

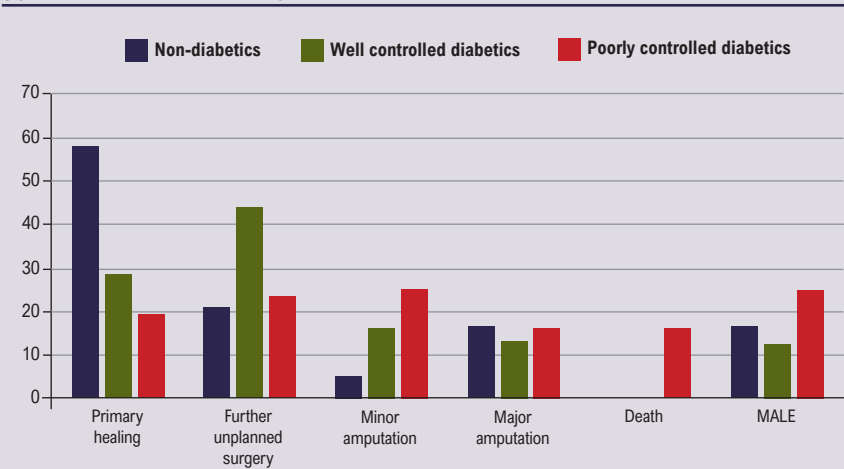
Variables	OR	SE
Unplanned surgeries/interventions		
Glycaemic control		
Good	—	—
Poor	1.60	0.821
Age (years)	0.98	0.021
CRP (mg/L)	1.00	0.003
BMI (kg/m ²)	1.08	0.058
Minor amputations		
Glycaemic control		
Good	—	—
Poor	5.77**	3.59
Age (years)	0.96	0.024
CRP (mg/L)	1.00	0.004
BMI (kg/m ²)	1.02	0.067
Major adverse events		
Glycaemic control		
Good	—	—
Poor	5.21**	3.04
Age (years)	0.97	0.023
CRP (mg/L)	1.00	0.003
BMI (kg/m ²)	1.09	0.063

BMI, body mass index; CRP, C-reactive protein; OR, odds ratio; SE, standard error. *p<0.05; **p<0.01; ***p<0.001

glycaemic control was significantly associated with an increased risk of requiring minor amputations (p<0.01) and developing major adverse events (major amputation and/or death) (p<0.01), but was not significantly associated with further unplanned surgeries (p>0.05). Age, BMI and CRP levels did not seem to affect the results and are not the primary drivers of the clinical post-surgical outcomes (Table 4).

When the poorly controlled group (diabetic and non-diabetic) were compared with the combined well controlled group (diabetic and non-diabetic) there was a significant association with poorer rates of primary wound healing (18.1% vs 42.5%, p<0.01) and higher rates of minor amputation (25.7% vs 9.2%, p<0.01) and major adverse events (ie, major limb amputation and/or death) (33.3% vs 12.9%, p<0.01), whereas there was no statistically significant association with further unplanned surgeries when a multinomial analysis was performed (22.7% vs 35.1%, p>0.05; Tables 3 and 4).

Figure 2 Post-procedural healing outcomes in the lower limb cohort in relation to glycaemic control. MALE, major adverse limb events.



Discussion

This contemporary audit of diabetes control among inpatients with CLTI was conducted primarily to assess compliance with NICE recommended glycaemic control targets in our cohort. It demonstrated a significant proportion of vascular inpatients with poorly controlled diabetes and correlated poorer outcomes in this group. Those with inadequate preoperative glycaemic control were three times less likely to achieve primary wound healing than those with well controlled or no diabetes. Major adverse limb events occurred in 25.7% of patients with poorly controlled diabetes compared with 12.9% of those with well controlled diabetes.

This finding is in keeping with published data demonstrating poorer surgical outcomes associated with inadequate glycaemic control.¹⁰

Yap *et al*¹¹ observed that patients with CLTI with poor perioperative glycaemic control undergoing infra-popliteal revascularisation were at increased risk of restenosis, which could be a potential mechanism for the observation of lower primary wound healing rates and a greater need for further unplanned surgery in this patient group. In addition, deranged blood glucose levels can have a deleterious effect on the immune response at the wound bed and directly impact wound healing.¹²

Arya *et al*¹³ also found that poor perioperative glycaemic control, defined as HbA_{1c} >7.0%, was associated with an increased risk of major adverse limb events such as amputation, in keeping with the findings of the present study. Another study including more than 2000 patients identified a greater risk of readmission within 30 days following an open or endovascular revascularisation in those with preoperative HbA_{1c} of >6.5%.¹⁴ A further recent publication in 2024 partially agreed with the above, concluding that increased HbA_{1c} is associated with a greater risk of early amputation.¹⁵ However, this study found similar outcomes following revascularisation for CLTI among patients with uncontrolled diabetes and those with well controlled diabetes.

In contrast to these studies and our currently presented data, Vogel *et al*⁶ did not find a significant difference in rates of major amputation associated with postoperative hyperglycaemia. However, this study confirmed the association between postoperative hyperglycaemia and other adverse outcomes including 30-day readmission, mortality and infectious complications. There was no difference in outcomes between patients with or without diabetes as hyperglycaemia was the main determinant factor.

This finding is corroborated by Kinio *et al*, who described hyperglycaemia as a factor in major adverse events following surgery including mortality, cardiac events and adverse limb events, regardless of diabetic status.¹⁰

A recent review noted that studies correlating outcome data with diabetes management often showed inconsistencies in variation of diabetes control definitions. This study has taken definitions of diabetes control from published national guidelines to overcome this potential weakness.¹⁶

There are some limitations to our study, which is a single-centre retrospective audit of current practice. As such, some data were missing from the electronic patient records and there may be unrecognised bias in the patients studied. However, it is a large busy tertiary vascular unit study, reflective of 'real-world' practice, and highlights a significant challenge in a highly complex patient group. Those with CLTI associated with diabetes are often found to have poor glycaemic control and, indeed, this may in part be a causative factor in their presentation. The urgent nature of revascularisation for CLTI to improve limb outcomes as recommended by national and international societies leaves little time for perioperative optimisation of diabetes control and other co-morbidities. Inpatient services across all specialties are struggling to meet current demands and therefore access to specialist diabetes team input within a short time frame can be difficult to achieve. Close collaboration between medical and surgical teams has led to the production of protocols to enable clinicians to address diabetic control in acute care settings (ie, THINK GLUCOSE guidelines).^{17,18} However, in these challenging cases there is likely to be benefit to more intensive and personalised support.

Conclusion

The current study goes some way to highlighting the challenges and impact of diabetes care on inpatient vascular patients with urgent lower limb presentations. Despite a dedicated multidisciplinary foot service within a tertiary vascular referral centre, glycaemic control in this high-risk cohort remains suboptimal, with an ongoing impact on patient outcomes. While recognising that the inpatient population may reflect a self-selecting higher risk group, current investment in multidisciplinary working has yet to achieve the desired improvements. These findings underscore the need to expand diabetes support beyond hub-site services, with greater emphasis on integrated community-based care – aligning with the direction of the NHS 10-year plan.

Further work is needed to understand what practically implementable solutions may improve glycaemic control and patient outcomes within the resources available. Identifying those at risk through ensuring blood glucose and HbA_{1c} testing are conducted on admission is a vital first step which should be achievable in all cases, as evidence suggests that perioperative hyperglycaemia in non-diabetic vascular patients may adversely affect surgical outcomes to a similar extent as in diabetic patients. It will also be interesting to explore the preoperative journey of these patients, highlighting community and primary care-based opportunities to act where possible through, for example, strengthened multidisciplinary foot clinics in community settings. Local responses to these challenging patients will depend on local resources and protocols. However, highlighting those at risk to specialist diabetes teams should form an integral component to care and be recognised as an important factor influencing outcome.

KEY MESSAGES

- Many vascular inpatients with CLTI have poor glycaemic control.
- Primary wound healing is adversely associated with poor glycaemic control.
- Uncontrolled hyperglycaemia is significantly associated with major adverse limb events following surgery.
- Early identification of poor glycaemic control in patients presenting with initial diabetic foot complications provides a key opportunity for multidisciplinary intervention, including input from diabetologists, dietitians and diabetes specialist nurses, to optimise metabolic control and mitigate the risk of progressive foot morbidity.

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CASE REPORT

Infection of small abdominal aortic aneurysm following a diagnosis of large vessel vasculitis and initiation of immunosuppression: presentation, diagnosis and management

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Abstract

Large vessel vasculitis is characterised by inflammation of the aorta and its major branches. This article presents the case of a patient with a 3.9 cm infrarenal abdominal aortic aneurysm at the time of diagnosis with large vessel vasculitis. Three weeks following diagnosis and initiation of immunosuppression, the patient required an emergency open repair due to confirmed methicillin-sensitive *Staphylococcus aureus* infection of the aneurysm. At the time of writing, there are no guidelines nor case reports in the literature to guide the management of suspected infected aneurysms in patients with active large vessel vasculitis.

Key words: abdominal aortic aneurysm, methicillin-sensitive *Staphylococcus aureus*, large vessel vasculitis

Introduction

Large vessel vasculitis (LVV) typically describes two main variants – giant cell arteritis and Takayasu's arteritis – although there is a large spectrum of LVV disease.¹ Current management of LVV relies on corticosteroids, in accordance with NICE and the 2018 update of the European Alliance of Associations for Rheumatology (EULAR) guidelines, with the potential addition of long-term immunosuppression to reduce the steroid dose and achieve remission.²⁻⁴ A case of an infected abdominal aortic aneurysm (AAA) 3 weeks following a diagnosis of LVV and initiation of immunosuppression, resulting in diagnostic uncertainty and difficulty choosing the most appropriate management, is described.

Case report

A 62-year-old male, previously in good health, presented to hospital with a 1-week history of constitutional symptoms, including somnolence, drenching night sweats and one episode of melaena. The patient reported a sudden onset of symptoms as though he had been "hit by a truck". An incidental subthreshold (3.9 cm) infrarenal AAA with significant calcium burden was noted on an investigative CT scan of the abdomen/pelvis performed during this admission (Figure 1).

The patient's inflammatory markers continued to rise despite initiation on co-trimoxazole for a potential urinary tract infection, suggesting a chronic inflammatory picture. A whole-body FDG-PET/CT scan 13 days after initial presentation showed mild-to-moderate FDG uptake involving the aorta and its branches, suggestive of LVV (Figures 2–4).¹

Three weeks following the diagnosis of LVV and initiation of high-dose steroids, the patient presented to the emergency department with a 3-day history of increasingly severe back pain radiating to the abdomen. A CT scan of the abdomen/pelvis showed new anterior fat stranding extending along the length of the aneurysm, concerning for impending rupture (Figure 5). Inflammatory markers were elevated on admission (white blood cell count $25.50 \times 10^9/L$, C-reactive protein 209.5 mg/L) and one of two peripheral blood cultures collected were positive for Gram-positive cocci (2/2 bottles). Splinter haemorrhages were present on both hands the following morning and a small painful cut on the left index finger was noted.

An open AAA repair using a 16 mm straight tube graft soaked in 600 mg rifampicin was performed on day 2 of the admission, with

Figure 1 CT scan of the abdomen/pelvis with contrast: axial slice demonstrating a 3.9 cm infrarenal aortic aneurysm as an incidental finding.

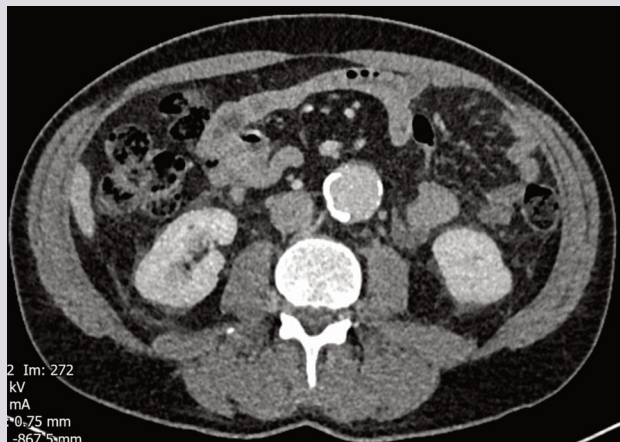


Figure 2 FDG-PET/CT scan: maximum intensity projection demonstrating increased uptake within both subclavian arteries, descending thoracic aorta and abdominal aorta. The pattern of uptake is in keeping with large vessel vasculitis.

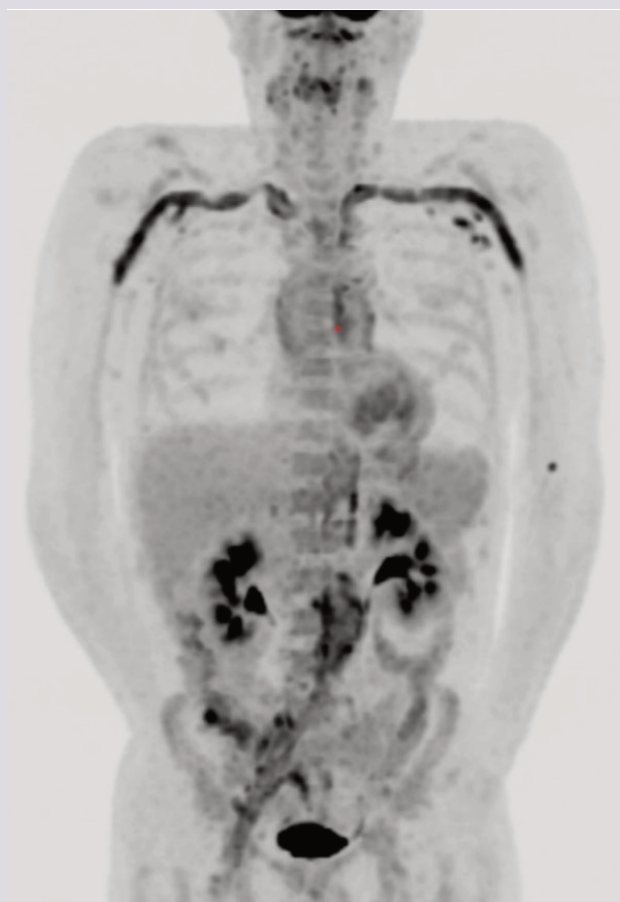


Figure 3 FDG-PET/CT scan: fused coronal slice demonstrating increased circumferential uptake in the wall of the ascending aorta, aortic arch and right common femoral artery suggestive of large vessel vasculitis.

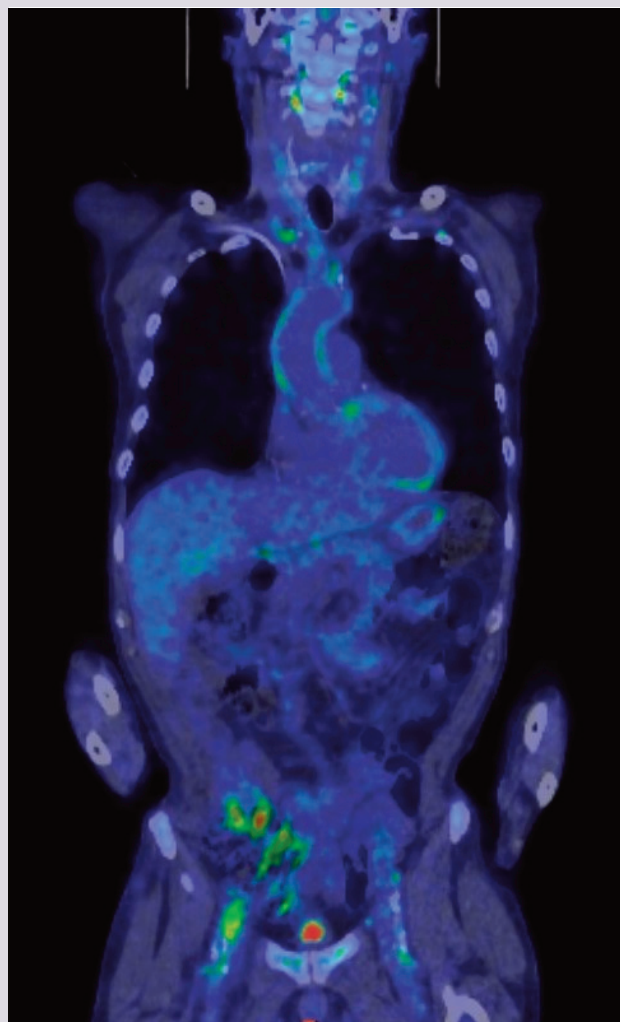


Figure 4 FDG-PET/CT scan: fused axial slice demonstrating increased circumferential uptake in the aortic arch and bilateral axillary arteries suggestive of large vessel vasculitis.

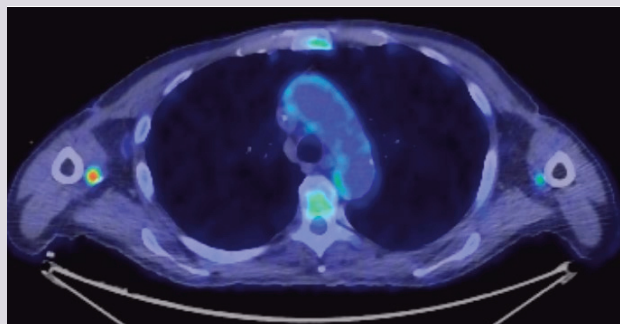


Figure 5 CT angiogram: axial slice demonstrating new circumferential periaortic mesenteric fat stranding, no contrast extravasation demonstrated. The appearance is in keeping with impending rupture.



180 mg gentamicin and 2000 mg flucloxacillin given intravenously as preoperative antibiotic prophylaxis. A silver-impregnated right aortofemoral jump graft was also inserted during this operation due to the intraoperative finding of a significantly stenosed right common iliac artery. Methicillin-sensitive *Staphylococcus aureus* (MSSA) was isolated from intra-aortic plaque and aortic sac specimens collected perioperatively and from the blood culture bottles positive for cocci taken on admission.

Whether postoperative management should focus on treatment of LVV or vascular infection was an area of ongoing discussion between involved specialties. The patient was initially commenced on both IV flucloxacillin and 30 mg daily oral prednisone, half the recommended dose for initial treatment of vasculitis.²⁻⁴ Considerable inflammatory soft tissue thickening involving the right aortofemoral bypass graft was seen on a CT scan 10 days following surgery, suggestive of a graft infection, and all immunosuppression was briefly withdrawn following multidisciplinary discussion. However, the patient experienced spiking fevers and rising inflammatory markers within 48 hours of this withdrawal and was recommenced on prednisone. A 2-week course of 300 mg once-daily rifampicin was added to the postoperative antibiotic regimen followed by 100 mg twice-daily doxycycline for lifelong antibiotic therapy.

Persistently active LVV was confirmed by serology and radiology 6 weeks after the surgery. It was determined that a course of six cyclophosphamide infusions would reduce the need for steroids faster than the addition of methotrexate, thereby reducing the overall infection risk.

At the time of writing this case report, a partial response to six cyclophosphamide infusions has been achieved with active LVV still apparent on a FDG-PET/CT scan (Figure 6). However, the patient's inflammatory markers are improved (erythrocyte sedimentation rate 17 mm/h, C-reactive protein 24.35 mg/L) and the patient has

Figure 6 FDG-PET/CT scan: maximum intensity projection demonstrating generalised uptake within the large vessel. When compared with Figure 2 there has been a reduction in the degree of avidity, in keeping with treatment response. Right subclavian SUV max was noted to drop from 6.6 to 3.7.



SUV, standardised uptake value maximum

regained the significant amount of weight lost since first presentation.

Discussion

This case presents a complex diagnostic and management dilemma. Prior to confirmation of MSSA bacteraemia and aneurysm infection, it was uncertain whether the aneurysm changes reflected the secondary infection of a pre-existing aneurysm in the context of immunosuppression or a symptomatic aneurysm associated with active LVV disease. Once the MSSA infection was confirmed, it was reconsidered whether the initial presentation was one of a primary infective process rather than LVV; a screen for vasculitis prior to the initial FDG-PET/CT scan was negative except for mildly elevated IgA at 3.74 g/L. However, the patient's clinical and serological

response to treatment with corticosteroids and the return of symptoms on withdrawal was deemed consistent with the diagnosis of vasculitis. Taken together, a secondary infection of a pre-existing aneurysm following diagnosis of LVV is most probable.

Infected aneurysms are rare (0.7–3% of all aortic aneurysms), and of those, secondary infection of a pre-existing aneurysm represents only 3%.⁵ In this case, the cut finger was a potential source of bacteraemia, with secondary infection of a vulnerable region of the vasculature promoted by immunosuppression. Tailored safety netting advice given to this patient regarding potential seeding events and awareness of how a symptomatic aneurysm may present (including pyrexia and dull pain corresponding to the affected vessel) may have expedited contact with healthcare services and recognition of an infected aneurysm.^{5,6}

Perioperative antibiotic prophylaxis was given within 60 minutes prior to surgery, in line with the Enhanced Recovery After Surgery (ERAS) Society and Society for Vascular Surgery (SVS) recommendation for open aortic surgery.⁷ Although there are no specific recommendations for perioperative antibiotic prophylaxis in patients with active LVV over the general population, flucloxacillin was given alongside gentamicin to provide additional Gram-positive cover, as per the advice of the local microbiology team.^{4,7,8} As an alternative, the 2006 systematic review cited for the ERAS/SVS recommendation suggests the addition of glycopeptide agents (vancomycin or teicoplanin) if there is a high local prevalence of antibiotic resistance or pre-existing infection, which may be appropriate if methicillin-resistant *Staphylococcus aureus* is suspected or isolated from intraoperative cultures.^{9–11} ERAS and SVS also recommend intraoperative re-dosing within two serum half-lives of the antibiotic agent(s) used, which was not required in this case.⁷

Both silver-coated grafts and rifampicin-soaked grafts have been used for repair of infective aneurysms. While rifampicin-soaked grafts are often used to reduce the greater risk of infection associated with synthetic grafts versus biological conduits, there is *in vitro* evidence to suggest that silver grafts (with or without the addition of triclosan) show superior bactericidal activity and reduced rates of bacterial resistance compared with rifampicin grafts.¹² Notably, silver-coated Dacron grafts have been reported to be comparable to cryopreserved arterial homografts in terms of early and mid-term survival when used to treat abdominal aortic infection (with positive intraoperative microbiologic specimens), although two out of 11 patients who received the silver graft developed graft reinfection compared with none of 22 patients in the homograft group.¹³ More recently, a retrospective clinical study of 71 patients with additional risk factors for infection undergoing AAA repair, including four cases suspicious for mycotic aneurysm, reported that silver grafts had a promisingly low incidence (4.2%) of graft infection.¹⁴ Thus, silver-coated vascular grafts might offer an appropriate alternative where a biological graft is not available.

Furthermore, the potential effect of corticosteroids on aneurysms remains not well understood: multiple case studies have

KEY MESSAGES

- A high index of suspicion of aneurysm infection should be maintained in patients with active large vessel vasculitis and a symptomatic aneurysm.
- Management of vascular infection on a background of active vasculitis disease requires careful MDT discussion and monitoring of both disease processes.
- Tailored cardiovascular risk assessment and management plan may be important in a new diagnosis large vessel vasculitis.

reported rapid expansion and spontaneous rupture of AAAs following initiation of immunosuppression, including steroids and chemotherapy.^{15,16} Following a paper by Lindholdt *et al* in 2000, which reported the mean annual expansion of AAAs to be 1.8-fold higher in COPD patients treated with oral steroids compared with those who were not, a 2017 Japanese study reported steroid use to be an independent risk factor for AAA expansion.^{17,18} Furthermore, a recent population-based cohort analysis investigating cardiovascular risk with steroid use noted a hazard ratio of 1.84 (95% CI 0.30 to 11.32) for the occurrence of AAA in patients diagnosed with vasculitis taking steroid doses equivalent to <5 mg daily oral prednisone, increasing to 3.47 (95% CI 0.79 to 15.22) for doses equivalent to 15–24.9 mg daily prednisone.¹⁹ It should be noted that no association between immunosuppressant drugs prescribed for non-transplant pathology was found in a subsequent paper published in 2022.²⁰

Conclusion

At the time of writing, there are no guidelines for the management of patients with both active LVV and an infected aneurysm. This case highlights potential risks associated with high-dose steroid therapy, arguing for prompt recognition and treatment of potential infection in these patients. Management of symptomatic aneurysms in immunosuppressed patients should carry a high index of suspicion for an infected aneurysm, for which use of either a biological or silver-coated vascular graft may be most appropriate. Careful monitoring of both disease processes allowed tailoring of treatment to achieve a favourable outcome in this case.

Conflict of Interest: None.

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CASE REPORT

First reported case of successfully deploying the GORE Thoracic Branch Endoprosthesis under local anaesthesia

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Abstract

Thoracic endovascular aneurysm repair (TEVAR) is an effective treatment option for thoracic aortic penetrating atherosclerotic ulcers (PAU) in both elective and emergency situations. The benefits of TEVAR over open surgery include reduced morbidity, length of hospital stay and short-term mortality. The GORE Thoracic Branch Endoprosthesis (TBE) increases the breadth of pathology that can be treated entirely percutaneously by allowing zone 2 TEVAR with preservation of the left subclavian artery. As it is an off-the-shelf device, it can be used in urgent cases. We present the first TBE deployed for PAU under local anaesthesia in the UK.

Key words: endovascular procedures/methods; aorta, thoracic/ surgery; time factors; anesthesia/methods

Introduction

Guidelines recommend thoracic endovascular aneurysm repair (TEVAR) for complicated (refractory/recurrent pain) and large penetrating atherosclerotic ulcers (PAU)^{1,2} which may indicate a high risk of rupture.^{3,4} TEVAR is an established treatment for PAU. When a zone 2 TEVAR is performed, observational data suggest that left subclavian artery (SCA) revascularisation does not reduce neurological complications.⁵ However, when combined with long aortic coverage (>30 cm), left SCA revascularisation should be considered in an attempt to reduce the risk of spinal cord ischaemia.⁶ Custom-made devices are available but, due to manufacturing times, are unsuitable for urgent cases.⁷ The GORE Thoracic Branch Endoprosthesis (TBE) (WL Gore & Associates Inc, Flagstaff, Arizona, USA) is a

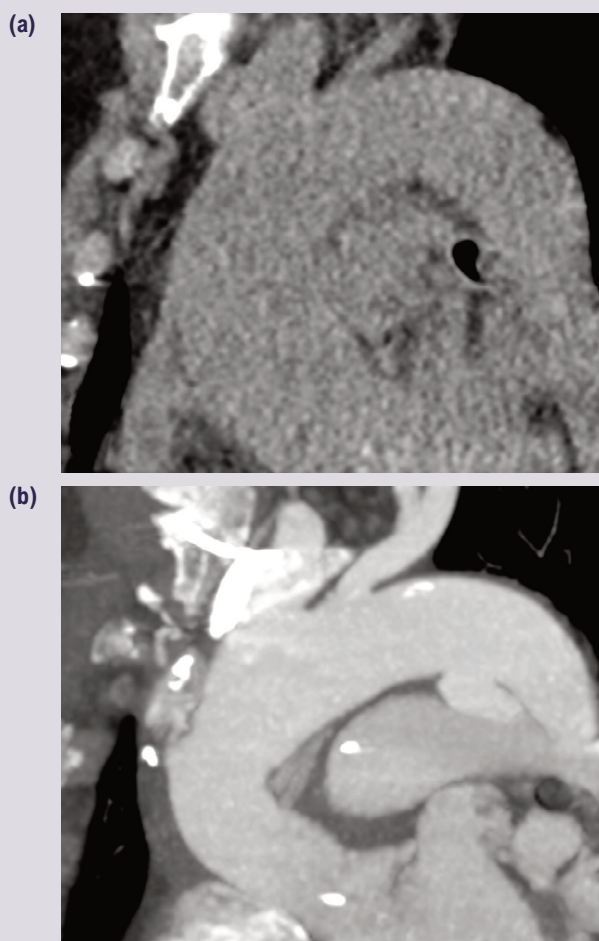
commercially available off-the-shelf device with a single retrograde side branch. Its Instructions For Use (IFU) currently define its indication being in zone 2 of the aorta. The first European implantation of the device occurred in early 2024 and the device launched in the UK later that year.⁸

Case report

A 58-year-old woman presented with chest pain radiating to the back 6 weeks after emergency ascending aortic and aortic valve replacement and a single coronary artery bypass graft for type A acute aortic syndrome with ascending aortic intramural haematoma and haemopericardium. Medical history included atrial fibrillation since the cardiothoracic surgery, chronic obstructive pulmonary disease, hypertension and Hartmann's procedure for perforated sigmoid diverticulitis 6 months previously. She smoked 10 cigarettes per day. The patient was morbidly obese (BMI 38), apyrexial and deconditioned since cardiothoracic surgery. All blood indices were normal, FEV₁/FVC ratio was 65% and left ventricular ejection fraction was 50–55%. Computed tomography (CT) demonstrated a new penetrating atherosclerotic ulcer (PAU) on the underside of the aortic arch. After CT and following discussion with the patient, she was transferred to our vascular unit.

The PAU was a new finding (not present on the original CT scan 15 weeks earlier) with a depth of 10 mm and width of 21 mm. It was an isolated lesion, located 15 mm beyond the origin of the left SCA. There were no clinical or laboratory signs of infection to suggest it may be mycotic. The two CT scans are shown in Figure 1. The aorta was maximally 29 mm between the left SCA and the left common carotid artery (CCA). Beyond the left SCA there was no aortic measurement above 26 mm. There was 16 mm of

Figure 1 (a) A non-contrast CT section through the aortic arch at the time of the acute type A intramural haematoma. The underside of the aortic arch is unremarkable. (b) A maximum intensity projection arterial CT angiogram section through the aortic arch at the time of re-presentation with chest pain. A penetrating atherosclerotic ulcer is seen on the underside of the arch, 15 mm distal to the left subclavian artery.



length between the middle of the left SCA and the proximal left CCA. The calibre of the left SCA was 10 mm. These measurements were suitable for a 31 mm TBE device with an 8 mm portal.

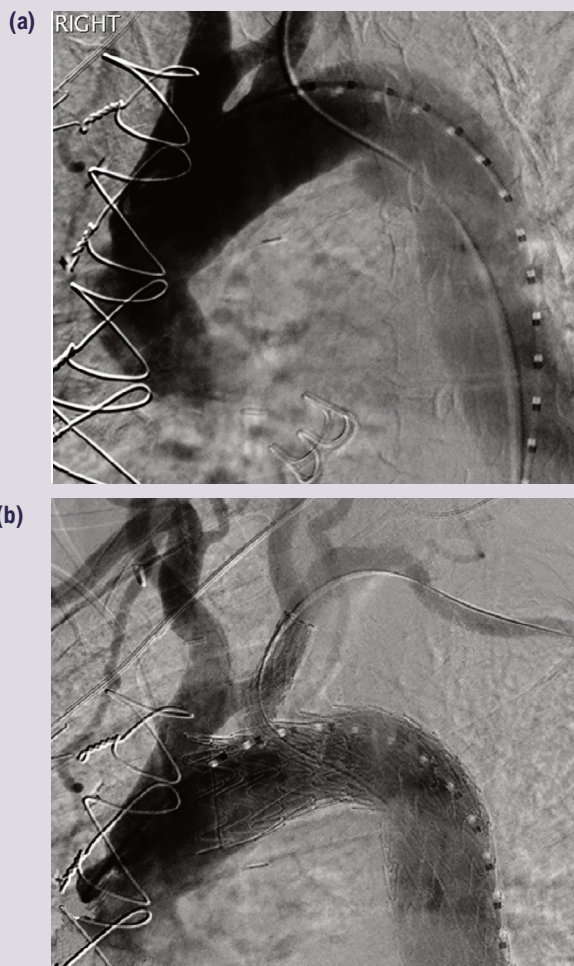
A labetalol infusion was commenced for blood pressure control and nicardipine was added over the first night. The patient was brought to theatre and positioned with the left arm out for access. Flucloxacillin (2 g) was given as antibiotic prophylaxis. An equal mixture of 0.5% levobupivocaine and 1% lidocaine hydrochloride was used for local anaesthesia, 20 mL around the femoral artery and 3 mL around the brachial artery. This was augmented with a remifentanyl infusion commenced at a targeted plasma concentration of 0.7 ng/mL and increased to 1.4 ng/mL during the procedure. 3,000 International Units of heparin were given intravenously when the large femoral sheath was in place. The activated clotting time was not monitored.

The left common femoral artery was punctured under ultrasound guidance and we proceeded to perform 'pre-close' in our standard fashion. A 180 cm Bentson wire (Cook Medical, Bloomington, Indiana, USA) was inserted and the arteriotomy was then dilated with the 7 Fr dilator of a 7 Fr Radifocus Introducer II (Terumo, Tokyo, Japan). Two Perclose ProStyle Suture-Mediated Closure and Repair Systems (Abbott Cardiovascular, Plymouth, Minnesota, USA) were deployed in turn and the 7 Fr sheath was then inserted. A Vanschie 1 Beacon Tip Angiographic Catheter (Cook Medical) was passed over the wire and that wire was then exchanged for a 300 cm Lunderquist Extra-Stiff Double-Curved Wire Guide (Cook Medical) which was advanced to the aortic valve. The 7 Fr sheath was then removed and replaced with a 20 Fr 33 cm DRYSEAL Flex Introducer Sheath (WL Gore & Associates Inc) which was hubbed at the skin.

During the pre-close steps, a second operator punctured the left brachial artery under ultrasound guidance. A 5 Fr Radifocus Introducer II was inserted over the Bentson wire until it was in the aortic arch. Our standard technique to access the descending aorta from the left subclavian is to pass a 5 Fr TEMPO Pigtail catheter (Cordis, Miami Lakes, Florida, USA) over the Bentson wire until the pigtail is in the aortic arch. The pigtail can then be torqued to face the descending aorta. When the Bentson is re-advanced through the pigtail, it begins to uncurl towards the descending aorta as the 7 cm floppy tip of the wire passes around it. The tip of the Bentson forms a large 'J'-shaped leading edge and, when the stiff portion of the wire begins to push through the pigtail, the wire and catheter often prolapse down the descending aorta. When sufficient wire has progressed down the aorta, the catheter can be tracked over it. This series of steps occurred with ease in this case. Next we passed a 260 cm Radifocus Guide Wire M Standard Type (Terumo, Tokyo, Japan) down the descending aorta to the level of the top of the DRYSEAL sheath. Parallel to the Lunderquist wire, a 6 Fr 30 mm ONE Snare Endovascular Snare System (Merit Medical Systems, South Jordan, Utah, USA) was passed through the adjustable valve of the DRYSEAL sheath and the Terumo wire was quickly snared, giving through-and-through access between the left femoral and left brachial arteries.

Angled angiography was performed to delineate the left SCA. A 31 mm calibre TBE with an 8 mm internal portal was inserted over the Lunderquist and Terumo wires and advanced to line up the portal markers with the SCA. There was mild wire wrap which was relieved using the simple measure of retracting the device to the descending aorta, turning it and re-advancing it. This was only required once. With the TBE in place, it was deployed by one operator while the second operator fixed the delivery system at the hub of the DRYSEAL sheath. A 12 mm calibre, 60 mm length side branch component was then inserted from the femoral side of the Terumo wire while the Vanschie catheter was inserted from the brachial side of the Terumo wire. With these two devices tip-to-tip, the side branch component was advanced into the portal and then the SCA and deployed. A 10 x 20 mm Advance 35LP Low-Profile

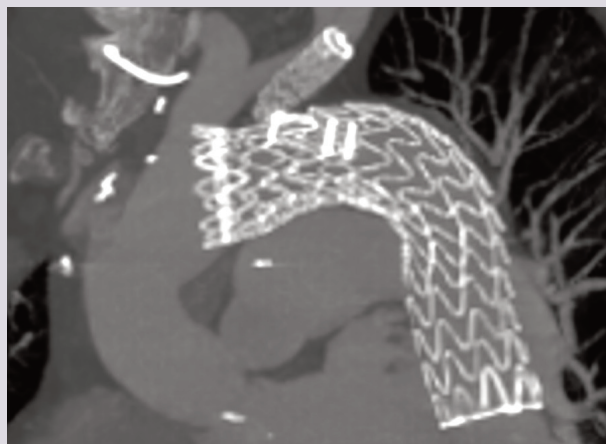
Figure 2 (a) Catheter angiogram of the aortic arch showing wire in the left subclavian artery and penetrating atherosclerotic ulcer on the underside of the arch. (b) Catheter angiogram after deployment of the GORE Thoracic Branch Endoprosthesis and side branch component showing preserved flow in the left subclavian artery and excluded penetrating atherosclerotic ulcer.



PTA Balloon Dilatation Catheter (Cook Medical) was advanced from the femoral access. The portal overlap was ballooned first, then the distal end of the side branch component, then the middle, as per the manufacturer's recommendations. No ballooning of the TBE was performed. Angiography was repeated, confirming exclusion of the PAU and patency of the left SCA branch. Pre- and post-deployment angiograms are shown in Figure 2. The anaesthetic chart records the procedure as commencing at 11:55 and finishing at 12:50.

The day after the procedure the patient experienced new back pain and a CT scan was performed. Back pain after TEVAR is common and there was no cause for concern on the CT. It confirmed the exclusion of the PAU with no endoleak and good side branch flow. An image from the CT scan is shown in Figure 3. Both the pain that caused the admission and the post-procedure back

Figure 3 A maximum intensity projection arterial CT angiogram section through the aortic arch one day after insertion of the GORE Thoracic Branch Endoprosthesis showing preserved flow in the left subclavian artery and excluded penetrating atherosclerotic ulcer.



pain settled quickly. The anti-hypertensive medication was switched to oral one day after the procedure. The patient was discharged home four days after the TBE.

Discussion

For a symptomatic co-morbid patient with a complicated PAU, TEVAR is the preferred treatment option. TEVAR is achievable under local anaesthesia and is often standard practice.⁹ To achieve adequate seal as per the manufacturer's IFU, the left SCA would have been covered. In a deconditioned co-morbid patient, local anaesthesia is preferable to general anaesthesia and, in the context of TEVAR, allows early assessment for spinal cord ischaemia.¹ The TBE device allows endovascular preservation of the left SCA, but it is a more complex procedure than TEVAR and we demonstrate it is feasible under local anaesthesia.

Two key areas for success in local anaesthetic aortic cases are procedural efficiency and the correct choice of medication. Procedural efficiency includes ensuring the ready prepared availability of all devices, catheters, sheaths, etc. Multiple experienced operators helps in this regard. Regarding medication, remifentanyl infusion, occasionally augmented with small doses of benzodiazepines, appears to be superior to a low-dose propofol infusion in maintaining a predictable degree of sedation and avoiding patient agitation. Using the Minto model for achieving stable plasma concentrations of remifentanyl, we have found we can perform most endovascular aneurysm repairs (EVAR), TEVAR and complex EVAR with similar doses to those used in this procedure, and little other medication.⁹⁻¹¹

The manufacturer's IFU suggests a 22 Fr sheath should be required for a TBE of 31 mm calibre. Since the device has become widely used, it has quickly become apparent that a single down-

KEY MESSAGES

- The GORE Thoracic Branch Endoprosthesis (TBE) can be safely and effectively deployed under local anaesthesia.
- TBE offers an off-the-shelf solution for zone 2 aortic disease with left subclavian artery preservation, expanding urgent treatment options without requiring general anaesthesia.
- Local anaesthesia with remifentanyl infusion and procedural efficiency can reduce patient risk and facilitate recovery, particularly in deconditioned or co-morbid patients.

sizing of sheath size is achievable with most TBE devices, as we did here. It must be noted that, while a TBE can usually be advanced into a sheath one size smaller than stated in the IFU, it cannot be retracted back out of that size sheath. Once the device is inserted, you are committed to deploying it. Another tip described in the literature is that a 5 Fr catheter or a guide sheath can be advanced from the brachial or radial access to effectively 'dock' with the side branch component, which helps it track through the portal into the left SCA.¹²

Compared to the TAG Conformable Thoracic Stent Graft with ACTIVE CONTROL System (cTAG) (WL Gore & Associates Inc), the TBE lacks some desirable features. The asymmetrical nose cone of the cTAG which orientates the outer aspect of the cTAG to the outer curve of the aortic arch is missing. However, the through-and-through left SCA wire usually assists with this orientation. There is no active angulation control to minimise 'bird-beaking' on the inner curve. The initial deployment of the TBE is a complete deployment, as opposed to cTAG which initially opens to 50% of its full calibre. Despite these differences, TBE remains relatively easy to use and reliable to deploy.

Both the USA and the European IFUs for TBE state that it is indicated for use in zone 2 of the aorta. However, it is licensed for use in zones 0 and 1 in the USA and reports of its use in these zones are encouraging.^{13,14}

Conclusion

TBE offers an off-the-shelf solution to a broader range of acute aortic syndromes than standard TEVAR and it preserves the left SCA. Despite the added complexity of a side branch, the procedure can still be performed successfully under local anaesthesia.

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ROULEAUX CLUB ANNUAL ESSAY COMPETITION

Rouleaux Club Winning Essays 2024

The Rouleaux Club run an annual essay competition to help promote interest in vascular surgery. Entrants are asked to write 1,500 words on one of three topics selected by the RC Executive. The essays are marked by the committee and the prizes are awarded to the best essay at the annual Vascular Society meeting. There are two prize categories, one for medical students and another for junior doctors. Below is the winning student essay. The doctor essay was published in May 2025 issue.

STUDENT CATEGORY

Should vascular surgery trainees be allowed to sub-specialise during training?

Oladimeji John Abiodun, *University of Nottingham, 5th Year medical student*

Introduction

"The Vascular Surgeon" as a distinct entity, is a novel concept in the UK, only formalising in 2013, with the introduction of the specialty vascular training programme.¹ Following the conventional pathway, it takes a trainee a minimum of 8 years post foundation training to achieve the competencies required to become a vascular consultant.^{2,3} Initially encompassed within general surgery, the increased demand and expertise needed for vascular intervention brought about a need for separation.¹ A 20-year predictive study foresaw an increase in vascular procedures of 40.5% over a 20-year period, (2000-2020), with a 5.5.% increase in patients over 65, a group at high risk of vascular disease.^{4,5} Between the years 2000-2020 the number of patients requiring vascular surgical intervention were all predicted to show a percentage increase: claudication 35.4%, critical limb ischaemia 44.2%, carotid surgery 34.0%, abdominal aortic aneurysm 40.7%, acute limb ischaemia 45.0% and access surgery 27.4%.⁴ Despite the projected increase in vascular procedures,⁴ vascular surgery makes up one of the smaller surgical cohorts.⁶ Data published by the Royal College of Surgeons showed that in 2022 there were 9,724 consultant surgeons in the UK (Figure 1).⁶ Out of this population, there were only 292 vascular consultants and 192 trainees.⁶ As with most specialties within the NHS, there is an evident need for more vascular trainees.⁷

The ever-expanding nature of surgery meant that the dawn of independent vascular consultants was inevitably followed by the need for sub-specialisation within vascular surgery. The current system takes a vascular trainee through each aspect of vascular and endovascular surgery.^{3,8} Upon completion, a consultant is able to home in on a specific domain within the field should they choose to do so. This includes, but is not limited to trauma surgery, endovascular aortic surgery, access surgery, venous and endovenous training, thoracic outlet specialist & sarcoma specialist.^{9,10} The drive towards sub-specialisation is not unique to the UK, for example 70% of General surgery residents in the United States

Figure 1 Number of surgical: consultants, specialist and associate specialist doctor, locally employed doctors in the UK, Arranged by specialty, for 2022. From the Royal College of Surgeons 2023 UK surgical workforce census report.⁶

Specialty	Consultants	SAS / LEDs	Trainees
Cardiothoracic surgery	439	378	169
General surgery	2,715	2,227	2,995
Neurosurgery	386	346	232
Oral and Maxillofacial surgery	343	923	121
Otolaryngology (ENT surgery)	824	615	672
Paediatric surgery	215	143	127
Plastic Surgery	608	422	395
Trauma & Orthopaedics	2,840	2,239	1,899
Urology	1,062	656	669
Vascular surgery	292	122	192
Total	9,724	8,071	7,471

pursue further specialist training after completion of their general surgery programmes.^{11,12} This begs the question, is there a need to delay the commencement of a trainees sub-specialist training & how could early sub-specialisation impact outcomes for patients and doctors?

Benefit to the doctor

Examination of the literature shows that early specialisation can lead to perceived improvement in lifestyle, job security, added independence and financial recompense.^{11,13,14} Furthermore, there is a growing appetite for surgical trainees to achieve stability earlier in their careers, an eagerness amongst some trainees for the length of training to decrease, and a desire to sub-specialise during training.^{6,15,16} Early specialisation could help combat the growing levels of burnout recorded amongst trainees.^{15,16} Whilst fears that early differentiation of trainees can lead to an asymmetrical skillset for the future consultants, this may not be entirely the case. A 2002 – 2017 analysis of case logs for 231 orthopaedic trainees found that residents who chose spine surgery (108.4 ± 50.7 vs 74.4 ± 60.2 ,

$p < .01$), hand surgery (242.2 ± 92.9 vs 194.3 ± 78.2 , $p < .01$), and sports medicine (278.5 ± 105.8 vs 229.0 ± 93.9 , $p < .01$) performed more procedures in their chosen fields than their colleagues. However, for total joint arthroplasty ($p = .18$) and foot and ankle surgery ($p = .46$), there was no significant difference in the number of cases between residents who chose the sub-specialty and those who did not.¹⁷ Whilst this study is limited in its range of specialities analysed, it does indicate that if properly structured, trainees are able to sub-specialise and still retain an appropriate breadth of surgical exposure.

Benefit to the patient

A small study on the effect of a surgeon's seniority and subspecialty interest on mortality, found that surgery carried out by a surgeon without subspecialty interest related to the pathology was associated with a higher risk of postoperative mortality compared with a surgeon with subspecialty interest (OR: 1.38, $p < 0.00001$).¹⁸ A systematic literature review of 22 studies and 144,241 patients found in 91% of cases, specialist surgeons had significantly better outcomes when compared to general surgeons performing the same procedure.¹⁹ This was quantified with a lower mortality rate in 11 of 12 studies (92%), shorter hospital stay in five of five studies and fewer complication rates in 14 of 17 studies (82%) (Figure 2). This favours the notion that allowing trainees to subspecialise earlier, would increase the pool of effective clinicians best suited to treat specific caseloads. Furthermore, a study into procedural specialisation showed mortality following abdominal aortic aneurysm repairs were lowest when carried out by vascular specialists (2.2%) compared to cardiac (4.0%) and general surgeons (5.5%, $p < 0.001$) (Figure 3).²⁰ This principle could then be extrapolated further for sub-specialisation within vascular surgery, where a trainee specialising in major trauma will be better suited to

Figure 2 Histogram Illustrating the effect of specialization on outcome, as measured by overall outcome, mortality, length of hospital stay and complication rate for specialist surgeons compared with general surgeons.¹⁹

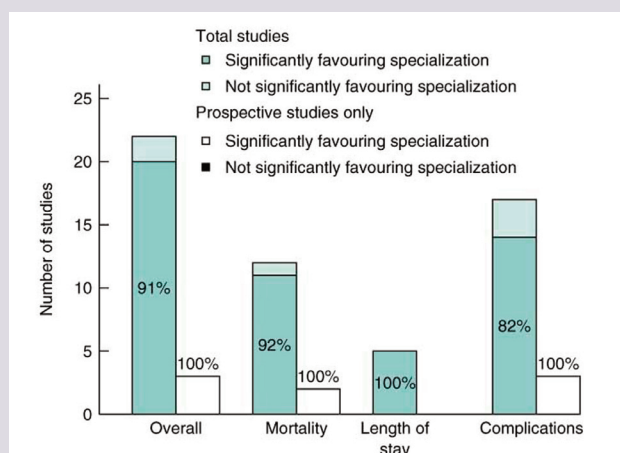
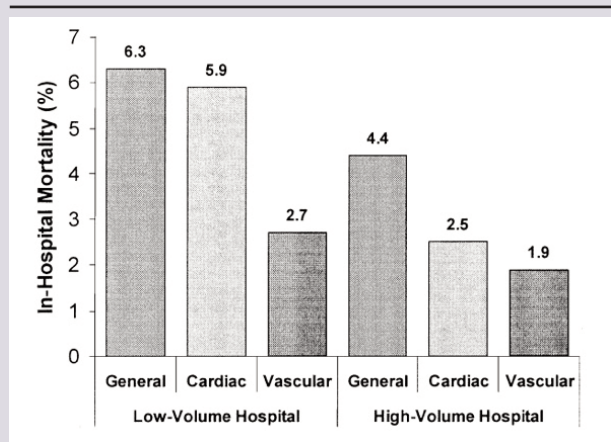


Figure 3 In-hospital mortality according to surgeon specialty at high volume hospitals and low volume hospitals in the United States. Vascular specialisation is associated with significantly lower mortality rate compared with general surgeons at both high volume and low volume hospitals ($p < .05$). In addition, vascular specialisation is associated with lower mortality compared with general surgeons at high volume hospitals ($p < .05$).²⁰

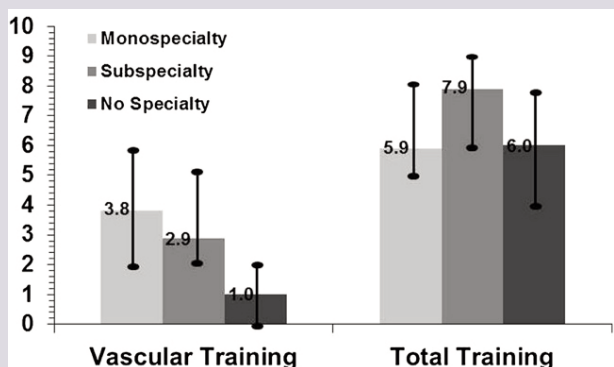


deal with, for example, a road-traffic accident, opposed to one focused primarily on endovascular techniques. It appears logical to infer from some literature that earlier sub specialisation could contribute to better patient outcomes.

Negatives to the doctor

It is well established that theatre time amongst trainees has diminished significantly since the start of the 21st century, as much as 50% in some cases, and there is significant variation in the opportunity for trainees to carry out basic procedures.²¹⁻²³ While new methods such as simulation – based medical training have shown to help prevent the decay of surgical skills,^{21,24} a systematic literature review by Higgins *et al* showed there are currently no substitutes comparable to “time in theatre developing surgical skills”.²¹ The UK has one of the longest training times for vascular surgeons across Europe,²⁵ and in instances where vascular surgery is a subspecialty, average training times are almost 2 years longer.²⁵ Studies also show that countries who view vascular surgery as a sub-specialty, have longer over all training times compared to those who don't (Figure 4).²⁵ It could be argued that further sub-specialisation would increase the years needed to achieve the necessary core surgical and specialist skills. Increased training time may deter trainees, as years taken to complete training is a key component of dissatisfaction in current doctors within surgery and medicine.^{6,15} Continuous sub-specialisation also narrows the working range for doctors, and may lead to them becoming less confident with their basic competencies in areas outside of their established scope of practise.²⁶ This was one of the factors contributing to vascular surgery becoming distinct from general breast and gastrointestinal surgeons.^{1,27}

Figure 4 Mean duration of total years of training is significantly longer for subspecialty certification models compared with mono-specialty (7.9 vs. 5.9 years, $p < .001$) or no specialty models (7.9 vs. 6.0 years, $p = .014$).²⁵



Negatives to the patient

Over specialisation can lead to de skilling of a surgeons general skills, which may be most acutely felt when providing care for patients in the emergency setting.²⁸ A recent evaluation of 1554 emergency cases, found 30% of 357 patients requiring complex operations, had their care overseen by a consultant whose subspecialty did not closely match their case.²⁸ It should be noted 72% of these cases happened out of hours and only 18% had the consultant scrubbed and in theatre. However, there are already shortages in surgeon numbers,²⁹⁻³¹ and the added complexity of matching suitable specialist trainees and consultants to ambiguous emergency and general cases, could mean more instances of sub-optimal patient care. Looking across medicine we see several articles warning about the devolution of the generalist and enabling early entry into specialist pathways before adequate exposure to a breadth of disciplines, can risk inappropriate patient diagnosis and referrals.³²⁻³⁴ Whilst the association may seem clear, there are limited large scale randomised controlled studies affirming that an increased level of sub specialisation results in improved clinical outcomes.

Conclusion

More research is needed to make conclusive statements about the benefit of early subspecialisation on patient care within vascular surgery. Having explored the potential positives and pitfalls, I believe trainees should be given the option to sub-specialise from the start of training, but not the requirement to. This provides flexibility for trainees who will inevitably differ based on personal circumstance. Most importantly, as with all medicine, the patient should be at the forefront of all decisions made.

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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.

British Society of Interventional Radiology (BSIR)

www.bsir.org
[@BSIR_News](#)



The BSIR Executive Officers are receiving valuable input in to the BSIR long term strategy through the regional roadshow which has taken place in the past few months, and which will continue in to next year. These sessions at regional meetings have been designed to engage the membership in the strategy content and gather their feedback and ideas. The strategy can be found here <https://www.bsir.org/society/our-strategy/>

The BSIR Paediatrics UK Annual Meeting took place on Monday 19th May in Birmingham. A successful and well attended meeting, highlights included hot topics such as hepatobiliary intervention, interventional oncology and vascular access. For the first time, the 2025 meeting included a dedicated session for allied health professionals, focussed on the challenges and regards of working in PIR as a nurse or radiographer.

The BSIR Interventional Oncology UK meeting took place on 19th-20th June at the Leonardo Tower Bridge in London. With record number of attendees for this event (over 180 onsite), the programme for IOUK focussed on cutting-edge treatments for Liver, Lung, Renal, Bone, and Soft Tissue cancers, and included a guest lecture from Dr David Breen celebrating 10 years of IOUK. Trainee focussed sessions ran in parallel to the main programme across both days.

IOUK was preceded on 18th June by the launch of Interventional Oncology Network for Research and Innovation Collaboration (IONIC-UK) sponsored by the National Institute for Health and Social Care Research (NIHR), and convened by Professor Tze Wah. This workshop focused on research and innovation in interventional oncology (IO), understanding research methodology in IO clinical trials, building a clinical infrastructure around IO and why Patient and Public Involvement, Engagement and Participation (PPIEP) and Equality, Diversity and Inclusion (EDI) are important in research and innovation.

The first BSIR Registrar Study Day took place virtually on 25th June, attracting over 50 attendees online. This event focussed on mastering the MDT with practical tips and insights to support procedural planning and clinical decision-making. Programme highlights included aortic interventions, embolisation, PAD and venous access techniques, dialysis fistula interventions, and career development sessions focussed on fellowships and maximising training opportunities.

Registration is open for BSIR 2025 in Liverpool on 11th-13th November. Join us to explore the latest innovations and protocols in IR designed to mitigate risks and ensure the highest standards of care for patients. Early Bird Fees are available until 11th September 2025. BSIR Members can access discounted registration. Applications for Educational Grants, Essay Scholarships and Case Study Awards are now closed. An overview of the programme can be found at: www.bsirmeeting.org.

You can find out more about upcoming BSIR events and activities on the BSIR website www.bsir.org

Rouleaux Club

www.Rouleauxclub.com
[@RouleauxClub](#)



Our BSET and National Vascular Training Day reps helped organise another fantastic course, held at Tortworth Court Hotel in June. The Joint Rouleaux and BSIRT session the following day was insightful and well received, covering the topics of AI in endovascular interventions and collaborative working between vascular surgery and interventional radiology.

Turning our attention to the run up to VSASM, we have received a good number of high quality, fascinating video abstracts for the MDT session. We currently have the difficult but enjoyable task of scoring these, hopefully curating an interesting session for surgeons of every stage, from aspiring to experienced.

Submissions for the second year of the Averil Mansfield prize surpassed the strong numbers we received last year; 48 submissions were received, nominating 36 candidates. We will be interviewing the top four nominees, along with VS representation, in the coming days.

Planning, support and sponsorship etc is underway for the Introduction to Vascular Surgery Course, an annual highlight, held on the Wednesday of VS ASM.

We have selected our three essay titles for the annual essay competition for both medical students and resident doctors (pre SPR level) and submissions are now open. The winner from each category has their essay published in JVSGBI and entrants receive free entry to the above course.

Dates for the Rouleaux Club and RCSEd Vascular Surgery Specialty Board's course "So you think you want to be a vascular surgeon?" have been announced-October 25th in Birmingham and April 25th 2026 in Edinburgh.

Please do encourage any junior members of your team to take advantage of the range of opportunities above.

*Lauren Sheldermine
President*

Vascular Anaesthesia Society of Great Britain & Ireland (VASGBI)
www.vasgbi.com
[@vasgbi](https://twitter.com/vasgbi)



The raison d'être of the Vascular Anaesthesia Society of Great Britain and Ireland (VASGBI) is to promote excellence in the peri-operative and anaesthetic care of patients undergoing vascular surgery. Our flagship conference where best practice is shared and recent research and quality improvement in vascular anaesthesia is presented is coming up next month. The VASGBI ASM 2025 will take place in London at the Royal Society of Medicine on 15th and 16th September. The programme is finalised and is available on the VASGBI website **VASGBI 2025 Programme**. The programme is varied as ever, with input from many members of the vascular surgery multi-disciplinary team.

Abstract submission has closed and residents have been invited to present their work. The top scoring abstracts will be presented orally and will be published in the JVSGBI in due course.

Members of the VASGBI committee have been working with the Royal College of Anaesthetists to produce Quality Improvement guidance for undertaking projects related to vascular surgery and anaesthesia. The webpages are due to go live in December 2025. Multidisciplinary engagement in quality improvement of services is key to overall success

Does your hospital have a VASGBI linkman representative? Our aim is to have a linkperson in every hospital to aid 2-way communication between the VASGBI and all anaesthetic departments involved in providing anaesthetic services for vascular surgery. You can check if your hospital has a linkperson via the link, and if not, get in touch [vasgbi-linkpersons.pdf](#)

We have recently updated the clinical guidelines area of our website; if you are interested in any of our clinical guidelines or have recently produced a guideline which you think others may find useful please get in touch via our administrator Jane Heppenstall jane.heppenstall@vasgbi.com

Peri-operative pain control is something most readers will be interested in. We are currently undertaking a survey to investigate the current national picture related to analgesic strategies in aortic surgery. We would be very grateful to if you would share your experiences and opinions, you can click on the link **Open Aortic Surgery Analgesia Survey** or go to the homepage of our website www.VASGBI.com to complete the survey. Completion only takes a few minutes, but you will need to have a rough idea of the number of open repairs performed on an annual basis in your hospital. As ever, if you have a survey you would like to distribute to our members, please get in touch to discuss.

Do you have a research or QI initiative that requires some funding to get started? VASGBI offer small grants which can be applied for via the NIAA website **VASGBI Trainee Development Grant — National Institute of Academic Anaesthesia** Applications for trainee grants are currently open: the closing date is noon on 26th September 2025.

This year a few of our longstanding VASGBI committee members are due to demit, we are very grateful for the many significant contributions made by Gary Matthews (past treasurer), Ronelle Mouton (past chair) and Manik Chandra (linkman co-ordinator). We welcome three new full committee members and one new trainee representative.

The Vascular and Endovascular Research Network (VERN)
www.vascular-research.net
[@VascResearchNet](https://twitter.com/VascResearchNet)



VERN have been busy over the summer in supporting the closing stages of the BLAST and ARMIES studies. The BLAST study, coordinated by committee member Paris Cai, examines blood loss, anaemia, and haemostasis in vascular surgery and is in the final stages of data validation before analysis may begin. Similarly, committee member Tamer El-Sayed leads on ARMIES in the data validation phase – the results of this study on acute upper limb ischaemia will be welcomed with open arms.

SIMBA-T was launched earlier this year and has seen great success in site recruitment. The study explores surgical site infection and in trans-metatarsal amputations, following on from the SIMBA study which focussed on major lower limb amputations. Thank you to all the collaborators who are contributing to this study.

Earlier in the year, VERN welcomed a new committee member to fulfil the role of Allied Health Professional representative. We are excited to bring you new projects that focus on collaboration between professional groups in the near future.

We are grateful to all who have contributed to previous projects and are continuing to support collaborative research within vascular surgery - thank you! We look forward to meeting everyone again at the Vascular Societies' Annual Scientific Meeting this year in Hull. For updates, please visit the website (www.vascular-research.net) and follow us on X ([@VascResearchNet](https://twitter.com/VascResearchNet)) – please keep an eye out for details concerning this year's Dragon's Den competition which will be announced soon!!

*Brenig Gwilym
VERN President*

Reviewer acknowledgement (Volume 4)

As we come to the end of our fourth year of publication and our sixteenth issue of *JVSGBI*, we would like to thank our reviewers for taking the necessary time and effort to review the manuscripts published in Volume 4. We appreciate their valuable comments and suggestions, which have helped us to improve the quality of the articles we have published online at www.jvsgbi.com



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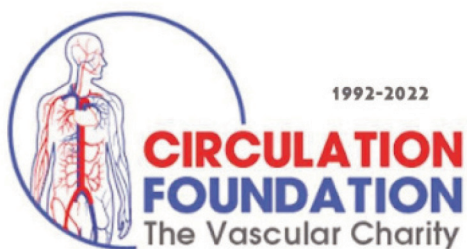
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Anyone interested in joining our team of reviewers, please email your name, place of work and your area of expertise to: editorialoffice@jvsgbi.com

A full list of reviewers, including those who helped with the review of articles that didn't make publication, can be found online at: <https://jvsgbi.com/authors/jvsgbi-reviewers/>



Raising **awareness** for **vascular disease** by walking the **circulatory system** of the body

JOIN US this September 2025 for Vascular Awareness Month

Aiming to collectively achieve the 60,000 miles of the whole circulatory system of the body

Reasons we would like you to fundraise are:

- To support vital research in to vascular disease
- To support individuals living with vascular disease
- To raise the awareness of the impact vascular disease has

We would love to see your walking, swimming, running, riding pictures on social media, and share them across our platforms.

Please tag in our social media accounts across Facebook, Twitter and Instagram and use the hashtag for this event: #TheBodyWalk

Thanks to everyone supporting the Circulation Foundation



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The Vascular Societies' Annual Scientific Meeting 2025

In conjunction with the Vascular Society of Great Britain and Ireland, the British Association of Chartered Physiotherapists in Limb Absence Rehabilitation, the Society of Vascular Nurses and The College and Society for Clinical Vascular Science Great Britain and Ireland

26th-28th November 2025

Connexin Live, Hull

SAVE THE DATE!

connexin
LIVE

The conference is a three day programme which showcases a wealth of topics for everyone across the spectrum of the vascular field and is a great opportunity to meet and network with the vascular community who share their enthusiasm for best practice and care of patients including consultants, vascular scientist, nurses and physiotherapists

www.vascularsociety.org.uk

The UK event for the whole vascular care team in 2025

