Volume 3 Issue 4 August 2024

Journal of VASCULAR SOCIETIES GREAT BRITAIN & IRELAND

ISSN 2754-0030

The journal is owned by the Vascular Society for Great Britain and Ireland (VSGBI)

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ADDRESS FOR CORRESPONDENCE:
Journal of Vascular Societies GB&I
c/o Executive Business Support
Davidson Rd
Lichfield
WS14 9DZ

ARTICLE SUBMISSIONS AND GENERAL ENQUIRIES PLEASE EMAIL:
Editorialoffice@jvsgbi.com

ADVERTISING AND SALES ENQUIRIES PLEASE EMAIL:
info@jvsgbi.com

The *JVSGBI* is published online quarterly in Feb, May, August and November on the *JVSGBI* website. Articles, when finalised for publishing, will be published online, and then at the discretion of the Editor in Chief, included in the online issue and/or printed issue.

ISSN 2754-0022 (print)
ISSN 2754 0030 (online)

Produced by: Executive Business Support and Production 10 Limited

Printed on 100% recycled paper

JOURNAL OWNED AND PUBLISHED BY

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J.Vasc.Soc.G.B.Irel. 2024;3(4):189
http://doi.org/10.54522/jvsgbi.2024.145

www.jvsgbi.com

Editor's foreword

Welcome to the August 2024 edition of the *Journal of Vascular Societies Great Britain and Ireland (JVSGBI)*.

This edition contains an editorial review regarding the assessment and management of the not uncommon condition of blue toe syndrome. Then there are 2 high quality systematic reviews, the first evaluating the safety & efficacy of tranexamic acid in vascular surgery and the second assessing the incidence of surgical site infection following trans metatarsal amputation. Both are certainly worth reading.

Also contained in this issue are five original research papers evaluating such diverse topics as you tube quality of information on phantom limb pain, experience of rigid dressings for transtibial amputees, thoracic outlet decompression practices, investigation of variation in UK AAA management, and finally a qualitative study assessing simulation learning. It is great to see such a range of topics and research design.

This issue finally contains winning abstracts from the ASM 2023, Rouleaux club winning essays and updates from the affiliated societies.

I would again like to take this opportunity to thank authors for choosing the *JVSGBI*, reviewers for their time & effort reviewing submitted articles and the editorial team who work so hard behind the scenes to ensure each edition of *JVSGBI* is high quality and published on time.

Ian Chetter
Editor in Chief JVSGBI
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Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2024;3(4):190-193
http://doi.org/10.54522/jvsgbi.2024.142

www.jvsgbi.com

EDITORIAL

Blue toe syndrome

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Received: 22nd July 2024
Accepted: 21st August 2024
Online: 27th August 2024

Introduction

Blue toe syndrome (BTS) is not an uncommon referral, with vascular services often being the first port of call from primary care or the emergency department setting. It is a condition which is often overlooked, misdiagnosed or falsely labelled in the wider medical setting. Nevertheless, it warrants a thorough history, examination and assessment due to its potential implications.

BTS was first named by Karmody *et al* in 1976,[1,2] with the perceived pathophysiology being that of a vascular aetiology. As its name suggests, the basis of its presentation is the finding of blue or purple discolouration of one or more toes, in one or both feet, without a clearly recognised underlying factor.[3,4] It typically occurs in the absence of any oblivious trauma, cold-induced lesion or disorders that induce generalised cyanosis.[4]

Definition and theories

In simple terms, BTS is acute or subacute tissue ischaemia, due to the occlusion of the distal small vessels of the feet and toes, leading to the cyanotic blue appearance of the lower limb digits. In the formative years of its definition, its description included the "3 Ps" – sudden onset **P**ain, **P**urple discolouration (of toes or digits) and presence of **P**alpable peripheral pulses.[5]

BTS remains a condition which is characterised by the sudden onset of painful discoloured toes and often poses a diagnostic challenge for healthcare professionals. The discolouration ranges from subtle blue hues to dark purple as a result of the compromised blood flow to the extremities.

BTS is by nature a very distal vessel occlusive vasculopathy which can be categorised into three broad categories of pathology: decreased arterial flow, decreased venous flow or abnormal circulating blood (see Table 1).[4] The initial perceived notion was that it was due to a non-obstructive underlying arterial lesion, with subsequent embolisation from the lesion expaining the frequent presence of palpable peripheral arterial pulses despite the presence of digital ischaemia.[2,5] Whilst the condition is frequently associated with underlying atherosclerosis and can serve as a harbinger of systemic vascular diseases such as peripheral artery disease (PAD) or aneurysmal disease,[6] cyanosis of the digits may have several aetiologies ranging from trauma to connective tissue disease, but more commonly it is secondary to cholesterol crystal or atherothrombotic embolisation. Importantly, BTS is often an isolated finding and the sole clinical symptom manifestation of an underlying pathology. An extensive differential diagnosis should therefore be considered in a patient who has one or several blue toes with progressive and/or bilateral symptoms, and performing appropriate imaging tests early in patients with BTS is imperative in establishing a diagnosis.[7] An example is shown in Figure 1.

Clinical assessment

Following a thorough medical, social and family history-taking, an important factor often brushed over is the clinical assessment which is often limited to the lower limb. A more comprehensive multi-system examination can yield important clues to the underlying cause of BTS. Figure 2 highlights the importance of a thorough clinical examination at the time of first review in establishing a cause.

Investigation and diagnosis challenges

Blood tests

The initial investigation should include routine blood tests: full blood count is essential to detect

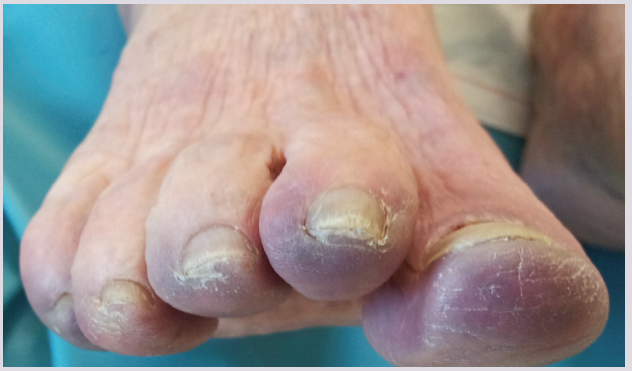
Key words: blue toe syndrome, thromboembolism, cholesterol crystals

Table 1 Causes of blue toe syndrome.

Decreased arterial flow
Embolism
Cholesterol emboli
Atheroemboli ("Trashing") – arrhythmia, central (ie, aortic) or peripheral (ie, popliteal) aneurysms
Cardiac vegetations – infective endocarditis, non-bacterial thrombotic endocarditis
Cardiac or aortic tumour – atrial myxoma, intimal aortic angiosarcoma
Thrombosis
Thrombophilia – antiphospholipid syndrome (most common)
Malignancy (paraneoplastic acral vascular syndrome)
SARS-CoV-2
Thrombotic thrombocytopenic purpura
Disseminated intravascular coagulation (ie, following acute pancreatitis, sepsis)
Warfarin skin necrosis
Infectious
Syphilis; Pyogenic infection
Non-infectious
Behcet's disease; Systemic sclerosis; Other forms of vasculitis
Other vascular occlusive conditions
Calcific vascuolopathy ('calciphylaxis')
Vasoconstrictive disorders
Raynaud's; Chilblain lupus erythematosus
Acrocyanosis; Medication-induced vasoconstriction
Perniosis; Dysautonomia
Decreased venous flow
Extensive venous thrombosis – leading to phlegmasia cerulea dolens with venous gangrene
Chronic venous disease
Dependent oedema
Abnormal blood circulation - hyperviscosity
Paraproteinaemia

Adapted from references 2, 4 and Tian C, Blue toe syndrome. DermNet 2018.

Figure 1 A 64-year-old female with a known history of systemic lupus erythematosus presented with acute onset of painful blue discolouration in the toes of her right foot. Clinical examination revealed diminished popliteal and right dorsal pedis and posterior tibial pulses, along with signs of livedo reticularis, indicative of an underlying vasculitis. Further investigations, including thrombophilia screen and inflammatory markers, confirmed a prothrombotic state secondary to her rheumatological condition, and the diagnosis of BTS.



anaemia, infection, inflammation and other haematological conditions that may, for example, affect blood viscosity (eg, polycythaemia); urea and electrolytes are important since vasculitides, lupus and renovascular disease can all impact on renal function; liver function tests can indicate blood clotting and metabolic abnormalities; a coagulation profile is useful to exclude abnormal clotting, which can contribute to embolic or thrombotic events; C-reactive protein is helpful to evaluate and monitor in acute or chronic inflammatory conditions and serum cholesterol levels are a risk factor for atherosclerosis, which is commonly associated with BTS.

If unwell, lactate levels may also be conducted to assess possible metabolic derangement in need of prompt management. Specialised tests in the form of erythrocyte sedimentation rate, thrombophilia and viral screens are typically not first line at the time of vascular assessment but may need to be considered.

Imaging

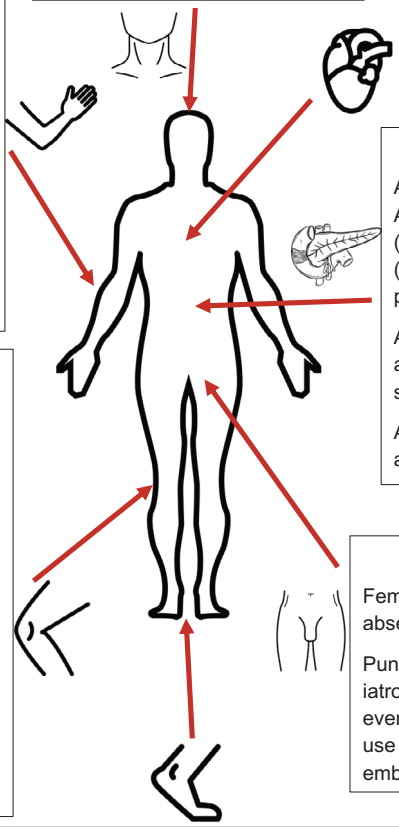
The largest investigative case series on BTS to date identified aneurysms and short-length severe stenotic arterial lesions as the culprit lesions in the majority of cases.[7] In addition, it also reported on the benefit of doppler ultrasound assessment of the arteries in the affected limb, including the aorta and iliac arteries, in establishing a diagnosis; this is therefore recommended as the first-line diagnostic examination.[7] Computed tomographic angiography of the aorta and lower limbs and, in some instances, catheter angiography may also be useful in determining a cause.

Beyond the conventional diagnostic methods used to assess arterial vessels, ensuring that there are no central embolic causes for the presentation is imperative, typically with CT aortography of the chest (looking for more proximal aneurysmal or atherosclerotic disease), echocardiogram (for cardio-embolic causes) and 24-ECG Holter (to exclude cardiac arrythmia), is recommended. These tools, when integrated into the diagnostic algorithm, contribute to a more comprehensive understanding of the disease, aiding a timely and accurate diagnosis.

It should be noted that one of the primary obstacles in managing BTS lies in its varied aetiology and clinical presentation,[4,6,8] and distinguishing between an embolic source, thrombotic occlusion and other potential causes requires a meticulous approach.

Table 1 highlights the primary vascular and secondary vascular causes. Discussion with the relevant specialties should be instigated to allow for a multidisciplinary team approach to patient care.

Figure 2 Systematic physical examination for a patient with blue toe syndrome.



Upper Limbs

Pulses – radial and brachial (if reduced consider proximal stenosis/occlusions or embolic source)

Peripheral perfusion – warmth, CRT, O2 saturations

Blood pressure – risk factor for PAD, discrepancy between both arms occurs in aortic dissection / proximal stenosis)

Hand changes – Osler's nodes, Janeway lesions & splinter haemorrhages (suggestive of infective endocarditis). Raynaud's (vasospasm). Tar staining (smoking being a risk factor for PAD)

Head & Neck

Neurological deficit - central source of emboli, vasculitis-associated neuropathy

Central cyanosis – cardiovascular or pulmonary pathology

Heart

Murmurs – patent foramen ovale (venous to arterial clot passage), valvular dysfunction, infective endocarditis (emboli)

ECG - arrythmias (thromboembolism)

Abdomen

Abdominal Masses - Aortic Aneurysms (emboli), malignancies (occlusive, prothrombotic)

Abdominal tenderness - abdominal causes sepsis (prothrombotic)

Abdominal bruit – atherosclerotic disease

Thigh/Leg

Popliteal pulse – present, reduced or absent (in PAD), aneurysmal (source of embolism)

Skin rash – livedo reticularis (disturbance of blood flow to skin), vasulitic rashes & ulcers (causes can be venous, arterial or due to systemic vasculitis)

Evidence of chronic venous disease – varicose veins (venous conjestion), oedema (compressive), skin changes lipomatodermatosclerosis,

Groins

Femoral pulse – present, absent or reduced (PAD)

Puncture sites/scars – iatrogenic (iatrogenic embolic events) / recreational drug use (foreign materials, embolic or infection)

Foot/Toes

Pulses – dorsalis pedis & posterior tibial arteries – present, reduced or absent)

Bedside doppler – absent, monophasic, biphasic & triphasic (consider emboli / PAD if abnormal)

Ankle Brachial Pressure / Toe Pressures (consider emboli / PAD)

Feet changes - ischaemia, necrosis, ulcers

Peripheral neuropathy/paraplegia – leading to dependent oedema

Management and implications

The management of BTS will be driven by the underlying pathophysiological cause and often demands a multidisciplinary approach. The goals of treatment are to alleviate symptoms, prevent further embolic events, and address the underlying vascular (or non-vascular) cause.

Prompt initiation of anticoagulant therapy is advocated in cases where thromboembolic events are suspected or have been confirmed. This may be in the form of therapeutic Low Molecular Weight Heparin, unfractionated intravenous heparin or a licensed oral anticoagulant. The duration and type of anticoagulation will be determined by the underlying cause.

Where an atheroembolic cause (cholesterol crystal emboli) is suspected, initiation of antiplatelet agents (clopidogrel or aspirin) with high-dose statin therapy is the typical course of treatment. Where events have occurred on a single antiplatelet, addition of a second may be considered. Secondary prevention of cardiovascular disease is vital with hypertension management, smoking cessation and glycaemic control of diabetics, in order to mitigate the risk of further thromboembolic events and enhance peripheral perfusion, particularly in those with likely advanced atherosclerotic disease.[9,10]

In cases where there is an identifiable source of emboli, whether cardiac or arterial, targeted interventions such as endovascular procedures or surgical revascularisation[1,6,8,11] may be warranted, although rare. The decision-making process requires careful consideration taking into consideration the patient's overall health, comorbidities and the extent of vascular involvement. However, when no obvious underlying vascular pathology or other named cause is found, antiplatelet therapy with monitoring could reasonably be offered.

Pain with BTS can be considerable and unrelenting, necessitating a systematic approach in accordance with the WHO pain ladder.[12,13] Initial pain assessment should involve evaluating the severity using a standard pain scale and identifying exacerbating

KEY MESSAGES

- Blue toe syndrome is a commonly encountered condition which often has a thromboembolic cause.
- It is characterised by pain and blue discolouration of the digits of one or more toes in one or both feet.
- Duplex imaging of the aorta and lower limb is a useful first-line investigation.

and relieving factors. For mild to moderate pain, the recommended approach includes paracetamol and non-steroidal anti-inflammatory drugs, if not contraindicated. In cases of severe pain, opioids such as morphine or oxycodone may be required with close monitoring, and adjuvant therapies like gabapentinoids can be considered for neuropathic pain.[14]

Systemic non-cardioselective vasodilators can improve blood flow and alleviate ischaemic pain including calcium channel blockers (eg, nifedipine) and are particularly useful for patients experiencing significant vasospasm.[15] Topical vasodilators (eg, glyceryltrinitrate ointment) can be applied to the affected areas to enhance local blood flow and reduce pain while minimising the systemic side effects associated with oral vasodilators.[15]

Additionally, iloprost, a prostacyclin analogue, can be administered intravenously to manage severe ischaemic pain, ulceration[16,17] and BTS.[18] Iloprost infusion significantly improves symptoms by enhancing microcirculation and reducing thrombotic events, particularly in cases of cholesterol emboli.[19] In instances where pain cannot be controlled, local anaesthetic blocks may be considered.[20]

Depending on the severity of the ischaemia, time to presentation and response to management, the toes may become non-viable. In these cases, surgical amputation should be considered.

The evolving landscape

The current literature on BTS is limited to case reports and case series. The mainstay of our understanding of the condition comes from clinical expertise passed on from generation to generation of vascular surgeon, with little changing in the overall body of literature and our understanding of BTS from 1975, when the condition was first recognised, to after 1985.

Conclusions

BTS is a complex vascular condition that requires a comprehensive and methodical approach, precise diagnosis and timely intervention. This article hopes not to offer an exhaustive list of possible underlying causes, but to offer a 'starting block' for assessing such patients when they present to vascular teams.

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

Funding: None.

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Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2024;3(4):194-202
http://doi.org/10.54522/jvsgbi.2024.141

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SYSTEMATIC REVIEW

Safety and efficacy of tranexamic acid in major non-cardiac vascular surgery: a systematic review and meta-analysis

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Received: 21st June 2024
Accepted: 7th August 2024
Online: 26th August 2024

Plain English Summary

Why we undertook the work: Tranexamic acid (TXA) is a medicine used to reduce bleeding in people undergoing major surgery by stabilising blood clots. However, too much clot can obstruct blood flow to important organs such as the heart, lungs and brain. There is a delicate balance between the formation and breakdown of clots. Using drugs such as TXA can help reduce bleeding and avoid the need for blood transfusion, but there are some concerns that these clots may cause harm by limiting blood flow to important organs. So far, TXA has been shown to reduce bleeding without causing clot-associated problems in patients having open heart surgery, women giving birth and in those who are injured from trauma. However, TXA has not been used very much in vascular surgery (surgery on major blood vessels of the body) because the procedures (which include applying clamps to stop blood flow) are per se more prone to clot formation. The aim of this research was to assess the safety and benefits of TXA in people having vascular surgery.

What we did: We searched seven large research databases for studies that looked at TXA versus a placebo (dummy treatment) or no TXA. We were interested in studies that looked at adult patients. We studied and summed up the results of these studies.

What we found: We found three studies. These included a total of 1,560 adults, which compared TXA to normal saline (salty water) in patients having vascular surgery. In two studies the TXA was given in a vein and in one study it was given as tablets. We found that TXA given to people through a drip does not increase the risk of clot-related problems such as heart attacks or blood clots in the legs. On the other hand, we found no evidence that TXA reduced severe bleeding (eg, major organ bleeds, fatal bleeds) either. However, our confidence in these results is low. One study investigated the use of TXA tablets in patients who had their aorta repaired. The use of TXA for 30 days in these patients had no effect on blood leakage around the repair site. This study also did not find that TXA increased the number of clot-related problems.

What this means: The information from our research suggests that TXA does not increase the risk of clot-related problems in patients having vascular surgery. However, the current studies are limited by small numbers of patients. This means that we do not have enough information to say for certain whether or not we should use TXA in vascular surgery. Ongoing and future studies will help reduce this uncertainty and provide more definitive information for doctors and patients.

Abstract

Background: Tranexamic acid (TXA) is a synthetic lysine analogue that inhibits fibrinolysis. The effectiveness of TXA in obstetrics, trauma and orthopaedic and cardiac surgery is well established. However, concerns regarding its prothrombotic potential remain, which is an important consideration for vascular surgery. We aimed to evaluate the safety and efficacy of TXA in adults undergoing major non-cardiac vascular surgery.

Methods: A pre-specified protocol (PROSPERO CRD42023427282) was followed. Relevant databases (PubMed, MEDLINE, EMBASE) were searched for randomised controlled trials (RCTs). Data extraction and risk of bias assessments were performed in duplicate. A random effects model was used to synthesise data from RCTs. Measures of effect were reported as relative risk (RR) with 95% confidence intervals (CIs). The primary safety outcome was a composite of arterial and venous thromboembolic events (composite of myocardial infarction, non-haemorrhagic stroke, peripheral arterial thrombosis and symptomatic proximal venous thromboembolism). Certainty of evidence was assessed using the GRADE approach.

Results: After screening 1989 records, three RCTs were included, cumulatively enrolling 1,560 participants. In all trials, patients received either TXA (intravenously or orally) compared with placebo. There was no evidence of the effect of intravenous TXA on thromboembolic events (RR 1.10, 95% CI 0.89 to 1.36, two RCTs, 1460 participants, low certainty of evidence) or on critical bleeding (composite of life-threatening, critical and major organ bleed) (RR 0.85, 95% CI 0.65 to 1.11, two RCTs, 1460 participants, low certainty of evidence). TXA may reduce postoperative blood loss, especially at 0–4 hours (Cliff's delta −0.41, 95% CI −0.19 to −0.59) and 0–24 hours (Cliff's delta −0.37, 95% CI −0.14 to −0.55) after surgery. There was no evidence of an effect of TXA on reducing perioperative red blood cell (RBC) transfusion requirements (RR 0.66, 95% CI 0.11 to 3.95, one RCT, 100 participants). One RCT assessed oral TXA and found no evidence of an effect on type II endoleak post endovascular aneurysm repair. No thrombotic complications were reported in this RCT during the study period.

Conclusions: We found no evidence of an effect of TXA on thromboembolic complications. While TXA appears to reduce early postoperative bleeding, the clinical relevance of this is uncertain. Due to limitations of study design and the variety of vascular procedures, the role of TXA in vascular surgery is still unclear. Ongoing trials may reduce this uncertainty.

Key words: tranexamic acid, vascular surgery, thromboembolism blood transfusion, bleeding

Registration: Prospectively registered on PROSPERO (CRD42023427282)

Introduction

Tranexamic acid (TXA) is a synthetic lysine analogue that inhibits the conversion of plasminogen to plasmin, thereby inhibiting fibrinolysis.[1] Large pragmatic randomised controlled trials (RCTs) have demonstrated that TXA is associated with a reduction in mortality in patients with major traumatic haemorrhage,[2] postpartum haemorrhage[3] and mild to moderate traumatic brain injury[4]; reduced transfusion requirements in adult and paediatric cardiac surgery[5,6]; and caesarean delivery[7]; and fewer critical bleeding events in major non-cardiac surgery.[8] TXA is on the World Health Organization's list of essential medicines.[9]

Despite evidence of efficacy in these settings, owing to the mechanism of action of TXA, concerns about thromboembolic risk remain. This risk may be more pertinent in patients with active thromboembolic disease, inappropriate administration or those with unbalanced haemostatic systems favouring thrombosis. In a large RCT enrolling patients with gastrointestinal bleeding, TXA was associated with an increased risk of venous thrombosis with no effect on mortality.[10] Possible reasons for these findings include the high dose of TXA administered (4 g over 24 hours) and the delayed presentation to hospital of many of the patients, missing the early period of excessive fibrinolysis.

Patients undergoing major non-cardiac vascular surgery are per se more prone to thrombosis than general surgery patients.[1,11] Hypercoagulability caused by TXA can potentially cause damage to – and occlude arteries recently operated on – new bypass grafts or endovascular stents and stent grafts, which can lead to rare but devastating complications such as limb loss and even death.[12] Although systematic reviews have not demonstrated an increased risk of thromboembolic complications associated with TXA in surgical and non-surgical settings,[13,14] these often include heterogeneous cohorts of patients. Therefore, we aimed to evaluate the safety and efficacy of perioperative TXA (any dose or route) focusing only on patients undergoing major non-cardiac emergency or elective vascular surgery.

Methods

This systematic review followed a protocol that was designed and reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (see Appendix 1 online at www.jvsgbi.com).[15] The protocol is registered on PROSPERO (CRD42023427282). Ethics committee approval was not required as this was a synthesis of previously published literature.

Information sources and search strategy

Relevant bibliographic databases including PubMed, EMBASE (via OVID), MEDLINE and Transfusion Evidence Library, were searched. The full search strategy (see Appendix 2 online at www.jvsgbi.com) included terms relating to or describing exposure (TXA), outcome (thrombosis, bleeding) and the study population (adults undergoing major non-cardiac vascular surgery). There was no restriction on the date of publication and only peer-reviewed RCTs published in academic journals were included.

Inclusion and exclusion criteria

Eligible RCTs included adult participants (as defined by the study authors) undergoing major non-cardiac vascular surgery and receiving either TXA (any route, dose and formulation) or placebo/no TXA during the perioperative period. Major non-cardiac vascular surgery was defined as including the following elective, urgent and emergency procedures: open or endovascular aneurysm repair of the abdominal aorta (AAA repair or EVAR), thoracic aorta, thoraco-abdominal aorta or lower limb artery; open

or endovascular repair of aorta (thoracic, abdominal, thoraco-abdominal) dissection; infrainguinal lower limb bypass surgery (including open and hybrid operations); major lower limb amputation (below, above and through knee amputations); carotid endarterectomy. Cohort studies (prospective and retrospective), case-control studies, letters, editorials, commentaries and case reports were excluded.

Outcomes

The primary outcome of interest was the risk of perioperative arterial and venous thromboembolic complications, which we defined as a composite of myocardial infarction, non-haemorrhagic stroke, peripheral arterial thrombosis and symptomatic proximal venous thromboembolism. Secondary outcomes that were analysed are as follows: critical bleeding (composite of life-threatening, critical and major organ bleed), measured perioperative blood loss, risk of receiving allogeneic blood transfusion in the perioperative period and in-hospital mortality. Given the concerns about thromboembolism associated with TXA in vascular surgery, safety was designated as the primary outcome for this review. Efficacy was chosen as the secondary outcome as it is safety concerns, rather than doubts about efficacy, that we hypothesise have deterred the use of TXA in vascular surgery.

Study selection and data collection process

Data from eligible studies were extracted using a pre-piloted spreadsheet. Extracted data included the number of participants in each study, participant characteristics, study duration, type of vascular operation undertaken, route and method of TXA and control administration, transfusion thresholds utilised (if stated), whether any additional co-interventions were used (eg, cell salvage), as well as information relating to quality assessment. This was done in duplicate by two authors (KA and LC) and disagreements were reviewed by a third author (KB or AS). For studies that did not report data on certain outcomes of interest, the relevant authors were contacted.

Risk of bias assessment

The Cochrane Collaboration's domain-based risk of bias (ROB) tool[16] was used to assess risk of bias in each included study. Each of these parameters was evaluated for each study and scored on a 3-point scale corresponding to a low, unclear or high risk of bias. This was also done in parallel by two reviewers (KA and LC) and disagreements were resolved by a third author (KB or AS).

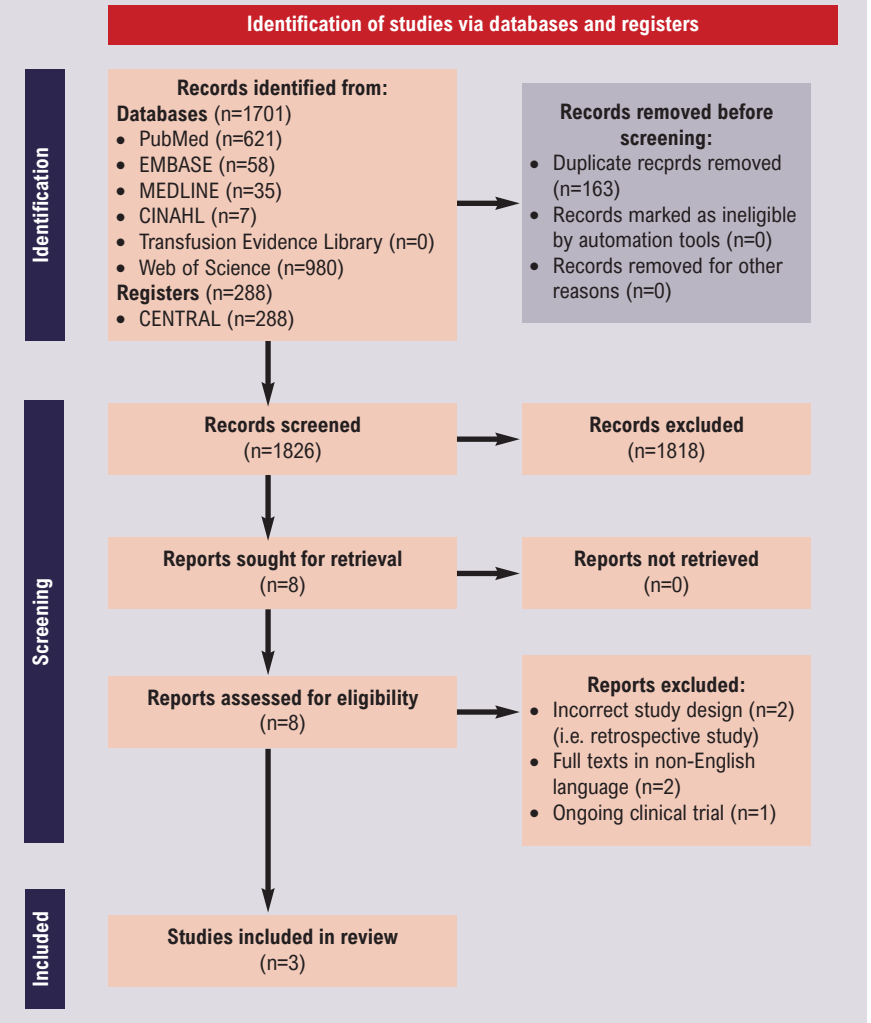
Data synthesis

Data were analysed using Cochrane Collaboration's Review Manager 5 (REVMAN 5) software. Wherever possible, a random-effect model was used to synthesise data about primary and secondary outcomes. Measures of effect were reported as relative risk (RR) with 95% confidence intervals (CIs). Each outcome was evaluated as relevant deviations from the control group. When comparing end points of interest, statistical significance was established at a threshold of $p<0.05$. Heterogeneity between studies was assessed with the use of I^2.[17] Any outcome data that could not be combined into a meta-analysis were synthesised narratively instead.

Assessment of the certainty of the evidence

The GRADE (Grades of Recommendation, Assessment,

Figure 1 CONSORT diagram.



Development, and Evaluation)[18] approach was used to assess the overall quality of evidence for the key outcomes of thromboembolic complications and critical bleeding.

Results

Study selection

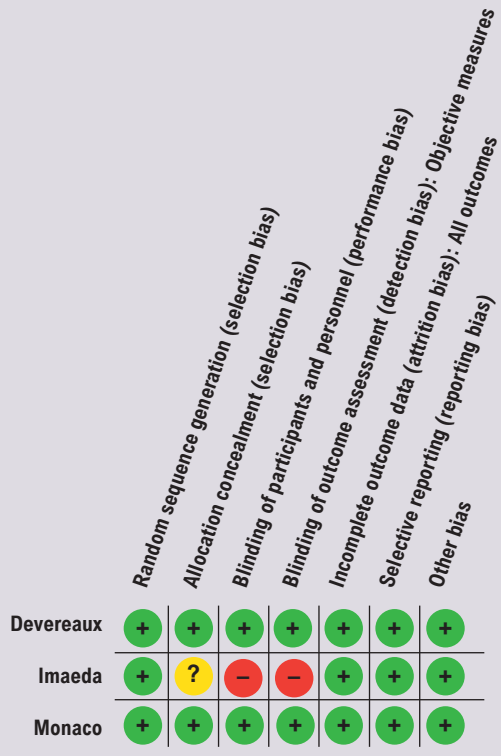
Our electronic search identified 1,989 relevant publications. Following title and abstract screening, eight articles were shortlisted. Subsequently, full texts were reviewed and three RCTs[8,11,19] were ultimately included in this review (Figure 1). The reasons for excluding the five studies were: incorrect study design (ie, retrospective studies) (n=2), full texts in non-English language (n=2) and ongoing clinical trial (n=1). Details of the included RCTs are shown in Table 1. We found one ongoing RCT (NCT04803747) that is planned to complete recruitment in 2024.

Study characteristics

The three included RCTs enrolled a total of 1,560 patients across 24 different countries (Australia, Austria, Belgium, Brazil, Canada, Chile, China, Denmark, France, Germany, Hong Kong, India, Italy, Japan, Malaysia, Netherlands, New Zealand, Pakistan, Poland, Russia, South Africa, Spain, UK and USA). There was one large multicentre international RCT which provided data on 1,360 participants who underwent vascular surgery.[8] In comparison, the other two RCTs included 100 participants each.[11,19]

In two RCTs the patients were administered intravenous TXA at a loading dose of 1 g preoperatively along with a continuous infusion intraoperatively or a bolus at the end. The third trial administered 750 mg oral TXA daily for a month after surgery (Table 1). Two of the RCTs only included patients undergoing elective AAA repair[11] and elective EVAR[19] and the other RCT included patients undergoing both elective and emergency vascular surgery but data on specific types of surgery were not available.[8]

Figure 2 Risk of Bias (ROB) assessment based on the Cochrane Risk of Bias Tool. Each study was evaluated against different parameters and scored based on a 3-point scale corresponding to a low (green), unclear (yellow), or high risk of bias (red).



Risk of bias assessment

Two of the RCTs had a low risk of bias across all domains (Figure 2)[11] and one RCT was judged to be at high overall risk of bias due to concerns regarding allocation concealment and participant and assessor blinding.[19]

Primary outcome

Thromboembolic risk

Two studies (1,460 participants) reported data on the incidence of thromboembolic events in patients receiving intravenous TXA.[8,11] Overall, when the data were pooled, there was no evidence of an effect of intravenous TXA on the incidence of thromboembolic events (RR 1.10, 95% CI 0.89 to 1.36) (Figure 3). On the basis of the GRADE framework, this finding was judged to be low certainty evidence (Table 2). One study (85 participants) evaluating oral TXA observed no thrombotic events during the study period.[19] Given the variability in the methodology (ie, intravenous vs oral TXA), the study reporting results from oral TXA use was not included in the meta-analysis.

Secondary outcomes

Critical bleeding

Two studies (1,460 participants) reported data on the incidence of critical bleeding in patients receiving intravenous TXA. Overall, there was no evidence of an effect of intravenous TXA on the incidence of critical bleeding (RR 0.85, 95% CI 0.65 to 1.11, low certainty of evidence) (Figure 4).

Blood loss

Only one study reported information on blood loss during the first 4 and 24 hours postoperatively.[11] During the first 4 hours, participants who received TXA lost a median (IQR) of 60 (40–80) mL blood compared with participants who received placebo who lost a median (IQR) of 100 (60–140) mL blood (Cliff's delta –0.41 (–0.19 to –0.59), p<0.001). Similarly, during the 24 hours post-surgery, participants receiving TXA continued to have a significantly lower volume of blood loss compared with those who received placebo (Cliff's delta –0.37 (–0.14 to –0.55), p=0.002) (Table 3).

Table 1 Characteristics of included (n=3) and ongoing (n=1) randomised controlled trials.

Study author	Methods	Participants	Intervention	Comparator(s)	Primary outcome	Secondary outcome(s)
Devereaux *et al*, 2022[8]	International multicentre parallel RCT across 114 sites	Age >45 years, undergoing inpatient, non-cardiac, emergency or elective surgery and at risk for bleeding and cardiovascular complications* (n=1360)**	IV TXA 1 g as bolus or 10-min infusion One dose at the start of surgery (20 minutes before incision) and one dose at the end	IV 0.9% saline as bolus or 10-min infusion One dose at the start of surgery (20 minutes before incision) and one dose at the end	Composite of life-threatening, major and critical organ bleeding at 30 days after randomisation Composite of MINS, non-haemorrhagic stroke, peripheral arterial thrombosis and symptomatic proximal venous thromboembolism at 30 days after randomisation	(1) Bleeding independently associated with mortality after non-cardiac surgery (2) Life-threatening bleeding (3) Major bleeding (4) Critical organ bleeding; (5) MINS (6) MINS not fulfilling the universal definition of myocardial infarction (7) Myocardial infarction (8) Composite of vascular death, bleeding (ie, non-fatal life-threatening, major or critical organ), MINS, stroke, peripheral arterial thrombosis and symptomatic proximal venous thromboembolism (ie, a net risk-benefit outcome)
Imaeda *et al*, 2022[19]	Single-centre parallel RCT (Japan)	Adult patients undergoing EVAR (n=100)	Oral TXA 750 mg every day (250 mg after each meal) for 30 days after surgery	No TXA	Incidence of EL2 at 1 week and 1 month after EVAR	(1) Changes in the aneurysm diameter at 1 week, 1 month, 6 months and 1 year after EVAR (2) Results of the blood coagulation/ fibrinolysis test at 3 days, 7 days and 1 month after EVAR (3) Rate of change in aneurysm diameter from baseline to 6 months and 1 year
Monaco *et al*, 2020[11]	Single-centre parallel RCT (Italy)	Age >50 years, undergoing elective open AAA surgical repair (n=100)	IV TXA loading dose of 500 mg diluted in 100 mL slowly infused before surgery Continuous undiluted infusion rate of 250 mg/hour (2.5 mL/hour) during surgery	IV 0.9% saline loading dose of 500 mg diluted in 100 mL slowly infused before surgery Continuous undiluted infusion rate of 250 mg/hour (2.5 mL/hour) during surgery	Intraoperative blood loss (sum of blood volume aspired during surgery and blood volume absorbed in gauzes (at the end of the surgery, all gauzes used were weighted and net weight of the gauzes was subtracted from the total weight))	(1) RBC transfusion requirements (2) Thromboembolic events (including acute MI, PE, bowel infarction or seizures) up to 28 days after surgery (3) Mortality: 28-day, 1-year
Ongoing NCT04803747	Multicentre RCT	Age >18 years undergoing major non-cardiac surgery with estimated risk >5% of requiring RBC and duration of surgery >3 hours (n=8320)	IV TXA 1 g bolus. One dose within 10 minutes of skin incision and one dose at 2–4 hours of surgery or prior to skin closure	IV 0.9% saline as bolus. One dose within 10 minutes of skin incision and one dose at 2–4 hours of surgery or prior to skin closure	RBC transfusion requirements Incidence of DVT or PE within 3 months of surgery	(1) Number of RBC units transfused (2) In-hospital MI, stroke, DVT or PE (3) Hospital length of stay (4) ICU admission (5) 90-day mortality (6) Days at home to day 30

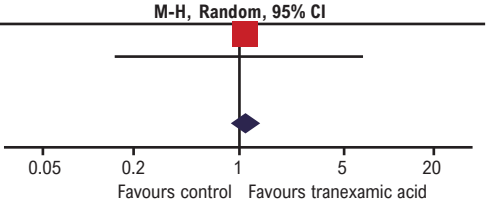
*Risk of bleeding and cardiovascular complications defined as known atherosclerotic disease, undergoing major surgery, age ≥70 years and serum creatinine level >175 µmol/L.
**Study included a total of 9,535 individuals undergoing several different higher risk surgeries. 1,360 of these participants underwent vascular surgeries. Details of the specific type of vascular surgery and the nature of the vascular surgery (emergency vs elective) are unknown.

AAA, abdominal aortic aneurysm; DVT, deep vein thrombosis; EL2, type 2 endoleak; EVAR, endovascular aneurysm repair; ICU, intensive care unit; IV, intravenous; MI, myocardial infarction; MINS, myocardial injury after non-cardiac surgery; PE, pulmonary embolism; RBC, red blood cell; RCT, randomised controlled trial; TXA, tranexamic acid.

Figure 3 Forest plot of the effect of tranexamic acid on the primary composite outcome: thromboembolic risk (composite of myocardial infarction, non-haemorrhagic stroke, peripheral arterial thrombosis and symptomatic proximal venous thromboembolism).

Study or Subgroup	Tranexamic acid Events	Total	Control Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Devereaux 2022	140	684	126	676	98.8%	1.10 (0.88, 1.36)
Monaco 2019	2	50	2	50	1.2%	1.00 (0.15, 6.82)
Total (95% CI)		**734**		**726**	**100.0%**	**1.10 (0.89, 1.36)**
Total events	142		128			

Heterogeneity: Tau² = 0.00; Chi² = 0.01, df = 1 (P=0.92): I² = 0%
Test for overall effect: Z = 0.84 (P=0.40)



M-H, Mantel-Haenszel

Table 2 GRADE assessment of key clinical outcomes.

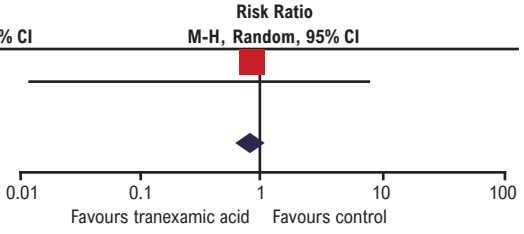
Certainty assessment							Summary of findings				
							Study event rates (%)			Anticipated absolute effects	
Participants (studies) Follow-up	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall certainty of evidence	With placebo/ control	With tranexamic acid	Relative effect (95% CI)	Risk with placebo/ control	Risk difference with tran-examic acid
Thromboembolic complications											
1460 (2 RCTs)	Not serious	Serious*	Not serious	Serious**	None	⨁⨁◯◯ Low	128/726 (17.6%)	142/734 (19.3%)	RR 1.10 (0.89 to 1.36)	176 per 1000	18 more per 1000 (from 19 fewer to 63 more)
Critical bleeding											
1499 (2 RCTs)	Not serious	Serious*	Not serious	Serious**	None	⨁⨁◯◯ Low	104/750 (13.9%)	88/749 (11.7%)	RR 0.85 (0.65 to 1.11)	139 per 1000	21 fewer per 1000 (from 49 fewer to 15 more)

*Downgraded due to differences in direction of point estimate **Wide confidence intervals (CIs). RCT, randomised controlled trial

Figure 4 Forest plot of the effect of tranexamic acid on the secondary composite outcome: critical bleeding (composite of life-threatening, critical and major organ bleed).

Study or Subgroup	Tranexamic acid Events	Total	Control Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Devereaux 2022	88	699	103	700	99.3%	0.86 (0.66, 1.11)
Monaco 2019	0	50	1	50	0.7%	0.33 (0.01, 7.99)
Total (95% CI)		**749**		**750**	**100.0%**	**0.85 (0.65, 1.11)**
Total events	88		104			

Heterogeneity: Tau² = 0.00; Chi² = 0.34, df = 1 (P=0.56): I² = 0%
Test for overall effect: Z = 1.21 (P=0.23)



M-H, Mantel-Haenszel

Table 3 Summary of results of secondary outcome

Outcome	Author, year	Number	TXA (events/total) (%)	Control (events/total) (%)	RR (95% CI)
Perioperative RBC transfusion requirements	Monaco *et al*, 2020[11]	100	7/50 (14%)	12/50 (24%)	0.66 (0.11 to 3.95)
Composite clinically important bleeding	Monaco *et al*, 2020[11] and Devereaux *et al*, 2022[8]	1499	88/749 (12%)	104/750 (14%)	0.85 (0.65 to 1.11)

Outcome	Author, year	Number	TXA (n=50)	Control (n=50)	Cliff's delta (95% CI)
Blood loss 0–4 hours after surgery, median (IQR), mL	Monaco *et al*, 2020[11]	100	60 (40–80)	100 (60–140)	−0.41 (−0.19 to −0.59)
Blood loss 0–24 hours after surgery, median (IQR), mL	Monaco *et al*, 2020[11]	100	180 (120–275)	275 (190–395)	−0.37 (−0.14 to −0.55)

CI, confidence interval; IQR, interquartile range; RBC, red blood cell; RR, relative risk; TXA, tranexamic acid.

Risk of receiving allogeneic RBC transfusion

One study (n=100) reported data on perioperative blood transfusion requirements and found weak evidence of an effect of TXA on reducing transfusion requirements (RR 0.66, 95% CI 0.11 to 3.95) (Table 3). Devereaux et al8 reported on allogeneic RBC transfusion across all included surgical specialties (HR 0.77, 95% CI 0.68 to 0.88) but did not provide transfusion data specific to vascular surgery. We contacted them for additional data regarding the vascular subgroup but they were unable to share it at this time.

In-hospital mortality

One study (n=100) provided data on in-hospital mortality and did not report deaths in either study arm.

Oral TXA

Imaeda *et al* evaluated the use of oral TXA for the prevention of type II endoleak in adults undergoing EVAR (n=100).[19] Acknowledging the heterogeneity in the administration of intravenous and oral TXA as well as the variability in reported outcomes, we have narratively summarised the findings of this trial. The study reported that seven days post EVAR, type II endoleak was observed in 14 patients (34.1%) in the TXA group and in seven patients (15.9%) in the non-TXA group. At 1 month follow-up post EVAR, 12 patients (29.3%) in the TXA group and six patients (13.6%) in the non-TXA group were found to have type II endoleaks. There was no significant difference between the two groups in the incidence of type II endoleak (p=0.051 and p=0.08). No adverse events such as thrombus formation due to oral TXA were observed during the study period.

Discussion

The key findings of this systematic review are: (1) there is no evidence of an effect of TXA on thromboembolic events or on critical bleeding in patients undergoing major non-cardiac vascular surgery (low certainty of evidence); (2) while TXA appears to reduce early postoperative bleeding, the clinical relevance of this remains unclear, particularly in an era of patient blood management interventions[20] such as cell salvage, restrictive transfusion and minimally invasive surgical techniques; and (3) the current evidence base is limited by the small number of RCTs and wide CIs around the effect estimates, which could encompass clinically important differences.

Both bleeding and thrombosis in patients undergoing vascular surgery are associated with poor outcomes and the underlying pathophysiology and mechanisms are multifactorial. Perioperative risk factors for bleeding include systemic anticoagulation with heparin (to prevent graft thrombosis or clot extension), preoperative use of antiplatelets and/or anticoagulants, intraoperative hypothermia, cross-clamp position, haemodilution and consumption coagulopathy during ongoing blood loss.[21] Similarly, a procoagulant state has been observed in AAA repair with increased thrombin generation and inhibition, which may lead to microvascular and macrovascular thrombosis. This can eventually manifest as myocardial infarction, graft thrombosis, multi-organ failure and venous thromboembolism.[22] The presence of hypercoagulable comorbidities is associated with an increased risk of developing venous thromboembolism and graft thrombosis in patients undergoing vascular surgery.[23,24]

The incidence of perioperative RBC transfusion in patients undergoing vascular surgery ranges from 0% to 25%.[25,26] Both excessive bleeding and perioperative RBC transfusion are associated with increased postoperative morbidity and mortality.[25,27] Certain patient groups such as those with preoperative anaemia, Jehovah's Witnesses or risk factors for bleeding (eg, anticoagulants)

may benefit from TXA, but further research is needed.

Operations at risk of moderate-to-severe blood loss (at least 500 mL) where the use of TXA is recommended by national guidelines include open AAA repair, complex lower limb bypass surgery and major lower limb amputation.[28] However, a survey of anaesthetists in Australia and New Zealand found considerable variability in the use of TXA in vascular procedures. While 3% of vascular anaesthetists routinely administered TXA, 40% did not administer it at all and 20% and 37% reported administering TXA selectively and on surgical request, respectively.[29] The reasons for this are unclear but may relate to concerns regarding thrombosis. It is worth noting that, in the study by Devereaux *et al*,[8] TXA did not meet the non-inferiority margin for the thromboembolic composite safety outcome, although some have argued that the upper bound of the CI (1.14) just surpassed the non-inferiority margin (1.125) and that it is likely that the true effect lies below this margin.[30] Others have expressed concerns regarding widespread prophylactic use in the absence of established fibrinolytic bleeding, and that a more individualised approach may be needed.[16,31] It is unclear whether similar patterns exist in the UK or elsewhere and how they may differ between elective and emergency surgery cases.

Our findings are broadly in agreement with recent work by Tsan *et al*,[13] although they did not include data from Devereaux *et al*[8] in their subgroup analysis for vascular surgery. The strength of this review is the strict methodological process. We followed Cochrane Collaboration, PRISMA and GRADE recommendations. We conducted a comprehensive search of multiple databases and clinical trial registries to ensure all relevant studies would be captured. All screening, data extraction and risk of bias assessments were done in duplicate. Limitations of this review stem from the limited number of studies included. There were only three eligible studies and only two were included in the meta-analysis given methodological and reporting differences between trials. Once available, we aim to update this review with data from an ongoing study (NCT04803747) to reduce the uncertainty on the benefits and risks of TXA in patients undergoing major non-cardiac vascular (or other) surgery.

The 2023 NHS Blood and Transfusion (NHSBT) National Comparative Audit in the UK found that only 900 out of 1,336 surgical patients were given TXA. Around one-third (32.6%) of patients who were eligibile for it did not receive it.[32] This prompts consideration of factors that are preventing clinicians from using TXA, even when it has been shown to reduce major bleeding by 25% without increasing the risk of thromboembolic events. Additionally, the audit also reported "the low use of TXA in vascular surgery noteworthy (13.5%)". We hypothesise that this may be explained by the paucity of evidence that we have identified in this systematic review. Evidently, the currently available data on the use of TXA in vascular surgery are insufficient to definitively guide clinical practice either for or against its use.

The publication of the Infected Blood Inquiry report along with recent national blood shortages has again re-ignited efforts to promote the use of TXA. Example recommendations include incorporating TXA in preoperative WHO checklists.[33,34] It is likely that a key reason TXA is not widely used in vascular surgery is due to safety concerns rather than issues of oversight during procedures. Hence, until these concerns are addressed, vascular surgeons and anaesthetists are unlikely to start using TXA merely because it is included in preoperative checklists.

At the moment there are no ongoing trials studying TXA solely in patients undergoing vascular surgery. However, if such a trial were to be conducted, it would need to include patients undergoing open procedures at high risk of blood loss. The end points of this trial should assess both safety (incidence of thromboembolic events) and efficacy (effects on major bleeding and RBC transfusion requirements). Future trials should also consider 'enrichment' strategies by enrolling patients at high risk of experiencing the outcomes of interest (eg, major bleeding, thrombosis) such as those on antiplatelet and anticoagulant therapy, scheduled to undergo complex surgery and likely to require prolonged aortic cross-clamping duration, and those with multiple comorbidities. Although a pragmatic TXA dose of 1 g is often used, the optimal dose, route and timing is still a topic of active research. For the time being, our data may provide some reassurance to vascular anaesthetists and surgeons with regard to the risk of thromboembolic complications, but further research is needed.

KEY MESSAGES

- We found no evidence of an effect of TXA on thromboembolic complications or on critical bleeding. However, the certainty of the evidence was judged to be low.
- TXA reduces early postoperative bleeding but the clinical relevance of this remains unclear. There was no evidence of an effect on red blood cell transfusion use.
- High-quality research is needed to determine the risk-benefit balance of TXA in vascular surgery.

Conflict of Interest: AS is an Editor of *Anaesthesia* and has received consultancy fees from Pharmacosmos UK outside of the submitted work.

Funding: None.

Author contributions: KA: study design; data extraction and analysis; preparation of figures and composition of the initial and final manuscript. LC: data extraction and analysis; composition of the final manuscript. KB: study design; data analysis; composition of the final manuscript; content expertise and co-supervision. AS: study design; data analysis; preparation of figures; composition of the final manuscript; overall supervision of this work.

Acknowledgement: We would like to thank Dr Paula Dhiman for providing statistical advice during the preparation of this manuscript.

Reviewer acknowledgement: *JVSGBI* thanks Sandip Nandhra, Northern Vascular Centre, Freeman Hospital and Rob Sayers, Glenfield Hospital Leicester, for their contribution to the peer review of this work.

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Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2024;3(4):203-208
http://doi.org/10.54522/jvsgbi.2024.139

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SYSTEMATIC REVIEW

The incidence of surgical site infection following transmetatarsal amputation: a systematic review

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Received: 4th May 2024
Accepted: 11th July 2024
Online: 18th August 2024

Plain English Summary

Why we undertook the work: The rate of wound infection following a forefoot amputation is unknown. This review aimed to assess the reported rate of wound infections following a forefoot amputation. The patients in the study had complications due to diabetic foot infection or peripheral arterial disease.

What we did: Several databases were searched for studies that included patients who had undergone forefoot amputations.

What we found: The search found 298 articles, of which only five reported forefoot amputations. Through analysis, the forefoot amputation wound infection rate was 24% across 233 amputations.

What this means: Across the five relevant articles there is a high infection rate. The infection definitions, differing study methods and small number of studies make comparison difficult. To improve this, further research is needed.

Abstract

Introduction: The rate of surgical site infections (SSIs) following transmetatarsal amputation (TMA) is unknown. This study aimed to determine the reported incidence of SSIs following TMAs in patients who underwent amputation secondary to peripheral arterial disease (PAD) or complications of diabetic foot infection (DFI).

Methods: This review was conducted following the guidance outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and was prospectively registered with the international prospective register of systematic reviews. The EMBASE, MEDLINE and COCHRANE databases were searched using a pre-defined search strategy without date restriction. All randomised controlled trials (RCTs) and observational studies including patients who underwent TMA due to PAD or DFI were included.

Results: The search identified 298 articles. One RCT and four observational studies, reporting 233 TMAs were included. The overall incidence of SSI per TMA was 24.0%. There was no reporting on the severity of SSI in any of the studies. The criteria used to define SSIs were heterogeneous amongst the studies.

Conclusions: The number of studies reporting the incidence of SSIs following TMA is very small, but the SSI incidence appears high and similar to that seen following major lower limb amputation. The heterogeneity of SSI definition, differing study methodologies and the small number of studies make comparison of outcomes challenging. Further high-quality research investigating SSIs following TMA is required including assessment of specific risk factors, the impact on patient outcomes and the effectiveness of prophylactic interventions.

Key words: transmetatarsal, forefoot, amputation, surgical site infection, vascular

Introduction

Transmetatarsal amputations (TMAs) were first popularised in 1949 by McKittrick *et al*, who used this procedure as an alternative to more proximal amputations when addressing gangrene or infection.[1] Its use has continued as an effective surgical approach in treating forefoot gangrene, infection and chronic ulceration, most commonly in patients with diabetic foot or vascular disease.[2] By preserving limb length and a functioning ankle joint, it enables patients to continue to walk without the need for a prosthesis.[2–4] TMAs also require lower additional energy for walking compared with more proximal amputations, increasing patient satisfaction.[2–5]

Wound dehiscence and skin breakdown (often due to ischaemia and small vessel diabetic disease) can require patients to return to theatre for a more proximal amputation or revision.[2,6] Patients undergoing TMA tend to have a high prevalence of other risk factors (eg, obesity, malnutrition and smoking) for the development of surgical site infections (SSIs).[7] Those who develop SSIs are at an increased risk of morbidity and mortality, prolonged hospitalisation and readmission or need for further surgery. [2,3,7,8]

The accurate incidence and factors predisposing to SSI following TMA are unclear. This systematic review aimed to determine the incidence of SSI in patients undergoing TMA for peripheral arterial disease (PAD) or diabetic foot infection (DFI).

Methods

This study was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta‐Analyses (PRISMA) statement.[9] The study protocol was prospectively registered with the international prospective register of systematic reviews (PROSPERO; CRD42023488553).[10]

Data sources, search terms and inclusion/exclusion criteria

The search strategy was developed in collaboration with a clinical librarian. The MEDLINE, EMBASE and COCHRANE databases were searched separately without date restriction using the following terms: [transmetatarsal amputation OR TMA OR forefoot amputation] AND [wound infection OR surgical wound infection OR surgical site infection]. EMBASE and MEDLINE were searched on 1 November 2023 and COCHRANE was searched on 6 November 2023.

Inclusion criteria were as follows: patients >18 years old; studies including patients undergoing TMA due to PAD or DFI; and incidence of SSI reported. Exclusion criteria were: TMA secondary to trauma or malignancy; SSI incidence not reported; case reports; and no English version of the full text available.

Review methods

Studies identified in the search strategy were exported onto Microsoft Excel and any duplicate articles were removed. Title, abstract and full-text screening was carried out by two reviewers (RJ and TJ) with any conflicts resolved by a third reviewer (either NA-S or MLW). For any studies where the incidence of SSI following TMA could not be extracted (n=1), the authors were contacted and the data requested.[11]

A risk of bias assessment was carried out by two independent reviewers (RJ and TJ) using the Cochrane risk of bias tool for randomised trials and the Newcastle–Ottawa Scale for observational studies (Tables 1 and 2).[12,13]

The primary outcome was the incidence of SSI following TMA. Data were organised and extracted onto a pre-designed data extraction tool. The incidence of SSIs was reported per TMA incision for all participants meeting the inclusion criteria. The SSI incidence in both the intervention and control arms of the RCT were included.

Secondary outcomes included: patient demographics, study follow-up period, any history of prior lower limb arterial revascularisation, the incidence of SSI according to severity, postoperative complications and length of stay.

Table 1 Cochrane's risk of bias assessment for randomised controlled trials[12]

Author	Year	Randomisation process	Deviation from intended interventions	Missing outcome data	Measurement of outcome	Selection of reported result	Overall
Souroullas[16]	2022	Low concerns	Low concerns	Low concerns	Some concerns	Low concerns	Low concerns

Table 2 Newcastle–Ottawa score for observational studies[13]

First author	Year	Selection (N/4)	Comparability (N/2)	Exposure (N/3)	Total (N/10)	AHRQ outcome
Dudkiewicz[2]	2009	3	2	2	7	Good quality
Dunkel[8]	2012	3	2	3	8	Good quality
Kono[14]	2012	4	2	3	9	Good quality
Rosendahl[15]	1972	3	1	2	6	Good quality

AHRQ, Agency for Healthcare Research and Quality.

Synthesis methods

The data collection tool was designed to allow the calculation of the incidence of SSI per TMA incision, which was carried out for all the studies. The mean was calculated for demographic variables including age and gender. Analyses were performed using Excel (Microsoft).

Results

The initial search identified 298 articles. Following removal of duplicates and title screening, 96 abstracts were reviewed and 42 articles underwent full-text review. After 37 further exclusions, five articles were considered eligible and underwent full data extraction (Figure 1).

Demographic details

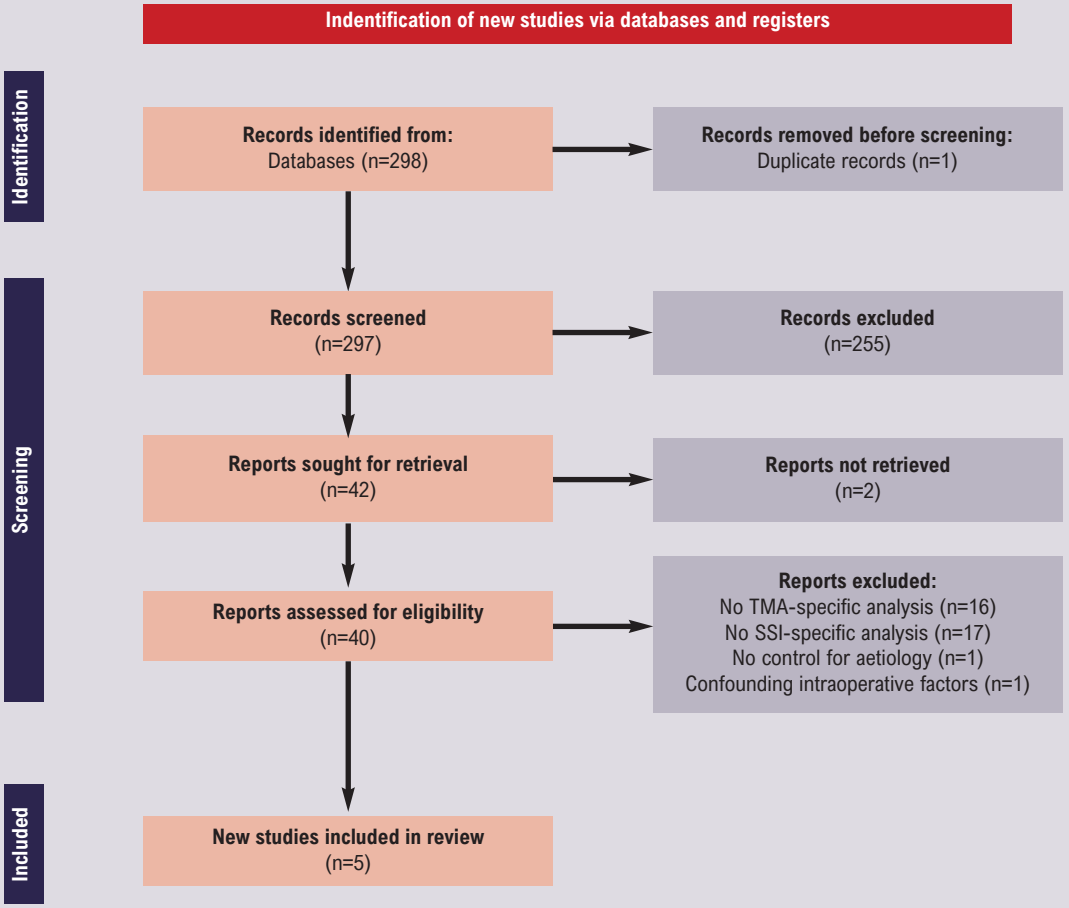
The five included studies were all published between 1972 and 2022 (Table 3).[2,8,14–16] One of the studies[16] was a RCT and the remaining four were observational studies. SSI was the primary outcome in two of the studies and a secondary outcome in three studies. Three of the studies used a definition for SSI which was either the Additional treatment, the presence of Serous discharge, Erythema, Purulent exudate, and Separation of the deep tissues, the Isolation of bacteria, and the duration of inpatient Stay (ASEPSIS), Centres for Disease Control and Prevention (CDC) or an author-specified definition.[17–19] The remaining two studies did not specify a definition of SSI.

Overall, 233 TMAs were performed in 232 patients. The mean age was 67 years and the mean percentage of male patients was 76.7%.

Overall SSI rates

There were 56 SSIs in 233 TMAs, equating to an SSI incidence of 24.0% per TMA No study reported the severity of SSI (superficial/deep). The SSI incidence varied considerably from

Figure 1 Flow diagram
Adapted from Page MJ, McKenzie JE, Bossuyt PM, *et al.*[9]



SSI, surgical site infection; TMA, transmetatarsal amputation.

Table 3 Study demographic data

1st Author	Year	Location	Study type	Centres	Total patients (n)	Male (%)	Mean age (years)	DM (n)	IHD (n)	CKD (n)	Smoker/ ex-smoker (n)	Previous re-vascularisation (n)	Average follow-up	Patients undergoing TMA (n)	No of TMAs (n)	No of TMA with SSI (n)	Incidence of SSI (%)	SSI primary outcome	SSI definition used
Dudkiewicz[2]	2009	Peta Tikvah, Israel	Observational	Multi	46	78	59.9	46	16	14	NR	NR	3.3 years	46	46	16	34.8	No	NR
Dunkel[8]	2012	Geneva, Switzerland	Observational	Single	270	69	70	172	NR	NR	NR	100	14 months	16	16	8	50	Yes	Author defined
Kono[14]	2012	Pittsburgh USA	Observational	Single	116	99.1	66.8	93	NR	8	41	20	3 years	116	116	16	13.8	No	CDC
Rosendahl[15]	1972	Copenhagen, Denmark	Observational	Single	35	NR	NR	36	NR	NR	NR	NR	2 years	35	36	4	10.8	No	NR
Souroullas[16]	2022	Hull, UK	RCT	Single	152	73	64	78	NR	NR	37	NR	30 days	19	19	12	63.2	Yes	ASEPSIS

CDC, Centres for Disease Control and Prevention; CKD, chronic kidney disease; DM, diabetes mellitus; IHD, ischaemic heart disease; NR, not reported; RCT, randomised controlled trial; SSI, surgical site infection; TMA, transmetatarsal amputation.

10.8% to 63.2%. In studies with SSI as the primary outcome, the SSI incidence was 57.1% (20/35), whereas in studies with SSI as a secondary outcome it was 18.1% (30/199). The incidence of SSI was highest in the RCT which used the ASEPSIS score to define SSIs.

Randomised controlled trial

The RCT with a TMA SSI incidence of 63.16% (12/19) recruited and randomised 161 individuals from a single vascular unit to receive either 5 days (intervention) or 24 hours (control) of prophylactic antibiotics.[16] Of the 161 individuals, 152 were included in the final analysis (19 TMA, 89 transtibial, 8 through-knee and 36 transfemoral amputations).

A 5-day course of prophylactic antibiotics was associated with a reduction in both SSI and impaired wound healing across the whole trial. TMA was associated with an increased risk of SSI (OR 10.63, 2.82 to 40.1; p<0.001) and impaired wound healing (OR 86.89, 8.03 to 940.07; p<0.001) in those who received 24 hours of prophylactic antibiotics.[16]

Observational studies

The overall incidence of SSI in the observational studies was 44/215 (20.5%). There was heterogeneity in the SSI incidence between individual studies (Table 3). Notably, in the study with SSI as the primary outcome, the SSI incidence was higher (50%) than in studies with SSI as a secondary outcome.

Factors that influence SSI incidence

Patient comorbidity and surgical practice data were infrequently reported. All five studies reported the prevalence of diabetes, but data reporting regarding smoking, ischaemic heart disease, chronic kidney disease and previous revascularisation was more variable, nor was it specific to TMAs (Table 3). There also appeared to be large variability and little standardisation regarding pre-, peri- and post-operative care.

The study by Dudkiewicz *et al* is the only one that gave outcomes on patients who required surgical re-intervention following TMA due to postoperative wound infection, ischaemia or wound breakdown.[2] In total, 21/46 patients required surgical re-intervention in the form of wound debridement or higher-level amputation. Of these patients, nine had a form of wound debridement; however, this study does not distinguish between the types of debridement. Eleven patients had TMA revisions to below-knee amputations and one was revised to a Lisfranc amputation.

Risk of bias in studies

Reviewers determined that the median Newcastle–Ottawa score for observational studies was 7.5 (range 6–9; Table 1). All studies were found to be of good quality. Using Cochrane's risk of bias tool, the RCT was found to have a low risk of bias (Table 2).

Discussion

SSIs have recently been under the spotlight in 2021 with the publication of the National Wound Care Strategy Programme (NWCSP), which offers generic best practice guidance designed to reduce SSIs in all wound beds.[20] Amputation wounds are, however, likely to pose unique challenges due to patient characteristics and the nature of the aetiology.

NHS England data reported that 1872 TMAs were undertaken in 2022.[21] TMA is therefore a relatively common procedure. However, given that this review identified only five studies involving 232 participants, it is clearly an under-researched procedure. This is the first systematic review to report the pooled SSI incidence following TMA for DFI or PAD. There are extensive reports of SSI following major lower amputation, but very little specific to TMA outcomes. The SSI incidence following TMA in the five studies identified in this systematic review was 24.0%, but varied greatly between studies (from 10.8% to 63.2%). The incidence of SSI was highest in studies that included it as a primary outcome. This may result from more focused and thorough follow-up and increased accuracy in SSI reporting. However, the studies with SSI as a primary outcome also had the smallest sample sizes, with the associated inherent implications regarding the generalisability of these results to everyday practice.

The study by Rosendahl *et al* reported the lowest incidence of SSI (10.8%), but it had no clear definition of SSI which may have resulted in a lower detection and reporting rate of SSI.[15] The studies by Kono et al and Dudkiewicz *et al* had designs which may have resulted in significant detection and reporting bias.[2,14] It was common in our review to find SSIs grouped with other postoperative complications (particularly wound complications such as dehiscence) and small inadequately powered low-level evidence studies assessing the use of novel approaches to reduce SSI post-TMA without controls from which we could derive usable data. The SSI incidence following TMA is clearly significant and may lead to surgical revision, prolonged hospitalisation, increased costs and increased patient morbidity and mortality.[2,3,16] There is clearly a significant evidence gap regarding the clinical and cost effectiveness of interventions to reduce SSI following TMA. This evidence gap should be addressed with high-quality well-designed clinical studies using appropriately designed core outcome sets.

None of the five studies categorised SSI severity, primarily due to limitations in defining SSIs. Clinically it can be difficult to classify SSI severity according to CDC criteria (superficial, deep or organ/space) without imaging (CT or MRI) or surgical exploration. Perhaps future studies should consider using a more clinically relevant severity classification.

Conclusion

We report the overall incidence of SSI in patients undergoing TMA for vascular disease at 24.0%. Due to the small number of patients, including only one RCT which was further stratified for different antibiotic use and poor reporting standards of non-randomised studies, it is difficult to draw any firm conclusions regarding the true SSI rate in this patient population. We recommend multicentre high-quality studies in patients undergoing TMA, with specific focus on SSI and its prevention, using valid, reliable and responsive outcomes which are important to patients, clinicians and healthcare services.

KEY MESSAGES

- This is the first systematic review to report the pooled incidence of surgical site infections (SSIs) following transmetatarsal amputation (TMA) for diabetic foot or peripheral arterial disease.
- This systematic review identified five papers with 233 TMA, with a SSI rate of 24.0%.
- None of the five studies categorised SSI severity, primarily due to limitations in defining SSIs.
- We recommend multicentre high-quality studies in patients undergoing TMA, with specific focus on SSI and its prevention.

Conflict of Interest: The authors declare that there is no conflict of interest.

Funding: None.

Acknowledgement: Black Country Vascular Network.

Reviewer acknowledgement: *JVSGBI* thanks Joseph Shalhoub, Imperial College Healthcare NHS Trust & Imperial College London and Jane Todhunter, Advanced Vascular Nurse Practitioner, SVN, for their contribution to the peer review of this work.

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J.Vasc.Soc.G.B.Irel. 2024;3(4):209-217
http://doi.org/10.54522/jvsgbi.2024.140

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ORIG RESEARCH

Evaluation of the quality of phantom limb pain information on YouTube

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Received: 27th June 2024
Accepted: 5th August 2024
Online: 29th August 2024

Plain English Summary

Why we undertook the work: Pain after the amputation of a limb is extremely common (95% of people). Of the different types of pain that patients can experience after amputation, 80% of patients experience phantom limb pain, which can have a significant effect on quality of life. Treatment options for phantom limb pain are expanding. Patients often access information about their health online, particularly through videos on YouTube. To our knowledge there has not been any previous study looking at the quality of information available to the public about phantom limb pain, and the authors wanted to find out more about how accurate and useful information available on YouTube is for patients suffering from this condition.

What we did: We identified the first 50 videos from a search on YouTube using the phrase 'pain after amputation', with 35 videos included for assessment. Two of the authors analysed these videos using five different measurement tools looking at various aspects of the quality, reliability and how understandable and actionable these videos are for patients.

What we found: Overall, the content of YouTube videos was of low to moderate quality, which is lower than studies looking at other pain-related conditions. There was no link between how high a particular video comes up on a search and its quality. There was also no strong link between the source of the information and quality; we found that even videos published by more reputable sources were not of higher quality.

What this means: The findings of this study highlight the challenges that patients suffering from pain after amputation may come up against when using online information to find out more about their condition. It may be difficult to find accurate, useful information about explanations and treatment options, and there is a potential to access incorrect information and advice. This is important for both patients to understand and also the healthcare professionals caring for them, and shows there is a need for easily accessible high quality health-related information. The quality assessment tools currently available are readily accessible and easy to use, so there is a potential for healthcare professionals to independently assess online resources.

Abstract

Background: Patients more frequently seek health-related information from online sources, including YouTube. Phantom limb pain (PLP) is a complex problem, with evolving research into its pathophysiology and management. As healthcare professionals, it is important to be aware of the quality of publicly accessible information. This study aimed to investigate the reliability and quality of YouTube videos about PLP.

Methods: 50 videos were identified from YouTube using the search term 'pain after amputation'. Sources and video parameters were documented. Two assessors examined the videos independently using five scoring systems including the *Journal of American Medical Association* (*JAMA*) Benchmark criteria, the Global Quality Score (GQS), a Subjective score, and the Patient Education Materials Assessment Tool for Audio-Visual Materials (PEMAT-A/V). At the time of video identification, the assessors included one final year medical student with an interest in anaesthetics and one anaesthetic speciality trainee doctor.

Results: Our study indicates that the overall quality and reliability of YouTube videos covering PLP is poor, with mean *JAMA*, GQS, Subjective, PEMAT-A/V Understandability, and PEMAT-A/V Actionability scores of 2.07 (minimum and maximum scores of 0 and 4), 2.66 (minimum and maximum scores of 1 and 5), 3.76 (minimum and maximum scores of 0 and 10), 16.67% (minimum and maximum scores of 0% and 100%) and 40.88% (minimum and maximum scores of 0% and 100%) respectively, demonstrating the inadequacy of currently available

online information. The percentage range of videos that were deemed high quality was 9–26%. We also found that videos that patients access more readily (calculated using an interaction index) are not necessarily of a higher quality, and that the publisher (ie, the professional, patient, independent academic or company who uploaded the video) of the content has no significant effect on the quality of the video (p=0.704, p=0.580, p=0.086, p=0.432, p=0.364).

Conclusions: Online audiovisual PLP-related information is of poor quality. When patients are searching for information online they are more likely to be directed to content that is inadequate and of poor quality. Clinicians should be aware of the quality of information that is available to patients. Higher quality videos are essential to aid patient understanding of PLP.

Key words: YouTube, phantom limb pain, health information, information quality, patient education

Introduction

Pain after amputation is an almost universal symptom in amputee patients with 95% reporting amputation-related pain.[1] Of these, phantom limb pain (PLP) is the most prevalent at 80%.[1] Increasing numbers of patients are undergoing amputations; an estimated prevalence rate in the UK is 26.3 per 100,000.[2] PLP significantly reduces quality of life[3] and has a large impact on the workforce and economic society.[4]

Research around amputation has been named as a priority area by The Vascular Priority Setting Partnership[5] in conjunction with the James Lind Alliance who play a pivotal role in directing the national research agenda based on workshops involving patients, carers and healthcare professionals. This study looks at one of the specific questions within this agenda: "How do we improve the information provided to patients undergoing amputation?". This highlights the importance of healthcare providers understanding the information that is accessible by the public.

Patients often access health-related information related to their existing conditions or symptoms, with online video-streaming sites a popular method.[6] Of the video-streaming sites, YouTube is the most commonly accessed in the world.[7] YouTube is an extremely popular and accessible hub of information with users simply requiring an internet connection and an audiovisual device such as a PC or mobile phone to engage with content on the site.[8] However, validity of information on the internet cannot be guaranteed[9] as there are no required standards for medical information that is published online and there are no restrictions for who can publish and upload YouTube videos regardless of qualifications or profession.[10] Information surrounding the mechanisms and treatment options for PLP is a rapidly developing field of medical research,[11] indicating that this may be a particularly relevant problem in publicly available information on PLP.

Multiple studies have assessed patient-centred health information on the internet for other conditions[12–14] and, to the best of our knowledge, this is the first time it has been done for PLP. In a study by Kwan *et al*[13] the authors investigated the reliability of internet-based information about statin therapy using the Global Quality Score (GQS) and *Journal of American Medical Association* (*JAMA*) Benchmark criteria and found that on the whole there was no significant correlation between video characteristics and content quality other than number of days since publication (p=0.022). The overall content quality on YouTube about hip osteoarthritis was poor in a number of studies with the range of videos of poor educational quality between 64% and 91%.[14–16]

The discourse varies about the reliability of video resources regarding chronic pain and chronic pain syndromes. Altun *et al*[12] evaluated video sources on YouTube covering complex regional pain syndrome using the GQS and *JAMA* scores and found that the majority of content was of intermediate to high quality. Furthermore, higher quality content achieved higher interaction indexes than lower quality videos (p=0.010), with patient sources being of a lower quality than information from health professionals (p<0.001). Other studies have investigated the online available content surrounding different types of pain such as inflammatory back pain, post-COVID pain and neck pain. The overall quality of videos were poor, with only 19–21% of high quality and 35% of moderate to high quality.[17,18] Authors have also found statistically significant differences between the source type and content quality, with 57.9–79.2% of high quality videos published by academics, professional organisations and healthcare sources.[17–19]

This study aims to evaluate the available online information from video sources publicly available on the topic of PLP.

Methods

This descriptive research evaluates information that is publicly accessible therefore does not require ethical committee approval.

Video identification

Videos were identified on YouTube (https://www.youtube.com) from a single IP address in Liverpool, UK without signing into a Google account using the search term 'pain after amputation'. Video identification took place between 12 November 2023 and 30 November 2023. The search results were sorted by relevance. Videos were first screened for duplicates and for those with a duration of less than 1 minute including 'YouTube Shorts' content; these videos were not assessed. After this screening process, the first 50 videos were recorded.

Exclusion criteria consisted of: (1) videos not in English; (2)

videos with a lack of relevance for patients (ie, intended for healthcare staff); (3) videos that did not focus on the search topic; (4) videos that were inaccessible (requiring sign-in, age restricted, region blocked); and (5) videos without a focus on PLP.

Video evaluation

Videos were assessed separately by two of the researchers independently. The following video characteristics were recorded: (1) title; (2) duration; (3) number of views; (4) number of likes; (5) number of dislikes; (6) source type; (7) number of days since upload; (8) viewing rate (number of views/number of days since upload × 100%); and (9) interaction index (number of likes and dislikes/total number of views × 100%).[12] Source type was defined by the authors and videos were grouped into assigned categories. Viewing rate was intended to estimate the number of views, irrespective of the time that the video has been available on YouTube. Similarly, the interaction index was intended to determine the number of interactions (both positive and negative) that a video has per view, indicating increased levels of viewer engagement. These metrics were used in this study as the authors did not have access to more in-depth video characteristics such as average view time.

All 35 included videos were evaluated by the two researchers separately. Assessment of the quality and the ability of the videos to provide better education to the viewer was evaluated using the following scores/tools: (1) Global Quality Score (GQS); (2) Subjective score; (3) Patient Education Materials Assessment Tool for Audio-Visual Materials (PEMAT A/V) Understandability tool; (4) PEMAT A/V Actionability tool. Assessment of the reliability of the videos was evaluated using the *JAMA* Benchmark criteria.

The GQS grading system devised by Bernard *et al*[20] provides a score of 1–5 based on the quality of the videos, with 1 being the lowest quality and 5 being the highest quality: (1) low quality, video information flow weak, most information is missing, not beneficial for patients; (2) low quality, low flow of information, some listed information and many important issues are missing, very limited use for patients; (3) moderate quality, insufficient flow of information, some important information is sufficiently discussed, but some are poorly discussed and somewhat useful for patients; (4) good quality and generally good information flow, most relevant information is listed but some topics are not covered, useful for patients; (5) excellent quality and information flow, very useful for patients.[21]

The Subjective score was developed by the authors and again provides a score of 0–10 based on the quality of the videos, with 1 being the lowest quality and 5 being the highest quality. A score of 0–2 (0: not mentioned, 1: mentioned with little detail, 2: mentioned with good detail) is provided for each of the following points: (1) possible causes of pain after amputation; (2) symptoms of PLP; (3) pharmacological options for PLP; (4) non-pharmacological options for PLP; (5) mention of psychological/MDT support as part of holistic management.

The PEMAT A/V tools are widely accepted methods for assessing the understandability and actionability of audiovisual materials. The extensive list of the items is available at https://www.ahrq.gov/health-literacy/patient-education/pemat-av.html, where each item is given a rating of either 0 ('disagree') or 1 ('agree'), or sometimes not given a ranking ('not applicable') depending on what is being assessed.[22]

The *JAMA* Benchmark criteria use four core standards to grade the reliability of each video on a scale of 0–4 based on the following criteria, where each is given a score of 0 or 1: authorship, attribution, disclosure, currency.[23]

Statistics

All statistical analyses were conducted using SPSS v.29.0.1.0 (171).

The interobserver correlation coefficient (ICC) was calculated between the two researchers for the *JAMA* criteria, GQS scores, Subjective scores, PEMAT A/V Actionability scores and PEMAT A/V Understandability scores (see Appendix 1 online at www.jvsgbi.com). The Shapiro–Wilks test was used to determine normality for all variables as our sample number was <50.[24,25] Either Spearman's or Pearson's correlation coefficients were used to investigate statistical significance between the video characteristics and the quality scores individually. Either one-way ANOVA or Kruskal–Wallis tests were then performed to investigate statistical significance between the source type and the quality scores.

Results

Video assessment

The YouTube search was performed with the term 'pain after amputation', allowing for the identification of the first 50 videos. Videos were included if they were not duplicates and they did not fall into the 'YouTube Shorts' content category or have a duration of less than 1 minute. The process of video selection is shown in the flow diagram in Figure 1.

The 50 videos were then screened for our exclusion criteria, with full details presented in Figure 1. The included videos (n=35) were categorised by source type into the following four main source types: independent academic channels, healthcare providers, doctors with independent channels, and patient testimonies. A representation of the different source types is shown in Figure 2.

The characteristics of all included videos are shown in Table 1, with the mean values displayed. The mean viewing rate was 3681.36 and the mean interaction index was 1.80.

The mean and median scores of the included videos are shown in Table 2. The quality scores were low, in particular the subjective score with a median of 3 out of 10. In addition, the PEMAT A/V Actionability score was very low with a mean score of only 16.67%.

Interobserver agreements were calculated and demonstrated that all quality and reliability scores showed excellent interrater reliability between the two researchers. This information is presented in the Appendix. The parameters for quality and reliability were then sub-categorised into low, moderate and high content

Figure 1 Flow diagram of the video selection process.

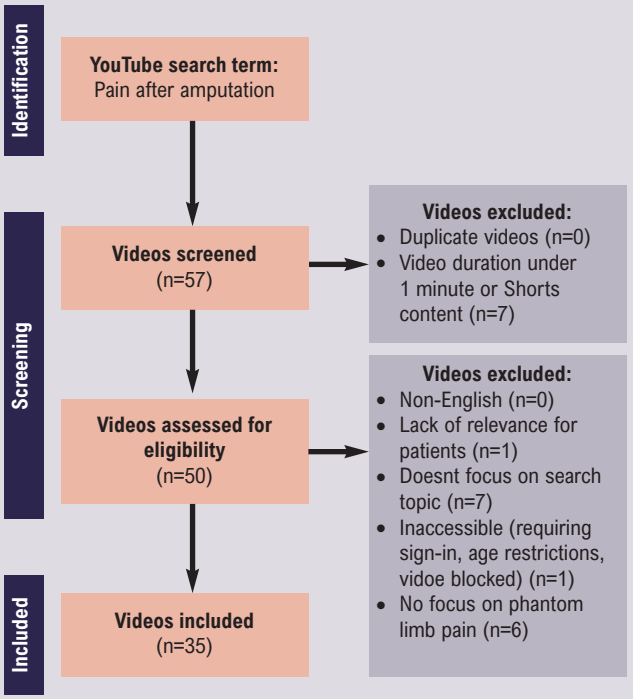

Figure 2 Pie chart showing the source types of the included videos.

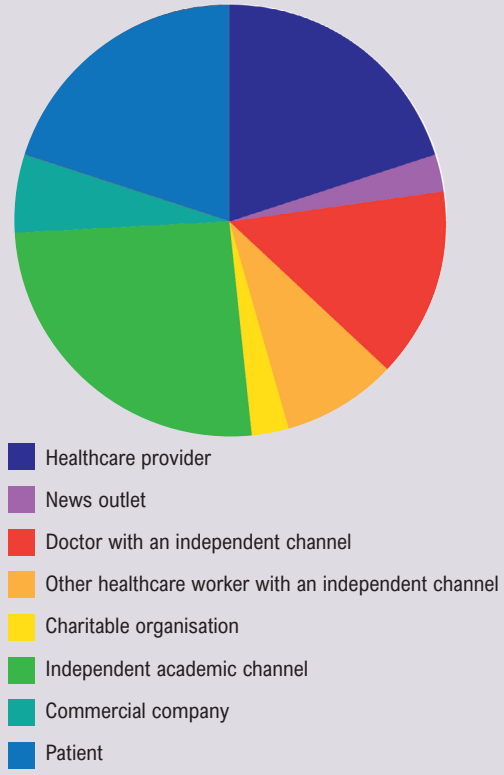

Table 1 Basic video characteristics.

Characteristics	Mean (minimum–maximum)
Video duration (min)	6.32 (1.28–20.40)
Number of views	55057 (242–774,769)
Number of likes	1207 (0–20,792)
Number of dislikes	18 (0–257)
Number of days since publication	1774 (9–4657)
Viewing rate	3681.36 (18–41,454)
Interaction index	1.80 (0.13–6.19)

Table 2 Overall quality and reliability scores of the videos including the minimum-maximum possible scores of each scoring system

	Possible (minimum–maximum)	Mean	Median
GQS score	1–5	2.66	2.5
Subjective score	0–10	3.76	3
PEMAT A/V Understandability score	0–100	40.88	–
PEMAT A/V Actionability score	0–100	16.67	–
JAMA Benchmark criteria	0–4	2.07	2

GQS, Global Quality Score; *JAMA, Journal of American Medical Association*; PEMAT, Patient Education Materials Assessment Tool for Audio-Visual Materials.

quality. The number of videos that fit into each quality and reliability score is shown in Table 3.

The Shapiro–Wilks test for normality was performed for all variables and showed that 'number of days since publication', 'GQS score' and the 'PEMAT Understandability score' were normally distributed, while all other variables were not normally distributed.

We investigated the correlation between the different quality and reliability scores using the Spearman's correlation coefficient when one or neither variable was normally distributed or the Pearson's correlation coefficient when both variables were normally distributed. From this analysis we found that many of the quality scores were statistically different from one another including the comparison between the GQS and the *JAMA* criteria ($p=0.039$), the Subjective score ($p<0.001$) and the PEMAT Understandability score ($p<0.001$). There were further statistically significant differences between the Subjective score and the PEMAT Understandability score ($p=0.021$) and the PEMAT Actionability score ($p=0.011$). Finally, the difference between the PEMAT Understandability and Actionability scores was statistically significant ($p=0.001$). These data are shown in Table 4.

We compared video characteristics data and quality scores

Table 3 Assessment parameter sub-categorisation into low, moderate and high content quality

	Quality scores	Number of videos (n=35)
GQS score (1–5 points)	Low content quality (1–2 points)	15 (43)
	Moderate content quality (2.5–3.5 points)	11 (31)
	High content quality (4–5 points)	9 (26)
Subjective score (0–10 points)	Low content quality (0–3 points)	19 (54)
	Moderate content quality (3.5–6.5 points)	10 (29)
	High content quality (7–10 points)	6 (17)
PEMAT A/V Understandability score (%)	Low content quality (0–33.32%)	14 (40)
	Moderate content quality (33.33–66.66%)	18 (51)
	High content quality (66.67–100%)	3 (9)
PEMAT A/V Actionability score (%)	Low content quality (0–33.32%)	24 (69)
	Moderate content quality (33.33–66.66%)	7 (20)
	High content quality (66.67–100%)	4 (11)
JAMA Benchmark criteria (0–4 points)	Low content quality (0–1 points)	7 (20)
	Moderate content quality (1.5–2.5 points)	20 (57)
	High content quality (3–4 points)	8 (23)

Values are presented as number (%).
GQS, Global Quality Score; *JAMA, Journal of American Medical Association*; PEMAT A/V, Patient Education Materials Assessment Tool for Audio-Visual Materials.

Table 4 Significance between quality scores

	JAMA	GQS	Subjective score	PEMAT Understandability score	PEMAT Actionability score
JAMA	–	–	–	–	–
GQS	0.039* (0.350)	–	–	–	–
Subjective score	0.232 (0.207)	<0.001* (0.845)	–	–	–
PEMAT Understandability score	0.602 (0.091)	<0.001* (0.871)	0.021* (0.390)	–	–
PEMAT Actionability score	0.215 (0.215)	0.068 (0.312)	0.011* (0.424)	0.001* (0.531)	–

Values are presented as p values (Pearson's/Spearman's correlation coefficient).
*Statistically significant difference.
GQS, Global Quality Score; *JAMA, Journal of American Medical Association*; PEMAT A/V, Patient Education Materials Assessment Tool for Audio-Visual Materials.

using the Spearman's correlation coefficient when one or neither variable was normally distributed or the Pearson's correlation coefficient when both variables were normally distributed. Statistical significance was found between 'Duration' and the GQS (p=0.022) and Subjective (p=0.044) quality scores, as well as between 'View number' and the PEMAT Actionability score (p=0.014). These data are shown in Table 5.

We then compared the source type to the quality scores using the one-way ANOVA test for the normally distributed GQS and PEMAT Understandability scores and the Kruskal–Wallis test for the remaining non-normally distributed scores. No statistical significance was found between source type and all of the quality scores individually. These data are shown in Table 6.

Discussion

The internet has become a regular source of healthcare-related information due to its highly accessible and inexpensive nature; often it is far quicker for patients to search the internet than to seek advice from their own healthcare professional. It is, however, an unregulated landscape which requires thorough evaluation in order to determine the overall quality and reliability of the information that patients are most likely to access.

The overall quality of the videos that we evaluated in this study was low to moderate, with the mean proportions of the low, moderate and high groups across all scoring systems of 45%, 40% and 17%, respectively. Furthermore, the largest proportion of videos fell into the low quality category when using the GQS,

Table 5 Significance between quality scores and video characteristics

	JAMA	GQS	Subjective score	PEMAT Understandability score	PEMAT Actionability score
Duration	0.086 (0.294)	0.022* (0.392)	0.044* (0.343)	0.222 (–0.212)	0.635 (0.083)
View number	0.889 (–0.024)	0.156 (0.245)	0.112 (0.274)	0.089 (0.292)	0.014* (0.410)
Like number	0.888 (0.025)	0.056 (0.326)	0.188 (0.228)	0.124 (0.265)	0.037 (0.354)
Dislike number	0.945 (–0.012)	0.370 (0.159)	0.317 (0.177)	0.615 (0.089)	0.149 (0.253)
Days since publication	0.174 (–0.232)	0.141 (–0.254)	0.777 (–0.050)	0.208 (0.231)	0.170 (0.237)
Interaction index	0.863 (0.031)	0.061 (0.324)	0.550 (0.106)	0.861 (0.031)	0.836 (–0.037)
Viewing rate	0.331 (0.169)	0.051 (0.338)	0.132 (0.259)	0.466 (0.127)	0.121 (0.267)

Values are presented as p values (correlation coefficient).
*Statistically significant difference.
GQS, Global Quality Score; *JAMA, Journal of American Medical Association*; PEMAT A/V, Patient Education Materials Assessment Tool for Audio-Visual Materials.

Table 6 Significance between quality score and source type (p values)

Quality score	p-value
GQS score	0.704
Subjective score	0.580
PEMAT A/V Understandability score	0.086
PEMAT A/V Actionability score	0.432
JAMA Benchmark criteria	0.364

GQS, Global Quality Score; *JAMA, Journal of American Medical Association*;
PEMAT A/V, Patient Education Materials Assessment Tool for Audio-Visual Materials.

Subjective and PEMAT A/V Actionability score (43%, 54%, 69%), while moderate quality content was the largest when using the PEMAT A/V Understandability score and the *JAMA* Benchmark criteria (51%, 57%). The particularly high prevalence of low quality content when using the PEMAT A/V Actionability score could be due to a number of reasons. First, the videos that we analysed were generally intended to demystify the phenomenon of PLP and not designed to provide actionable avenues for patients to explore. The 3–4 criteria (depending on if there are charts, graphs, tables or diagrams) are also extremely specific and challenging to meet, making it difficult to score highly. This indicates that the audiovisual materials for PLP available on YouTube may not be of an adequate quality to provide patients with accurate and important information about this highly prevalent symptom. This in turn may lead to the spread of misinformation, causing patients to misunderstand and potentially doubt the advice they have been given by specialists.

Altun *et al*[12] investigated the quality of YouTube resources for complex regional pain syndrome and found that the information was of a much higher quality than in our study, and that this content was interacted with much more than videos of poorer quality. This could indicate that publicly available audiovisual materials about complex regional pain syndrome are of much higher quality than those covering PLP. We propose that alternative explanations of this could be that PLP is a less well understood condition or possibly that the algorithm is less well suited to the terminology used around pain after amputation. However, our study is not the first to indicate that health-related YouTube content is not of a satisfactory quality. Studies that analysed the content covering other pain-related topics found that only 19–21% of videos were of high quality,[17,18] which is similar to our findings (GQS: 26%, Subjective score: 17%, PEMAT A/V Understandability score: 9%, PEMAT A/V Actionability score: 11%, *JAMA* Benchmark criteria: 23%) and that 64–91% were of poor quality,[14–16] which overall was higher than the results of our study (GQS: 43%, Subjective score: 54%, PEMAT A/V Understandability score: 40%, PEMAT A/V Actionability Score: 69%, *JAMA* Benchmark criteria: 20%). These findings may indicate a general lack of quality in healthcare-related audiovisual materials on YouTube that is not limited to just PLP but also to other pain-related conditions.

Of the first 50 videos (after exclusion of short-form content <1 minute), 14 were deemed irrelevant to the search topic or not pitched at a patient level by the two researchers. This could indicate that, when patients seek health-related information on these sites, they could find it challenging to identify suitable sources of information that are relevant to them. The promotion of irrelevant information may cause patients to gain a false understanding of symptoms and diseases which could have a number of consequences such as following incorrect advice and misunderstanding essential information about their condition, which could be damaging to both physical and psychological health.

During our initial search, seven videos were excluded as 'YouTube Shorts' content as the length of these videos would likely negatively influence their quality scores due to a simple lack of time to convey enough information, and the algorithm is different from the traditional YouTube algorithm meaning it would be unfair to

compare long-form and short-form content together. It is important to note, however, the high number of views that these videos had at the time of the researchers' initial video search, with an average view count of 1,142,857. As short-form content becomes more prevalent with the rise in popularity of features and applications such as 'YouTube Shorts', 'Instagram Reels' and 'TikTok'; more research is also needed to evaluate the quality and reliability, particularly with the higher engagement levels that this type of content achieves.

The *JAMA* Benchmark criteria indicate the reliability of the source depending on how much information is disclosed to the viewer. In our study, 77% of included videos were classified into the 'low' or 'moderate' quality measures based on these criteria, which may indicate that highly recommended videos may have a high risk of publisher bias which in turn damages the credibility of the source. This is made more apparent considering that all videos scored one point for currency, as all videos uploaded on YouTube are required to publish an upload date.

Currently the literature does not present a clear picture as to whether higher quality videos covering health-related topics are more readily recommended to patients and are accessed more frequently. In our study there was no overall correlation between the degree of interaction with the videos and the quality, with the only significant difference being between the view number and the PEMAT A/V Actionability score (p=0.014). However, Altun *et al*[12] found that, in videos covering complex regional pain syndrome, higher quality content achieved higher interaction indexes than lower quality videos (p=0.010). This could indicate that patients who access YouTube in search of PLP-related educational content will predominantly access low quality and potentially misleading videos, which could be damaging for the patient population. It is unclear why differences are apparent when analysing complex regional pain syndrome versus PLP, and more research needs to be done to analyse whether this is the case for other health conditions.

It is expected that seeking information from sources such as healthcare professionals or academic channels would produce higher quality and more reliable information; however, our study has shown that there is no statistically significant difference between the quality of the information provided and the source type. This does not agree with some of the findings in the literature which have previously found statistically significant differences between the quality and the source type, particularly that videos published by healthcare professionals and academics are of a higher quality than those published by patients. These findings could indicate that more regulated and higher-quality content should be published on YouTube by healthcare professionals or healthcare organisations regarding PLP to allow patients to access more accurate information.

This research has significant implications for patients who suffer with pain after amputation and the clinicians who care for them. This study alters perceptions about how patients access information, the quality of the content that they are accessing, and gives an indication of how misinformation can spread within patient communities. Future research should focus on more specific reasons as to why patients access the information that they do, and how we can improve the online information landscape for PLP and other conditions. Furthermore, our understanding about online information sharing must improve in order to determine the optimal way to distribute accurate health-related online content and how such videos should be developed.

Strengths

To our knowledge, this is the first study to assess the quality and reliability of YouTube sources covering the topic of PLP, meaning that our study can aid patients to make decisions about where they seek health-related information on the internet. Our study also identified sources using popular search strategies in line with how a lay person would access information, increasing the reliability and accuracy of our results. To reduce subjectivity, two evaluators independently evaluated each source and used non-subjective grading criteria as well as subjective grading criteria. This use of multiple grading criteria also decreased the potential for inaccuracies to arise.

Limitations

The primary limitation of our study is that it is cross-sectional and only represents a snapshot in time of the ever-changing landscape of online content, and there is a possibility that the same study would produce different results if it was repeated over a different time period. During the initial video search the two assessors were not signed in; however, YouTube still uses a personalised algorithm meaning that patients may not be recommended the same first 50 videos as the assessors accessed. For patients who viewed the content, they may have been signed in and so this algorithm may in effect be potentially artificially inflating view numbers (including of 'poor quality' content) and is a confounder when investigating the relationship between video characteristics and quality. It is also important to note that there was no consideration of 'cookies' when the assessors completed their video identification, which may have affected the search results.

There is a debate over what constitutes a high quality source, meaning the use of scoring systems will never represent a completely accurate analysis of quality.[26] The subjective scoring criteria relies upon researchers creating domain-specific instruments based on medical guidelines, textbooks, literature and medical expertise to guide the evaluation of the quality of the content, which is something that the validated tools used do not address.[26] The lack of correlation between the different scoring systems makes this apparent, and emphasises that no single scoring system can provide a definition of quality. Other studies have previously developed new grading systems for the audiovisual content, which is something that this study does not explore and could be a better determinant of quality than the existing systems.[27]

KEY MESSAGES

- The public is increasingly using YouTube videos to gain knowledge on health-related issues as well as other online content platforms such as 'Instagram' and 'TikTok'.
- Healthcare providers have a responsibility to understand the information that is accessible by patients.
- There is a need for improved quality scoring systems for health-related audiovisual online information.
- High quality online educational videos are required to effectively guide patients.

Recommendations

The quality and reliability of videos related to PLP on YouTube is insufficient, which might lead to the spread of misinformation within the patient population. The systems for grading these parameters are not adequate, so a generalised method of analysis is needed for future researchers. To address the issues that this paper identifies, we recommend a higher level of regulation by video publishing platforms to limit the spread of poor quality health-related information or, alternatively, to provide better support to professionals involved in patient care to evaluate sources that their patients are reviewing to ensure they are viewing high quality content. Furthermore, to ensure that future research studies can assess audiovisual materials accurately, it is necessary to increase education and training for researchers with online tutorials about health information evaluation. It may also be possible to design tools that automatically detect quality indicators such as the tool created by Griffiths *et al*.[28]

Conclusion

This study demonstrates that, when patients seek health-related information from YouTube, they are likely to be presented with inadequate and poor quality information. It also shows that YouTube's independent engagement statistics such as likes and views should not be considered indicators of quality. This is highly relevant to clinicians, as they must understand what information patients are likely to come across from their independent research in order to tailor their own communication to patients. It is also important to understand which sources of information patients value the most, including whether they value content from other patients or non-patient sources. Furthermore, patients will continue to access these sources due to their easily accessible nature, so high quality educational videos are needed to effectively guide patients on the complex condition that is PLP.

Conflict of Interest: The authors declare that there is no conflict of interest.

Funding: None.

Reviewer acknowledgement: *JVSGBI* thanks Louise Tisdale, Clinical Specialist Physiotherapist Amputee Rehab, Royal Wolverhampton NHS Trust and Brenig Gwilym, South East Wales Vascular Network, for their contribution to the peer review of this work.

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Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2024;3(4):218-225
http://doi.org/10.54522/jvsgbi.2024.136

www.jvsgbi.com

ORIGINAL RESEARCH

A case study project to explore physiotherapists' experiences of using removable rigid dressings with patients post transtibial amputation in the UK

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Received: 28th February 2024
Accepted: 17th June 2024
Online: 16th August 2024

Plain English Summary

Why we undertook the work: A transtibial amputation involves removal of a leg between the knee and ankle joint. Guidelines advise that after amputation a removable solid or semi-solid shell that extends to at least the knee is placed around the wound while healing takes place; this is called a removable rigid dressing. At present removable rigid dressings are not widely used in the UK and little is known about the experiences of using them. This study was therefore designed to look at the experiences of physiotherapists who have used removable rigid dressings.

What we did: We interviewed physiotherapists who had experience of using removable rigid dressings with patients as part of their rehabilitation. Ten physiotherapists who worked in acute hospitals and rehabilitation centres within the UK were included. Data from the interviews were analysed by looking for codes and then themes. Trustworthiness of the study was increased as researchers worked as a team to analyse the data and participants were then asked to check that the results reflected their views.

What we found: We found three themes from the interviews: (1) application of removable rigid dressings; (2) removable rigid dressing design; and (3) education and training related to use of removable rigid dressings and the advantages and disadvantages that can occur with these.

What this means: To make sure removable rigid dressings are used in the most effective way, the design and education and training provided needs to be thought about to achieve as many of the possible positive effects while reducing any potential negative effects. More research is required to work out the best design for removable rigid dressings and what education and training is needed.

Abstract

Introduction: Removable rigid dressings (RRDs) provide a solid or semi-solid shell around the residual limb post transtibial amputation. Clinical guidelines advocate the use of RRDs; however, in practice they are not widely used and little is known about the experiences of using them. This study explored the experiences of physiotherapists who have used RRDs with patients post transtibial amputation.

Methods: Qualitative research methods involving a constructivist epistemological approach with inductive reasoning and a case-study methodology were employed. Semi-structured interviews were completed with 10 physiotherapists from acute hospitals and rehabilitation centres within the UK. Thematic analysis was verified through respondent validation and researcher corroboration.

Results: The three themes identified were (1) application of RRDs; (2) RRD design; and (3) education and training related to the use of RRDs, and the associated advantages and disadvantages concerning these.

Conclusions: To ensure RRDs are used as part of patient rehabilitation most effectively, the design and education and training provided needs to be considered to achieve as many of the possible positive effects whilst minimising potential negative effects. Further research is needed on the design of RRDs and the education and training required.

Key words: transtibial amputation, removable rigid dressing, physiotherapy, qualitative study

Introduction

Traditionally, post transtibial amputation (TTA) a soft dressing consisting of elasticated bandage and padding would be applied in theatre and kept on for up to five days. In 1969, Berlemont *et al* challenged the use of soft dressings with a rigid plaster replacement.[1] Soft dressings have since been associated with pressure sores and persistent oedema.[2] However, lack of access to inspect wounds with a rigid plaster dressing resulted in fears of wound breakdown.[3]

In response to the desire to regularly inspect the residual limb, Wu *et al* designed a removable rigid dressing (RRD) made from plaster cast and socks.[4] It was noted that RRDs provided progressive compression of the residuum, contributing to a reduction in average healing time from 109.5 days in the control group to 46.2 days in the study group.[4] Reduction in healing time is of particular importance for TTAs, as prosthetic rehabilitation becomes more expensive and less successful the longer it is delayed postoperatively.[2] Since this early work, RRDs have evolved to either be 'off-the-shelf' vacuum-formed dressings or custom made from casting materials. All provide a solid or semi-solid shell around the residuum and are removable for wound inspection, exercises and hygiene. RRDs can finish above or below the patella depending on the type used and clinical reasoning.

Clinical guidelines worldwide recommend RRDs post TTA to manage oedema, promote healing, protect the residuum and reduce incidence of fixed flexion deformities at the knee.[5–7] However, it is acknowledged within the clinical guidelines that limitations of the current literature include small sample sizes with poorly defined outcome measures.[5–7] Adherence to the guidelines is poor, with 72.27% of physiotherapists surveyed in the UK not using RRDs post TTA, although the survey return rate was not published raising questions regarding non-response bias.[8]

The literature investigating RRD effectiveness is inconsistent. Deutsch *et al* found no significant difference (p=0.61) in length of stay with an average 15.5 days spent in hospital post amputation when using an RRD and 17.4 days in the control group.[9] However, Taylor *et al* reported a significant (p=0.001) reduction in acute inpatient length of stay from an average of 15.9 days to 8.7 days with the use of an RRD.[10]

A narrative review by Reichmann *et al* concluded that RRDs should be the first treatment choice post TTA to optimise outcomes with regard to reduction in injury post fall, knee flexion contractures, oedema, healing time, time to prosthetic fitting and pain.[11] Although the narrative review involved a comprehensive literature search and appraisal process, as expected with a narrative review rather than a systematic review, it was a literature summary with no control of bias.[11]

Meta-analyses have been used to compare soft dressings to RRDs with results dependent on the criteria for the included literature. In 2019 Kwah *et al* focused on randomised controlled trials or quasi-randomised controlled trials, concluding that the benefits and harms of RRDs were still unknown due to very low-certainty evidence.[12] More recently in 2023, Koonalinthip *et al* added in non-randomised studies to their meta-analysis and concluded that RRDs are significantly favourable to soft dressings when examining time to wound healing and prosthetic fitting, stump volume, postoperative pain and incidence of revision or joint contracture. However, Koonalinthip *et al* acknowledge that caution is needed in interpreting their results due to a high risk of bias within the studies included.[13]

In summary, due to lack of clarity in the literature for the multidisciplinary team and patients to make a fully informed decision on dressing type, more information is needed on the experiences of using RRDs. This study aimed to explore the experiences of physiotherapists who have used or are using RRDs with patients post TTA.

Methods

This study has been reported adhering to the Consolidated Criteria for Reporting Qualitative Research (COREQ).[14]

The study sought to explore and understand experiences by adopting qualitative research methods. More specifically, the philosophical underpinning involved a relativist ontological stance whereby it was accepted that multiple realities were created by participants' subjective understandings.[15] A constructivist epistemological approach was used to accept that reality is socially constructed.[16] The relativist ontological stance and constructivist epistemological approach involved the use of inductive reasoning, allowing the researcher to create theory by understanding patterns.[15] Case study methodology with semi-structured interviews was chosen to reflect the philosophical underpinning and to generate rich exploratory data with new thinking and ideas.[17] A case study is usually considered a retrospective investigation into an event that has occurred and, in this project, the event was the use of RRDs on patients.[18]

Agreement was granted by the British Association of Chartered Physiotherapists in limb Absence Rehabilitation (BACPAR) Executive Committee to advertise the study to their members. BACPAR membership was chosen as it provides a UK network for physiotherapists specialising in limb absence rehabilitation. Given that 72.27% of physiotherapists working in amputee rehabilitation report not using RRDs in practice, it was expected that there would be few potential participants from which to recruit.[8] A purposeful approach, whereby participants were selected for convenience with additional snowballing was therefore used to maximise participants.[19] Participants were screened for suitability using the following inclusion criteria:

- Physiotherapist registered with the Health and Care Professions Council
- Able to read, understand and speak fluent English
- Able to participate in a virtual interview
- Experience of using an RRD with patients in hospital post TTA within the past 5 years
- To not be receiving any financial incentives from or work for a company marketing RRDs

Table 1 Removable rigid dressings (RRDs) used by participants.

Participant	RRD design	RRD type	Length of dressing
P1	Off-the-shelf	Vacuum formed	Above the knee
P2	Custom made	Scotchcast	Below the knee
P3	Custom made	Plaster of Paris	Above the knee
P4	Off-the-shelf	Vacuum formed	Above the knee
P5	Off-the-shelf	Vacuum formed	Above the knee
P6	Off-the-shelf	Vacuum formed	Above the knee
P7	Custom made	Plaster of Paris	Below the knee
P8	Custom made	Plaster of Paris	Below the knee
P9	Custom made	Scotchcast	Above the knee
P10	Off-the-shelf	Vacuum formed	Above the knee

Ten volunteers met the inclusion criteria and took part in the study; five primarily had experience using custom made RRDs and the other five using 'off-the-shelf' RRDs, as shown in Table 1. Participants identified seven different acute or rehabilitation centres within the UK where they had mainly used RRDs. All participants who started went on to complete the study. Qualitative research is required by the COREQ checklist to consider data saturation, although the meaning of data saturation is poorly defined with variation in meaning.[19,20] In this study saturation was considered to have been reached as data were only adding to a code rather than leading to the emergence of new codes.[21]

The lead researcher, who was a physiotherapist completing an MSc and who had recently undertaken qualitative research training as part of her studies, collected the data. The lead researcher was working in the field of amputee rehabilitation at the time of the research and knew two of the participants through her involvement with BACPAR. However, the lead researcher had no prior experience of RRD use. The insider status allowed the lead researcher to understand medical terminology used by participants and build a rapport without risk of her own experiences influencing discussions.

One 30 minute interview was conducted for each participant. All interviews were virtual using Webex in the lead researcher's home or workplace and were captured using both audio and visual recording. Field notes were made as appropriate after each interview rather than during the interview to reduce distraction. The interview process and guide was piloted with one participant. No changes were required, therefore permission was gained from the participant to include their data in the study. Interviews were professionally transcribed and participants conducted respondent validation of the transcript; changes requested were made.

Ethics approval was granted by the University of Kent on the 21 August 2021. Participants were provided with a Participant Information Leaflet to ensure they were fully informed on their right to withdraw, confidentiality and anonymity. Participants signed a consent form before interviews commenced.

Data analysis

Thematic analysis was used to systematically create meaning from data, comprising four stages.[21] Data analysis took place concurrently with data collection to allow for follow-up of emerging ideas, moving backwards and forwards between the stages.[21]

To enhance credibility, researcher corroboration was used as a form of inter-rater reliability throughout the coding, categorisation and theming. In addition, participants were given the opportunity to 'member-check' the final analysis and confirm that their contributions had not been misinterpreted or misrepresented.

Results

The codes, categories and themes identified from the data analysis are shown in Table 2. Coding produced 17 codes from the data and categorising led to six categories. Finally, theming resulted in three themes: (1) application of RRDs; (2) RRD design; and (3) education and training related to the use of RRDs.

Application of RRDs

Application of RRDs included the effects of using RRDs correctly that were reported by participants. Effects were mainly positive, with just one potential negative.

Participants discussed the importance of RRDs for residual limb protection and explained 'protection' was one of the main reasons for RRD use. The solid construction was noted to provide protection in the event of a fall or trauma that can occur during daily activities: *"It's [RRD] also an extra layer of protection when they're in bed, so if they're rolling around and accidently knock their leg … It's an extra layer to, to help with that." (P4)* Participants also mentioned positive effects of RRDs on residual limb oedema, although effectiveness was affected by timing, with application in theatre giving favourable results. *"It [RRD] does contain the swelling to a certain degree, although perhaps not as much as it would if put on in theatre." (P3)*

As well as oedema reduction, improvements in residual limb shape ready for prosthetics were reported. *"I would say, probably the stumps are a bit better shaped and a bit less oedematous because of the use of RRDs."(P1)* RRDs were also described as helping to prepare for prosthetics by increasing tolerance to pressure: *"[Positives of RRDs] Getting used to actually being enclosed in something for a significant part of the day. So that definitely will help patients when they're actually getting used to the wearing tolerance of the socket." (P8)*

Patient confidence towards rehabilitation and activity were reported to improve with RRD use. It was not only patients who were noted to be more confident; staff confidence improved as well: *"I think they [RRDs] give them [patients], more confidence and clinicians kind of peace of mind as well that they've done everything in their power to protect that vulnerable, healing leg."*

Table 2 Codes, categories and themes identified from the project data

Code number	Code title	Categories title	Category definition	Theme title	Theme definition
1	Residual limb oedema control	**Positives from correct application of RRDs**	Positive effects of using RRDs correctly that were reported by physiotherapists	**Application of RRDs**	Effects of using RRDs associated with correct application that were reported by physiotherapists
2	Residual limb preparation				
3	Residuum limb protection				
4	Patient confidence				
5	Staff confidence				
6	Length of stay				
7	Patient anxiety	**Negatives from correct application of RRDs**	Negative effects of using RRDs correctly that were reported by physiotherapists		
8	Cost-effectiveness	**Positives from RRDs due to design**	Positive effects from the RRD design that were reported by physiotherapists	**RRD design**	Effects of using RRDs associated with dressing design
9	Ease of use				
10	Prevention of knee flexion contracture				
11	Patient comfort	**Negatives from RRDs due to design**	Negative effects from the RRD design that were reported by physiotherapists		
12	Skin damage				
13	Restrictiveness				
14	Patient adherence	**Positives from education and training related to use of RRDs**	Positive effects from education and training related to the use of RRDs that were reported by physiotherapists	**Education and training related to use of RRDs**	Effects of using RRDs associated with education and training that were reported by physiotherapists
15	Patient skills				
16	Staff understanding	**Negatives from education and training needs related to use of RRDs**	Negative effects from education and training needs related to the use of RRDs that were reported by physiotherapists		
17	Incorrect use				

RRD, removable rigid dressing

(P7) Participants suggested length of stay was reduced due to improvement in patient confidence from RRD use. However, others acknowledged the impact of numerous factors upon length of stay: *"Length of stay-wise, potentially there is [a benefit], because again we don't have as many wound issues and the rehab's being speeded up. But it's hard to put length of stay down to just one thing, isn't it?" (P2)*

The only negative code within the theme was 'patient anxiety', which occurred due to being asked to use RRDs: *"To put a great big dressing on gives, could give, if they're healed and further down the line, it could give them a bit of a negative message about moving and fear." (P7)* Patient anxiety was also noted to occur when RRD use was discontinued, potentially reducing patient progress: *"I've had a few patients who have got quite attached to having it, their leg covered and … yes, so they were kind of declining taking it [RRD] off and moving to the next steps." (P5)* It was debatable whether 'patient anxiety' would be better placed in the 'Education and training related to the use of RRDs' theme. However, despite appropriate education and training, patient anxiety related to RRD use could still be an issue.

RRD design

The theme included effects of using RRDs associated with design. Codes related to RRD design did not always have exclusively positive or negative effects.

Generally, participants viewed RRDs as simple to use for the multidisciplinary team and patients: *"Patients can take it on and off really easily." (P9)* However, other participants reported requiring two staff members to reapply RRDs when the patient was less able to help or noticed that method of securing RRDs affected ease of application: *"Sometimes patients find them difficult because the Velcro is sticky, so if that gets a bit crinkled, that can be a little bit tricky for them." (P6)*

The design of RRD and cost impacted participants' perceptions

of effectiveness. One participant felt RRDs were not cost-effective as they are single-patient use: *"They are not cost-effective, perhaps, if you could clean them it would be better, it seems such a waste to put them in the bin if they have not stayed on long." (P10)*. In contrast, others compared the cost of the RRDs to the potential cost of residual limb complications and concluded cost effectiveness: *"I would say they probably are [cost effective]. I think the consequences of not using them are probably quite significant … prosthetically if someone has a fixed flexion contracture then that's a nightmare to manage." (P5)*

Participants reported prevention of knee flexion contractures as a benefit of RRDs extending above the knee joint; for those that do not routinely go above the knee participants explained they could be extended when required: *"Occasionally we can do them [RRDs] above the knee, if someone's got fixed flexion, we almost like serial cast them into more extension." (P2)*

Skin damage was a major risk linked to RRD design. Participants reported patients could actively flex within some types of RRDs, resulting in patella pressure sores. Participants commonly talked about the potential for skin damage to the residual limb and noted it could occur on the remaining limb too: *"The bulky corners could dig into the remaining limb, causing pressure problems and potential lesions." (P10)* Additionally, participants suggested some RRDs cause patient discomfort with heat and bulkiness whereas others were unaware of any problems with comfort. As well as causing discomfort, bulkiness was also described as restricting patients, making it harder to complete personal activities of daily living: *"For personal care and toileting, it [RRD] gets in the way." (P4)*

Education and training related to the use of RRDs

The theme included the effects of using RRDs associated with education and training that were reported by participants. This considered education and training of staff within the multidisciplinary team and patients.

Through the use of RRDs, patients were noted to learn how to manage the number of socks to obtain a comfortable fit, a skill required when using a prosthesis: *"I'd definitely say there have been some patients who have begun to understand sock management. Because actually they have had to add socks." (P8)* Patient education on benefits and reasons for use was noted to improve the likelihood of patients wearing RRDs: *"Generally, people got into the habit of it [wearing RRDs] and if you explained … it's to protect your wound so to get you … further along your rehab, then they were on board with it." (P7)*

As identified in RRD design, RRDs used incorrectly were reported to risk skin breakdown, RRD breakage or a loss of the potential benefits of RRDs: *"Sometimes if the patella window's not cut adequately then they can get pressure areas across the patella." (P9)*

Education and training were mentioned as areas where improvement was essential to prevent negative experiences, and development of competencies was suggested as a method of preventing incorrect use: *"We probably need to roll out some more regular training and develop competencies for the ward staff. I think the whole being able to put it on correctly is the biggest element to it." (P4)*

Discussion

The discussion explores the relationship between the three themes derived from data analysis and the previous literature.

Application of RRDs

Preparation for prosthetics as a benefit from using RRDs was identified from the literature and the results of this study.[11,13] A major component of preparation for prosthetics is residual limb oedema control. The use of RRDs for oedema control is widely publicised within professional guidelines and there was a risk that participants would cite guidelines rather than their own experiences.[5–7] However, it was found that participants related to their own practice and questioned if greater benefits in oedema control could be seen with earlier application of RRDs.

The other component of preparation for prosthetics is residual limb preparation. Increased tolerance to residual limb pressure was described in this study and has been previously discussed by Hughes et al in their reflective account.[22] In this study, limb shape was also suggested to be improved with RRD use. It was not explored in the literature reviewed and, since it is affected by surgical approach, technique and skin condition, it is difficult to assess objectively.

Another common theme in the literature was residual limb protection, with outcome measures focusing on damage sustained or need for revision surgery.[11,13] In this study, protection from falls featured in the participants' comments, but importance of protection was also noted for activities of daily living. Studies investigating protective effects of RRDs using complications or falls as outcome measures may miss recording the more subtle effects.

The combination of residual limb protection and increased confidence was speculated by participants to contribute to a reduction in length of stay. Logically, if residual limb complications are reduced through improved protection and both patients and staff are more confident to participate in rehabilitation, length of stay may decrease. Previous studies have demonstrated an inconsistent impact on length of stay with RRD use, and it has been suggested that length of stay may be approaching the minimum number of days as other factors such as adequate pain control or availability of a care package prevent further reductions.[9,10]

Patient anxiety was the only negative effect identified from correct application of RRDs. Anxiety occurred due to fear from the need for a large dressing and apprehension at the time of removal. This negative effect from covering the residual limb with a RRD had not been previously discussed in the literature reviewed and is an important consideration.

Design of RRDs

Some of the positive and negative effects identified in this study are specific to certain materials and designs of RRDs, and these effects are encompassed in this theme. However, it is beyond the scope of this study to compare effects of different RRD designs.

Prevention of knee flexion contracture was one of the most apparent ways in which design affected the outcomes from RRD use. RRDs extending above the patella were reported by participants and in the literature to be beneficial in helping prevent knee flexion contractures.[11,13] With contractures affecting only 13% of transtibial amputees in hospital and small sample sizes in research, it has been difficult to demonstrate statistical significance.[23] The benefits of RRDs going above the patella and potentially preventing knee flexion contractures require balancing against potential negatives. Participants reported some patients still flex their knee within the RRD, causing patella pressure damage. Others found that dressings above the patella had potential to cause skin damage to the remaining limb. Additionally, participants suggested other design factors played a part in skin problems, comfort and restrictiveness, with certain materials causing perspiration or bulkiness affecting clothing that could be worn.

The design of RRDs affected their ease of use for both patients and members of the multidisciplinary team. Generally, design made RRDs easy to use but there were elements of design that increased application difficulty. Going forward it would be useful to consider whether ease of use can be improved through design, education and training or potentially a combination of both.

The cost of providing RRDs was determined by design and some custom types required further RRDs to be manufactured when oedema reduced. Generally, participants reported RRDs to be cost-effective when considered against potential costs of complications, such as knee flexion contractures or trauma to the residuum. It has been claimed in the literature that RRDs are more costly than standard dressings, but this study highlighted that those costs need to be balanced against potential cost savings.[12]

Education and training related to the use of RRDs

Provision of education and training related to the use of RRDs was reported by participants to lead to positive effects if done well, or negative effects such as incorrect use of RRDs when education and training were not effective.

Positive effects included patient acquisition of skills that are important for use of prosthetics, such as sock management which may make it easier for patients to adapt to prosthetic use. It was also noted that provision of education and training to patients helped to encourage adherence, despite problems with discomfort and restrictiveness, as it created a greater understanding.

Negative effects related to education and training mainly revolved around staff understanding and incorrect use. Participants identified that greater benefits and fewer negatives could have been achieved from RRD use if the multidisciplinary team used them more effectively. The development of formal training and competencies for staff using RRDs, as suggested by participants, would be a useful consideration if not already in place. The role of education and training had not been explored in the literature reviewed, possibly because, when conducting research, the environment is often artificial without the impact of real-life factors within a healthcare environment such as high staff turnover, and education and training may therefore have not been an issue.

Methodological considerations

A case study methodology with virtual semi-structured interviews was used to answer the research question. Virtual interviews had the advantage of using the valuable visual cues and body language that traditional 'gold standard' face-to-face interviews offer.[24] They also allowed access to participants from a much wider geographical area without travel costs or time constraints.[25] Completing interviews virtually created technological challenges too. Participants experienced difficulties accessing the virtual meeting as many were not familiar with the platform used. The technological difficulties may have assisted in establishing rapport as the researcher and participant worked together to resolve problems.[26] However, technological difficulties also caused delays to interview start times and stress to both participants and researcher. Despite the difficulties encountered with virtual interviews and the technology used, they were still found to be an effective method of data collection to answer the research question.

This project had the time and financial budget available to include more than 10 participants. However, the limiting factor was the number of people who volunteered to be interviewed. Given that 72.27% of physiotherapists surveyed in the UK were not using RRDs with patients, there was not a large pool from which to draw volunteers.[8] Purposeful recruitment with additional snowballing led to some participants having their main experience of using RRDs at the same centre. The methodological underpinning of this study recognised that individual participants would have different subjective understandings regardless of the centre where experience took place and that participants may have prior experiences from previous education and practice that influence them. It could be argued that physiotherapists using RRDs are likely to have been proactive in establishing their use and be generally positive about the benefits. However, participants were included if they had experience of using RRDs within the last five years, so they were not necessarily still using them. It may be useful for future studies to examine continuation rates after RRD use has been introduced to a service and underpinning reasons.

This study could be expanded further by seeking the views of physiotherapists from other countries. The researchers also recognise that it would be useful for future work to explore experiences of patients and other members of the multidisciplinary team such as surgeons, occupational therapists, prosthetists and nurses to establish a wider viewpoint.

KEY MESSAGES

- Clinical guidelines recommend the use of removable rigid dressings post transtibial amputation.
- There are both positive and negative experiences when physiotherapists use removable rigid dressings in practice.
- When introducing removable rigid dressings into practice the team needs to carefully consider the best removable rigid dressing design for their patients and service.
- When using removable rigid dressings education and training appropriate to the service needs to be provided for both patients and staff.

Conclusion

In the opinion of the participants, from correct application of RRDs five positive effects were identified: oedema control, preparation, protection, patient and staff confidence, and resultant potential for reduced length of stay. However, correct application of RRDs also brings potential for increased patient anxiety. The design of RRDs impacted experiences of physiotherapists. Generally, design was reported to make RRDs easy to use, useful for prevention of knee flexion contractures, and was considered cost-effective when compared with the potential complications of not using RRDs. However, design was also linked to potential skin problems, discomfort and restrictiveness. Further work is required to establish the optimal RRD design.

Education and training in relation to use of RRDs offers opportunity to teach patients skills ready for prosthetics and, when effective, was also noted to increase adherence to RRD use. However, ineffective education and training caused negative effects on staff understanding and application on patients. To improve within this area, participants suggested regular training and introduction of staff competencies.

This study identified a wide range of possible positive and negative effects within the themes generated. Choice of outcome measures and small sample sizes in previous research may have missed the more subtle but equally important effects from use of RRDs. This study may therefore guide outcome measures for future RRD research projects. Further research is required to expand this study, with inclusion of participants from a wider geographical area, involvement of other healthcare professions and patients, and investigation of the optimal design and education and training required for RRD use.

Conflict of Interest: The authors declare that there is no conflict of interest.

Funding: The authors disclose receipt of the following financial support for the research, authorship or publication of this article. This work was supported by the British Association of Chartered Physiotherapists in limb Absence Rehabilitation (BACPAR).

Acknowledgement: The authors thank the interview participants who very generously donated their time. Without them this project would not have been possible. The authors also thank Dr Anne-Maria Brennan for her academic support with this project.

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Reviewer acknowledgement: *JVSGBI* thanks Louise Tisdale, Clinical Specialist Physiotherapist Amputee Rehabilitation, Royal Wolverhampton NHS Trust and Elizabeth Bouch, Clinical Lead Physiotherapist Manchester Foundation Trust for their contribution to the peer review of this work.

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Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2024;3(4):226-230
http://doi.org/10.54522/jvsgbi.2024.135

www.jvsgbi.com

ORIGINAL RESEARCH

Thoracic outlet syndrome: a survey of operative practice amongst vascular surgeons

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Received: 22nd March 2024
Accepted: 5th June 2024
Online: 17th August 2024

Plain English Summary

Why we undertook the work: Thoracic outlet syndrome (TOS) is a condition that occurs when the nerves or blood vessels in the space between the collarbone and your first rib are compressed. This can lead to pain in the neck, shoulders and arms, as well as numbness in the fingers. Although TOS is relatively rare, it can impact a person's daily life. Identifying and treating TOS can be challenging, partly because there is no single definitive test for diagnosis, and treatment options can vary between surgeons. This study aims to better understand how vascular surgeons manage TOS.

What we did: A questionnaire made up of 12 questions covering various aspects of TOS operations was developed. This included assessment before surgery, surgical approaches and care following surgery. The survey was distributed online to vascular surgeons globally, allowing responses to be collected over eight months.

What we found: Eighty-one vascular surgeons responded, mainly from the UK. TOS operations were performed at multiple hospitals and the number of procedures differed amongst surgeons. Most operations addressed relieving the compression on the nerves or veins. While different surgical approaches were used, an incision above the collarbone was employed most frequently. The type and length of follow-up varied between the survey respondents. Most surgeons supported the idea of creating a database for TOS, where information about patient cases is collected and stored.

What this means: Our findings highlight how TOS is being managed by vascular surgeons. Creating a database for TOS operations could be valuable to better understand treatment options, patient outcomes and to help improve future care.

Abstract

Introduction: Thoracic outlet syndrome (TOS) poses a significant challenge in clinical management due to its varied presentation and impact on patients' quality of life. Currently, there are no standardised guidelines used for the management of these patients and guide surgical intervention. This survey aimed to assess practices related to the pre-, peri-, and postoperative management of patients with TOS amongst vascular surgeons.

Methods: This online cross-sectional survey was designed and distributed to vascular surgeons at consultant or specialist registrar levels. The survey was designed by two vascular surgery trainees and validated by vascular surgery consultants with a specialist interest in TOS. Data collection occurred over eight months through an online survey platform, and responses were analysed using descriptive statistics and narrative analysis.

Results: The survey was completed by 81 vascular surgeons. This included 55 consultant-level and 26 speciality registrar-level surgeons, primarily from the UK. Most survey respondents (86%) reported that their centre performed surgical decompression for TOS. The median number of cases performed by each centre annually was eight. Venous and neurogenic TOS were the most reported indications for surgical intervention (78%) and the supraclavicular approach was the most frequently used operative approach (87%). There did not appear to be any standardisation in postoperative management or follow-up, including reporting of treatment outcomes.

Conclusions: This survey highlights the significant variability in pre- and postoperative practices related to TOS among vascular surgeons. Further research, including observational studies, is needed to better understand the relationship of assessment, surgical approaches and perioperative care with patient outcomes to help guide future practice.

Key words: thoracic outlet syndrome, surgical decompression

Introduction

Surgical management for thoracic outlet syndrome (TOS) is undertaken in several surgical specialties including thoracic, plastic, vascular and neurosurgery.[1] The reported incidence of TOS is approximately 1–3 per 100,000;[2,3] however, despite the uncommon nature of this condition, it can have a significant impact on patients' quality of life.[4,5] Currently, there are no established guidelines for the surgical management of patients with TOS, although reporting standards published by the Society for Vascular Surgery in the USA have attempted to address this issue.[6] As a result, surgical practices are largely dictated by individual surgeon preferences,[7,8] which are likely to be influenced by training and experience.

More information is needed to better understand practices related to TOS and to explore the potential benefits of a registry to inform guidelines and clinical decisions. It is known that surgical registries offer numerous advantages including identifying practice trends, developing treatment protocols, directing research efforts and enhancing patient outcomes.[9] Establishing a registry for TOS operations would enable the collection, monitoring and analysis of data related to patient operative workup and outcomes. This data could significantly influence the development of national guidelines for diagnosing and managing patients with TOS.

We designed a specific questionnaire to explore current practices related to TOS including preoperative, operative and postoperative practices among vascular surgeons. It also aimed to establish the willingness of vascular surgeons to take part in a formal registry of patients with this condition who undergo surgical intervention.

Methods

This study is reported in line with the Checklist for Reporting of Survey Studies (CROSS).[10] A survey was designed by two vascular surgery trainees (AS and AE). The survey was validated after being piloted by four vascular surgery consultants (FS, LF, ADP and AG) who have a specialist interest in the management of TOS. Minor changes were then made to the survey including changing the formatting and wording of some of the questions to improve readability. The final version of the survey can be found in Appendix 1 online at www.jvsgbi.com.

An online cross-sectional survey assessing variability in practice related to the surgical management of patients with TOS was undertaken. The target population of the survey was vascular surgeons including those in specialist training programmes. The study was primarily designed to understand practices by vascular surgeons in the UK (there are approximately 400 consultant members of the Vascular Society of Great Britain and Ireland); however, it was also open to vascular surgeons internationally.

The survey consisted of 12 questions and comprised four main sections: identification of centres which carry out surgical decompression for TOS and estimated number of cases per annum; preoperative practice including assessment and indication for treatment; operative practice; and postoperative practice. The survey consisted of a combination of free-text responses and closed questions. It could be completed anonymously by the respondents, who also had the option of providing their email addresses to be involved in future studies on a voluntary basis.

Data collection and analysis

The survey was undertaken via the SurveyHero tool[11] and distributed via the VSGBI mailing list, UK national education programmes for trainees and social media platforms. The survey was open for a period of eight months from 1st February to 1st September 2020.

At the end of the survey period all the responses were collated and entered into Microsoft Excel for data cleaning and analysis. This was password-protected and could only be accessed by the first author (NA-S). At the end of the survey, participants had the option of providing an email address so that contact could be made regarding any future study. This information was also used to screen for multiple participation. For any duplicates identified, only the most recent response was included in the results. Incomplete survey responses were also included in the analysis. Missing data are clearly identified in the Results section. Free-text responses were collated, analysed and themes were identified, when possible, by the first author (NA-S) and reviewed and independently verified by another author (AS). Descriptive statistics including percentages and frequencies were used in the analysis of the closed questions. Graphical illustrations were created using GraphPad Prism version 10.

Ethical considerations

The surveys were all completed optionally by persons meeting the inclusion criteria listed above and consent was indicated by survey completion. Formal ethical approval was not sought as this work did not meet criteria to be classed as research using the Health Research Authority (HRA) decision tool.[12] Data were kept and managed in accordance with local governance policy with strict adherence to the Data Protection Act (1998) and the principles of Good Clinical Practice.[13]

Results

Survey respondents

This survey received responses from 81 vascular surgeons including 55 (68%) consultant level surgeons and 26 (32%) vascular speciality, non-consultant level surgeons. Due to the online nature of the survey and it being shared on social media, it was not possible to calculate a total response rate. Most respondents (70/81; 86%) stated that surgical decompression for the management of TOS was carried out at their vascular centre. The number of cases performed annually between the respondents ranged from 0 to 40 (Figure 1).

Of the respondents who provided their contact details (60/81), 41 (68%) worked at a vascular centre in the UK at the time of survey completion and 19 (32%) worked in other centres internationally (Figure 2).

Figure 1 Number of cases performed by survey respondents per year.

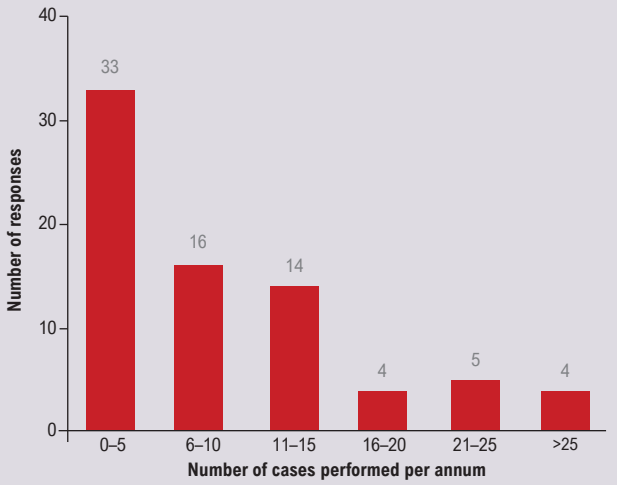


Figure 2 Number of survey respondents from each country.

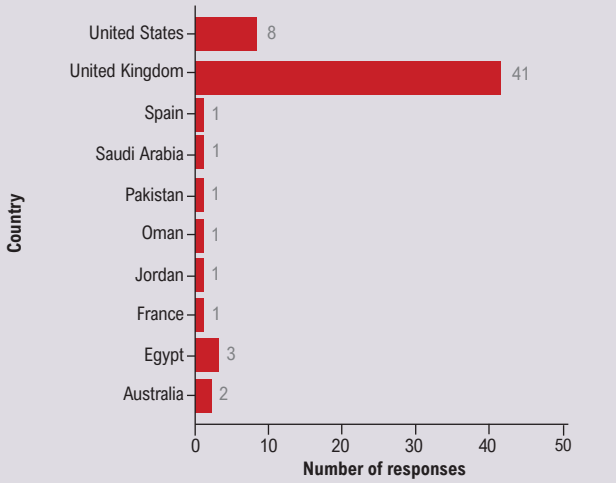
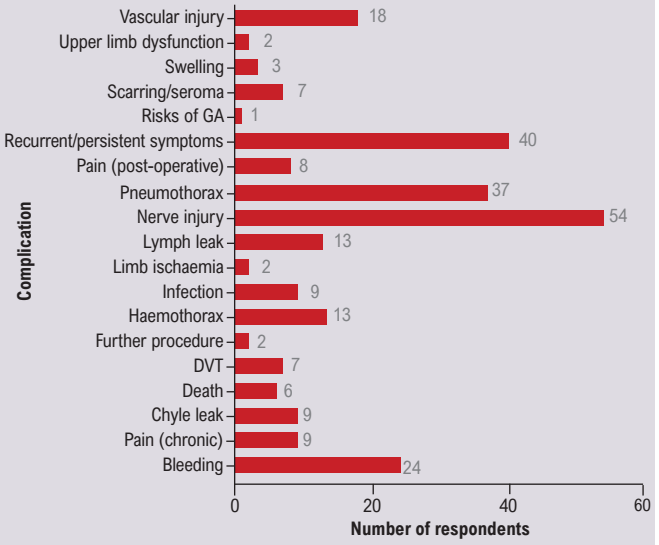


Figure 3 Risks and complications of surgical decompression of thoracic outlet syndrome described to the patients by the survey respondents.



Preoperative practice

The types of TOS most often referred for surgical decompression were venous TOS (VTOS) (25/65; 39%) or neurogenic TOS (NTOS) (25/65; 39%). Arterial TOS (ATOS) was reported as the most common indication for surgical intervention by 15 respondents (23%).

The most common operative risks explained to patients preoperatively were the risk of nerve injury (54/65, 83%), including mentioning injury to specific nerves (phrenic or long thoracic) and non-specific nerve injury, and recurrent or persistent symptoms (40/65, 62%). Other risks mentioned to patients included pneumothorax, haemothorax and bleeding (Figure 3).

Operative practice

There was varying practice in the surgical approach used to manage TOS between the respondents. The surgical approaches used included supraclavicular, infraclavicular, transaxillary, paraclavicular, transmanubrial or a combination of two or more of the approaches. The most common surgical approach used was the supraclavicular approach (54/62, 87%), followed by the transaxillary approach (21/62, 34%) and the infraclavicular approach (12/62, 19%). More than one-third of respondents used more than one surgical approach (23/62; 28%).

Postoperative practice

Most respondents (53/77; 69%) used routine clinical examination as their primary method of assessing patients' symptoms postoperatively. Some respondents (24/77; 31%) used an objective assessment of postoperative outcome including the disabilities of the arm, shoulder and hand (DASH) questionnaire (6/24; 25%) and postoperative imaging investigations (18/24; 50%).

Reported duration of follow-up postoperatively ranged from 1.5 months to 72 months. Median length of follow-up was 6 months (IQR 3–12 months). In the free-text responses some participants (5/64; 6%) noted that length of follow-up depended on the patient and symptom relief and one respondent reported they would continue to follow patients with TOS life-long.

Scope and support for a national TOS registry

Support for a national registry of patients who undergo an operation for TOS was expressed by 78/81 (96%) respondents and 65/81 (80%) welcomed being part of a discussion group to develop this.

Discussion

This study is the first survey to examine the practices of vascular surgeons regarding TOS and is the first survey to assess this to the best of the authors' knowledge. Survey respondents were primarily

from various centres throughout the UK. The limited representation of centres internationally could be due to the survey being distributed via UK-based society mailing lists and social media platforms. Most responses were from consultant vascular surgeons who are directly responsible for patients under their care and therefore most likely to be able to describe their perioperative practices.

Differences in the experience of vascular surgeons in the management of patients with TOS was demonstrated by this survey. Whilst most survey respondents reported that surgical decompression for TOS was undertaken at their centre, the annual number of cases performed at each centre varied. Twenty-five or more cases were performed annually by 17% of centres, with respondents from the remaining centres reporting fewer numbers of cases performed per year. This highlights that, although surgical decompression for TOS is carried out by multiple units across the UK, the volume of cases remains comparatively low when compared with other vascular surgery procedures. Also, given that only a small number of centres and/or surgeons are performing surgery for TOS decompression, there could be a case for supra-regional centralisation. In other areas of vascular surgery in the UK (complex aortic work), we have already seen this trend over the last decade. Furthermore, with the relatively low volume of cases, a comprehensive registry used to collect and analyse outcomes from all surgeries performed for patients with TOS could provide valuable insights to guide future practice.

The most common indications for surgical intervention were distributed equally between VTOS and NTOS. NTOS has often been cited as the most common type of TOS, accounting for over 90% of cases.[14] Although the incidence of VTOS is lower (8 per 100 0000),[3] our findings may be explained by a higher proportion of patients with VTOS being likely to require surgical intervention compared with those with NTOS. This is supported by a systematic review which described the management of most patients with NTOS as conservative in the first instance.[15] In contrast, the mainstay of interventional treatment for VTOS is thrombolysis before surgery, with anticoagulation alone associated with a high rate of vascular re-occlusion.[16] Patients with ATOS often require immediate surgical intervention for upper limb ischaemia.[17]

There was some variation in the complications mentioned by survey respondents during the consent process for surgery. Whilst most respondents cited nerve injury and persistent or recurrent symptoms as a risk, pneumothorax was mentioned less frequently. In a study assessing postoperative complications following surgical decompression for TOS, it was found that nerve injury, pneumothorax and haemothorax were the most frequently reported complications.[18] Despite this, over half of this survey's respondents did not mention pneumothorax or haemothorax as a complication of the operation. This could be explained by the interpretation of the survey question by respondents, with some only commenting on the main risks they mention in their consenting process and others listing all possible risks in the free-text response. To better inform the consent process for surgical decompression of TOS in the future, larger-scale observational studies are required, which may help to determine the incidence of these complications based on surgical approach and type of TOS. This may be useful in helping to develop standardised consent information for patients undergoing TOS procedures.

The surgical approaches used included supraclavicular, infraclavicular, paraclavicular, transaxillary and transmanubrial. The supraclavicular approach was employed most frequently. This approach has previously been described to permit a greater exposure of the thoracic outlet and of the structures above the first rib.[19] The use of more novel approaches, such as the video-assisted thoracoscopic and robot-assisted thoracoscopic approach[20,21] for TOS decompression, was not selected by any of the participants. The latter approaches are more commonly undertaken by thoracic surgeons and, as our survey was directed at vascular surgeons, this could explain why experience of these procedures was limited in this study. A greater understanding of the reasons why different approaches are employed by clinicians and outcomes associated with the use of each is one of the benefits a national registry could offer. It is important to note, however, that establishing a national registry demands substantial financial resources, expertise and approval from advisory groups.[22,23] With the creation of the national TOS dashboard, progress has already been made in this direction, which is promising.[24]

Most participants indicated they would rely on clinical evaluation for postoperative assessment, with objective tools being used less frequently. There was also considerable variation in the duration of postoperative follow-up among respondents. This variability in practice may be due to the lack of evidence regarding optimal methods and duration of postoperative follow-up for these patients. Clinician experience is likely to play a significant role in shaping individual surgeons' practice.

The DASH questionnaire was designed for the assessment of quality of life and functional recovery following surgery for musculoskeletal conditions.[25] There are no validated tools that measure similar outcomes specifically for patients with TOS. This is a potential reason why the use of DASH in the survey was low. However, specific reasons were not assessed in the scope of this study. A further understanding of this and the impact of longer follow-up periods on outcomes would be valuable for informing future practice.

The main limitation of this study is the random cross-sectional design. This may lead to some selection and reporting bias. However, we feel that this was the most appropriate way to increase participation in the study. Another limitation of our study included the small number of responses from participants outside the UK, suggesting that collaboration with other international societies could have enhanced the survey's reach and generalisability. Additionally, the contact details were available for only 60 respondents, preventing us from assessing the affiliations of the other participants or identifying potential duplicates in these responses.

KEY MESSAGES

- Thoracic outlet syndrome (TOS) poses challenges in diagnosis and treatment, with surgical practices varying widely among vascular surgeons based on individual preferences and experience.
- Establishing a registry for TOS procedures could help standardise treatment approaches and guide future research efforts in this field.
- There is a need for further research and collaboration to further our understanding of the surgical management of TOS and develop guidelines for the management of patients with this condition.

As the survey specifically targeted vascular surgeons, insights into the practices of thoracic and plastic surgeons remain unknown. It may be beneficial to undertake an international pan-surgical speciality survey to determine the experiences of vascular, plastic, thoracic and neurosurgeons in the management of patients with TOS.

Conclusion

This study has revealed that, although surgical decompression for TOS is uncommonly performed, there is variability in the preoperative and postoperative practices amongst vascular surgeons. Indications for operative decompression are more commonly neurogenic or venous TOS and the supraclavicular approach is the one most often used. Our results support undertaking an observational study to understand the impact of different practices on patient outcomes and the establishment of a registry for patients who undergo a surgical operation for TOS. This could guide future patient management and inform national guidelines.

Conflict of Interest: The authors declare that there is no conflict of interest.

Funding: None.

Reviewer acknowledgement: *JVSGBI* thanks Devaraj Srinivasamurthy, University Hospital Coventry & Warwickshire and Ian Chetter, Hull University Teaching Hospitals NHS Trust for their contribution to the peer review of this work.

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Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2024;3(4):231-238
http://doi.org/10.54522/jvsgbi.2024.138

www.jvsgbi.com

ORIGINAL RESEARCH

Understanding variation in the management of AAA in the UK: composition and function of multidisciplinary team meetings and information resources provided to patients

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Plain English Summary

Why we undertook the work: The 'aorta' is the largest blood vessel in the body. It starts at the heart and passes through the chest and tummy. Over time, the aorta can become bigger and weaker. When this happens, a person may have an abdominal aortic aneurysm (AAA). People do not normally feel unwell, but the aorta may burst and cause bleeding inside the body and death. If an AAA is diagnosed and the aorta reaches a certain size, a person can have an operation to repair it. This reduces the risk of the AAA bursting. The NHS performs about 6,000 AAA repairs each year in hospitals across the UK. To help doctors decide how to treat AAA, national guidelines are available. Despite this, there are large differences between hospitals in how AAAs are repaired, including who is offered treatment and the type of treatment that is carried out. These differences are not because of differences between patients (eg, age, sex, ethnicity). They suggest that medical teams have different ways of making decisions about who should have treatment for an AAA and how the treatment is carried out.

What we did: This study described how different medical teams at different hospitals make decisions about treating patients with AAA. Seventeen doctors (24% of centres) leading AAA care completed a questionnaire about how their service organises and delivers care. We used this information to describe how AAA care varies between hospital teams and explore how this might lead to different treatments offered to patients.

What we found: All centres hold multidisciplinary team (MDT) meetings with health professionals from different specialties. However, there were differences in who attended, and how and when the meetings occurred. Clinicians also reported differences in how they presented information about risk, how they ask patients about their preference for treatment, and how someone is managed if they are not suitable for surgery. The written patient information leaflets did not describe the 'non-surgical' option adequately.

What this means: The survey shows differences in how people with AAA are prepared and managed across UK vascular centres. Including the wider healthcare team, improving the way in which risk is presented to patients and defining a non-surgical pathway for those unsuitable for surgery may help improve consistency between hospitals for the management of people with AAA.

Abstract

Objective: Variation in abdominal aortic aneurysm (AAA) repair practice is reported nationally. This may be due to gaps in the evidence supporting clinical decision-making, historical preferences in repair practices within centres, and variation in decision-making in multidisciplinary team (MDT) meetings. This study aims to understand the reasons behind variation in AAA repair practices in UK NHS vascular centres in terms of MDT discussions, written patient information and patient involvement in decision-making.

Design: An observational, cross-sectional organisational survey of NHS vascular centres.

Methods: Consultant vascular surgeons at 50/72 UK centres were invited to participate in a researcher-administered survey. Centres were categorised using 2022 National Vascular Registry (NVR) dataset into low versus high endovascular aneurysm repair (EVAR) rates and low versus high rates of MDT review; the sample was stratified to achieve balance across the four groups. The survey captured centre characteristics, individual clinical decision-making practices, integration of patient perspectives within MDT decision-making and information provision.

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Received: 18th April 2024
Accepted: 11th July 2024
Online: 26th August 2024

Results: Seventeen clinicians completed the study (24% of centres). All centres hold MDT meetings but differ in composition, skills mix, remit and delivery. Variation was observed in how clinicians present risk information, elicit patient preferences and manage someone not deemed suitable for (or declining) repair. Written information given to patients to supplement consultations does not adequately describe the conservative management option.

Conclusions: This survey highlights variation in preparation and management of people under consideration for AAA repair across UK vascular centres. Improving input of other specialties, improving the presentation of risk to patients and defining active, non-surgical 'conservative management' pathways may help to improve the consistency of practice between vascular centres.

Key words: abdominal aortic aneurysm, clinical decision making, multidisciplinary team, vascular surgical procedures, endovascular repair

Introduction

There is marked national[1,2] and international[3] variation in abdominal aortic aneurysm (AAA) repair practice and, more specifically, in the proportion of patients undergoing open surgical repair (OSR), endovascular aneurysm repair (EVAR) or no repair (conservative management). In 2022, the UK National Vascular Registry (NVR) reported that 59% of 2,744 patients undergoing repair of infrarenal AAA had an image-guided minimally invasive EVAR. Rates per centre ranged from 22% to 97%.[1,2] For 1.2 million men screened via the national AAA screening programme (NAAASP) with an AAA that required consideration for elective repair from 2009 to 2016, decisions regarding patient suitability for repair varied between centres, with 'turndown rates' – that is, those not deemed suitable for (or declining) intervention – of between 2% and 22%.[1] These datasets identify significant regional variation in repair practice which cannot be explained by patient characteristics or case mix.[1,2]

Variation in AAA management may relate to a variety of reasons including gaps in the evidence base, historical preferences in repair practice and differences in the composition and function of multidisciplinary team (MDT) meetings.[4] MDT meetings are recommended to promote good quality clinical decision-making about AAA management within vascular surgery.[5] In 2022, an estimated 84% of patients with AAA were discussed at an MDT meeting.[2] As a minimum, the AAA MDT should include surgeons, interventional radiologists, anaesthetists and vascular nurses.[5] With an increasingly old, frail and co-morbid population presenting with AAA, it is recommended that a preoperative review from cardiologists and geriatricians is also included in any MDT discussion.[6]

MDT discussions add value due to the diverse clinical perspectives brought by different sub-speciality teams.[7] Describing the potential sources of variation in AAA repair practice (OSR, EVAR and conservative management) between vascular centres, and how the MDT manages the patient pathway and supports clinical decision-making and patient involvement, is an essential step to identifying opportunities to improve patient care.[5,8] This study aims to understand the reasons behind the variation in AAA repair practices across the UK in terms of MDT discussions and involvement of patients in decision-making. We also compare MDT implementation with best practice guidelines,[5,6,8] and describe the information resources provided to patients to support decision-making.

Methods

Design

An observational cross-sectional organisational survey was undertaken with the clinical lead (or a consultant vascular surgeon nominated by the clinical lead) within participating NHS vascular centres.

Sampling and recruitment

The sampling frame included all 72 UK centres; we aimed to recruit a third (n=24). Rates of EVAR versus OSR and the proportion of patients reviewed by an MDT were obtained from the 2022 NVR annual report.[2] Centres were categorised into high (≥60%) versus low (<60%) EVAR utilisation rates, and low (<90%) versus high (>90%) rates of MDT review. The centres sampled were then stratified, with purposive recruitment aiming to achieve a balance across the four groups so participating centres were sufficiently diverse to reveal variations in centres' organisation and delivery of AAA care. A member of the national (UK) Vascular and Endovascular Research Network (VERN: https://vascular-research.net/) contacted a local clinical lead in each centre and provided study information. Researcher (AW) organised interview times with participants, and verbal consent for study participation was confirmed prior to data collection.

Procedure

A study questionnaire (Item S1) was developed with an interdisciplinary and multiple stakeholder study team to capture details about:

- Centre and MDT composition and functional characteristics.
- Individual clinical decision-making practices within the context of the MDT.
- Integration of patient perspectives into MDT processes.

Clinicians received a copy of the survey in advance of the interview. Interviews were conducted using Microsoft teams or a telephone call. The researcher completed a paper copy of the questionnaire during the interview, capturing responses to closed questions and made brief notes on open-ended responses. Survey questions were read out verbatim to minimise interviewer bias. Video calls were recorded to ensure accurate capture of open-ended responses. A copy of the completed questionnaire was returned to the participant to check for accuracy. Participants were asked to provide copies of any written materials routinely provided to patients.

Data analysis

Data from the closed survey items were analysed using descriptive statistics (eg, proportions, medians and associated interquartile ranges (IQR)) and are presented in an aggregated format so individual centres cannot be identified. Responses to open-ended questions were transcribed verbatim and checked for accuracy before deleting the video recordings. Names and identifying characteristics were removed from data sets to ensure anonymity. Transcripts were coded and content analysis[9] was undertaken. Interviews were coded iteratively, with preliminary codes revised in light of coding of subsequent transcripts and applied to all interviews. Consistent with a content analysis approach, no individual quotes were used in the presentation of findings, with data presented descriptively. A three-tiered framework was adopted to understand clinicians' views on factors driving variation in AAA practice.[10] Standards for reporting qualitative research were followed.[11] The STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) checklist for observational, cross-sectional studies was followed.[12]

Research ethics and governance approvals

The protocol was approved by the University of Leeds School of Medicine Research Ethics Committee (ref: MREC 21-059; 28/08/2022) and the UK Health Research Authority (ref: 22/HRA/5341; 24/01/23).

Patient and public involvement

A co-author and expert patient (LR) provided input to all stages of the project.

Table 1 Descriptive characteristics of participating centres within the four sampling groups.

	Sampling frame cells			
	<60% EVAR <90% MDT	<60% EVAR >90% MDT	>60% EVAR <90% MDT	>60% EVAR >90% MDT
No of centres	5	4	3	5
NVR cases, median (IQR)	40.0 (29.5–56.5)	19.5 (12–51)	41.0 (39–41)*	40.0 (20.5–56.5)
EVAR, median (IQR)	52.0 (43–53.5)	47.0 (38.3–55)	73.0 (62–73)	64.0 (63–94.5)
Discuss MDT, median (IQR)	81.1 (63.9–83.5)	92.8 (91.9–95)	83.3 (80–83.3)	94 (92–97.4)

*25th and 50th percentile only in this cell.
EVAR, endovascular aneurysm repair; IQR, interquartile range; MDT, multidisciplinary team; NVR, National Vascular Registry.

Table 2 Composition and specialities invited and in regular attendance at regular and complex aortic MDT meetings.

	Regular MDT N (%) centres		Complex aortic MDT N (%) centres	
No of centres	17 (100)		8 (47)	
Frequency – weekly	13 (77)		5 (63)	
Format – hybrid	12 (70)		7 (78)	
Duration, min, median (IQR)	120 (112.5–210)		60 (33.8–142.5)	
	Invited N (%) centres	Regularly attend N (%) centres	Invited N (%) centres	Regularly attend N (%) centres
Vascular surgery	17 (100)	17 (100)	8 (100)	8 (100)
Vascular radiology	17 (100)	17 (100)	8 (100)	8 (100)
Vascular anaesthesia	11 (65)	9 (53)	4 (50)	3 (38)
Geriatric medicine	5 (29)	5 (29)	0 (0)	0 (0)
Clinical/vascular nurse specialist	15 (88)	15 (88)	5 (63)	5 (63)
Admin support	15 (88)	15 (88)	6 (75)	6 (75)
General medicine	1 (6)	0 (0)	1 (6)	1 (6)
'Other' health professionals*	10 (59)	7 (41)	3 (38)	2 (29)

*Other health professionals include cardiac, plastics and colorectal surgery, trainees, rheumatology.
MDT, multidisciplinary team..

Results

The VERN collaborator contacted consultant vascular surgeons at UK centres (n=72). One individual – either the clinical lead or vascular surgeon nominated to take part by the clinical lead – took part from each centre. Fifty of the 72 centres (69%) were contacted, at which point recruitment ceased due to time constraints. Seventeen (34%) of the 50 clinicians responded (24% of the total number of UK centres), divided roughly equally between the four groups (Table 1).

Composition of multidisciplinary team meetings

All 17 centres hold regularly timetabled MDT meetings at which patients with asymptomatic unrepaired AAA are discussed, and around half (n=8) convened additional MDT meetings to consider 'complex' patients (Table 2). The majority of centres reported a similar standardised procedure for referring patients to the meeting, supported by an MDT coordinator. Vascular surgeons and radiologists are invited and attend all regular vascular and complex aortic MDT meetings (Table 2). Almost all MDTs have clinical nurse

specialists and administrative support in regular attendance. Geriatrician and anaesthetist participation was less common. No centres invited patients or carers to attend MDT meetings.

The majority of centres (n=14/17, 82%) have a quorate number of attendees for the regular vascular MDT and half reported a minimum quorum for attendance at complex aortic meetings (n=4/8, 50%). Centres varied in the number of specialties required to be present at a regular vascular MDT, reporting between 1–2 radiologists and 1–3 surgeons. Of the eight centres holding a complex MDT, four (50%) reported that at least one radiologist and 1–2 surgeons were the minimum requirement, three centres (38%) did not know the quorate number and one (12%) reported that an anaesthetist was required to attend.

Quality assurance measures

Two-thirds of centres had written criteria for patient referral (n=11, 65%). Around half of centres (n=8, 47%) had written terms of reference describing the minimum quorum and skill mix, and documentation, minuting and communication supporting the meetings (n=9, 53%). Similarly, around half reported a regular audit of clinical outcomes that was fed back to the MDT (n=7, 47%). Typically, centres reviewed unexpected outcomes in either the MDT (n=9, 53%) or another forum (n=15, 88%).

Clinicians' beliefs about the role and function of the MDT

Clinicians (n=17) considered that the MDT is effective in achieving an evidence-based decision (median score 8 (IQR 6–8); scores range from 1 (not at all effective) to 10 (very effective). They reported being satisfied that MDTs include a range of specialties; decisions are based on 'best available' evidence; decisions are discussed and challenged, and processes are fair and transparent. A minority of respondents reported that MDTs are too time-pressured, especially for complex cases (n=3, 18%), too opinion-based (n=1, 6%) or have a tendency towards over-treatment (n=2, 12%).

Information used to support clinical decision-making

Routinely offered tests

Routinely offered tests are summarised in Figure 1. Most frequently, people are reviewed in a pre-operative assessment clinic (n=15, 88%) and by a consultant anaesthetist (n=12, 71%). Only two centres (12%) offer people with AAA a routine comprehensive geriatric assessment; five centres offered a 'frailty' review (n=3, 17%) or referral to a perioperative care for older people undergoing surgery (POPS) clinic (n=2, 12%).

Patient facing information

Patient facing information is provided from multiple sources including leaflets, introductory letters and web-based information (median 3 (IQR 2.5–3) sources per centre). Additional information included graphs of survival, risk information, NVR centre level data reports and the Carlisle risk prediction formula.

Patient information leaflets

Patient information leaflets are commonly used to supplement consultations. Fifteen centres provide written information to patients and 11 of these provided 16 leaflets to the investigators. Leaflets were produced in-house (n=10, 62%), by the Circulation Foundation (n=3, 19%), EIDO Healthcare (a private company producing health information resources to support informed consent) (n=2, 13%) and the Vascular Society (n=1, 6%). Five leaflets provided generic information about AAA and options for management and 11 were focused specifically on a particular repair type. None focused specifically on conservative management. We did not ascertain at which point in the patient pathway each leaflet was offered.

Leaflets presented risks as percentages, adjectives (high or low) or relative adjectives (higher, lower). Risks were overwhelmingly anchored to the risk of an event rather than the risk of no-event. No pictograms of risk were provided. No leaflet contextualised AAA risk within figures for overall (all-cause) medium- and long-term mortality risk. Uncertainties in the evidence base supporting repair decisions were not referenced in the majority of leaflets (14/16).

Six leaflets provided general health advice and management of cardiovascular risk. The effects of AAA diagnosis or repair on family, social and work life were described in 10/16 leaflets: the ability to drive, sexual function and exercise were the most common narratives. No leaflet provided advice on – or signposted to support for – the management of psychological aspects of an AAA diagnosis or end-of-life planning.

All procedure-specific leaflets provided detailed information on technique, likely inpatient experience, procedure risk, short- and long-term outcome and side effects. One leaflet included two vignettes of different decisions for repair. This leaflet advised thinking about personal priorities when making decisions. Other than this, no leaflets offered direction about how to make a repair decision or recommended discussion with friends, family, carers or professionals. All in-house leaflets signposted to telephone numbers for local clinical nurse specialists, vascular wards, and almost half to smoking cessation services (n=7, 44%) and the Circulation Foundation website (n=6, 38%). No leaflets signposted to a patient support network.

Describing risk and making decisions with patients

All participants reported using more than one method to discuss risk to support decision-making with patients (median 5 (IQR 3–6); Figure 2). Thirteen participants reported the annual risk of rupture for Caucasian males with a 5.5 cm AAA as between 1% and 5%; nine reported within this range for females. One participant reported the risk for males was between 6% and 10% and five reported within this range for females. A minority of participants used a verbal descriptor (n=3, 18%) or did not quote a figure (n=2, 12%). Risk of surgery was 'usually' (n=7, 41%) or 'sometimes' (n=7, 41%) contextualised within a patient's all-cause mortality risk when

Figure 1 Routinely offered preoperative tests.

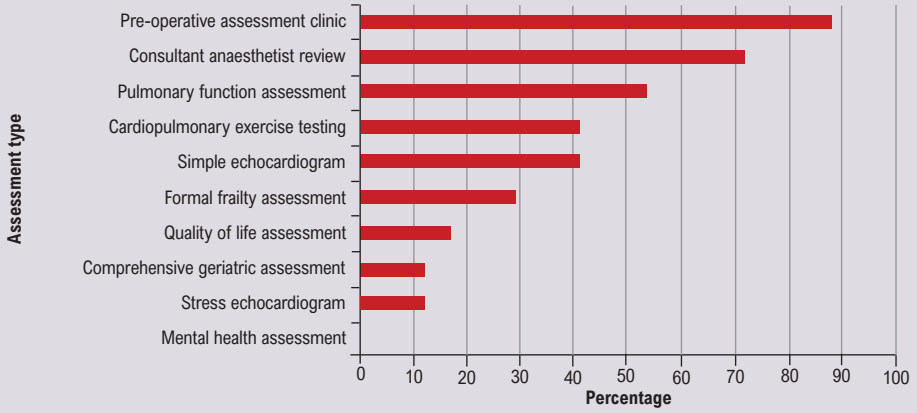
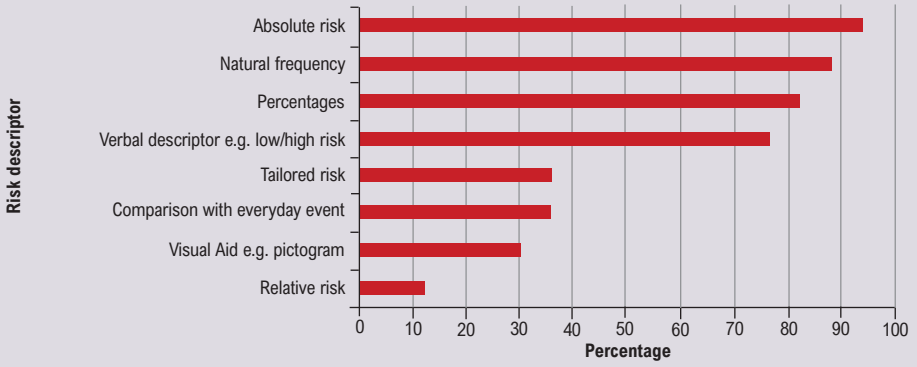


Figure 2 Techniques used to describe abdominal aortic aneurysm (AAA) surgical risks.



they are judged to be frail or co-morbid. Few vascular surgeons used tools such as the Vascular-POSSUM and Carlisle Risk indicator[13,14] to calculate all-cause mortality (n=3, 18%). Clinicians explained the decision options to their patients using a method (n=10, 59%) similar to the structure provided by the Choosing Wisely Patient Prompt – BRAN (benefits, risks, alternatives and doing nothing)[15]; two (12%) provided BRAN for their patients to use in consultations.

Including patient preference to support clinical decision-making

All participants reported ascertaining a patient's preference for surgery and eight (50%) reported a formal process for doing so. The majority of centres reported making patients aware that they will be discussed in a MDT in their absence (n=14, 82%). Patient preference was elicited by a surgeon or anaesthetist and recorded in hospital notes, letters to the GP and MDT meeting minutes. Clinicians (n=15) rated the MDT as effective in achieving a patient-centred decision (median 8 (IQR 5–9); scores range from 1 (not at all effective) to 10 (very effective)). Participants stated that time was spent understanding patient preferences, and patient wishes were respected even when treatment preference differed from the MDT recommendation. Barriers to understanding patient preference were identified if the referring clinician did not attend the meeting. Three participants felt that some patients welcomed a steer from their clinician towards a particular decision. Two participants did not provide a rating as they did not consider patient preference relevant for inclusion in MDT discussion.

Management of people unsuitable for surgical repair

The majority of participants (n=14, 82%) reported that all patients considered for repair are discussed at MDT meetings, but older, co-morbid and/or frail patients and those whose aneurysm is discovered through incidental screening may not be discussed. The definition of those deemed not suitable for surgery varied. Some participants (n=2) disliked the use of the phrase 'turn down' to describe someone deemed unsuitable for repair or those choosing not to have an intervention. The decision to forgo repair was described as either patient-led, a joint discussion between patient and clinician, or based on clinical judgements about the patient's best interests. Management of patients not undergoing repair included remaining on surveillance and offering repair at an

Table 3 Three-tiered framework for understanding clinicians' beliefs about variation in AAA repair practice

Factors that might drive variation in AAA repair practice		
Micro level, individual factors	Meso level, within service factors	Macro level, between service factors
Patients vary in their desire to be involved in decision making	Bias in performance indicator measurement. Centres that do a lot of complicated surgery with a good success rate are more likely to take on more of those cases	Centres organised in a hub and spoke model, some patients requiring specific type of repair are referred to another centre
Developing a relationship with patients is more important than the MDT recommendation in deciding how to manage AAA	Impact of impromptu meetings to discuss emergency cases outside of the MDT	Clinicians at an operating centre may not agree with tertiary referral treatment recommendation or may be uncertain how patient preferences were elicited prior to referral
Lack of confidence and skill in communicating about management of those suitable for a 'non-surgical' pathway	Time pressure to see patients coming through the screening programme puts a strain on the system	Centres differ in preoperative patient assessments and there is a lack of standardised approach to integrating patient preferences into the MDT
Inherent bias to treat with surgery and a drive to try out treatments that might not be in patients' best interests	Potential for over-treatment in larger centres where there is more supporting infrastructure (eg, available bed space)	Variable impact of NICE guidelines[6] and new scientific evidence on practice
Clinician and cultural bias to interpret acceptable risk for management options at different levels	Varying skill mix, experience and clinician preference both within and between centres	
Lack of input from other specialties (eg, geriatrics and cardiology) can impact on how decisions are made, especially for older people and more complex cases	Rationalising services as a result of the impact of COVID-19 (eg, an increase in thresholds for treatment, reduced postoperative follow-up of scan results)	No admin support to input NVR data so likely there are gaps in what is reported

AAA, abdominal aortic aneurysm; MDT, multidisciplinary team; NICE, National Institute for Health and Care Excellence; NVR, National Vascular Registry

increased AAA diameter, or removal from surveillance at the patient's request. The decisions in this group are recorded variously, either by communicating the decision with a GP (n=2, 12%), in the hospital electronic record (n=5, 29%), MDT minutes (n=4, 24%), recorded on a spreadsheet (n=5, 29%) or a combination of these processes. Some reported no formal record keeping (n=2, 12%).

Clinician beliefs about what drives variation in practice

Clinicians provided views on what drives variation in practice. This is summarised in Table 3 using a three-tiered framework.[10]

Discussion

This survey, completed by consultant vascular surgeons from a quarter of UK vascular hospital centres, provides an overview of how MDT meetings are structured to support clinical decision-making about AAA repair surgery.

Understanding variation in practice composition of the MDT

Quality standards introduced in 2012 recommend that each patient with an AAA should be reviewed preoperatively by an MDT.[5] All clinicians in participating centres reported regular MDT meetings, with around half also hosting MDTs dedicated to complex cases. There was considerable variation in the frequency, duration and skills mix of those invited and present at MDTs between centres, possibly accounted for by the size of centres. Internal governance procedures varied; not all MDT meetings are guided by standardised procedures and protocols or quality assurance mechanisms. This likely reflects the relative infancy of MDT meetings in this clinical space.[15] Vascular surgeons and anaesthetists reflected that clinicians' skills mix and differences in service infrastructure and referral patterns were likely to impact the pre-operative assessment and optimisation of patients undergoing elective AAA repair.[16] A lack of diversity in specialities attending the MDT has the potential to bias decision-making, as each speciality has its own goals and protocols, and without their contribution the overall clinical reasoning of a team may be impacted. Barriers to participation of all specialties were outside the scope of this study. However, previous work has described issues relating to both funding and availability of specialties such as geriatric medicine to attend surgical MDTs.[17] Enablers may include appropriate job planning or facilitative approaches such as virtual MDT meetings.

Information to support or bias shared decision-making with patients

NICE guidelines recommend that people with AAA are provided with information about their options for repair or conservative management, including risk figures and information about

uncertainties from the evidence.[6] Most commonly, clinicians report presenting treatment options in an outpatient consultation by describing an approach consistent with 'benefits, risks, alternatives and doing nothing' (BRAN). Presenting AAA repair as a choice between options is more likely to support patients to make trade-offs between management plans. However, written information provided about AAA repair is not balanced, focusing on preparing for surgery or making decisions between types of surgical procedures. Conservative management was not described actively. Patients are unlikely to be able to weigh up the pros and cons of 'doing nothing' unless it is framed using the same attributes as repair options.

Figures describing the annual risk of rupture were variable. Annual risk of rupture for men with an AAA of 5.0–5.4 cm is estimated at 0.4%.[6] While the contemporary annual rupture risk for a 5.5 cm AAA is unknown, participants quoted a figure ranging between 1% and 10% for both men and women. Using a patient decision aid to present accurate and balanced treatment information of all options may support people to make AAA repair decisions aligned with their preferences.[18] Adopting a user-centred design approach to their development may help ensure that information supports people with lower health literacy.[19] Some centres reported the use of risk assessment tools, despite this being contraindicated in NICE guidance.[6] Enhancing clinicians' skills to share individualised risk information of options and ameliorate unconscious bias may help both parties to agree and implement a treatment plan.[20,21] It would be reasonable to suggest that the effective implementation of the NHSE Decision Support Tool rests on a reasonable degree of consistency of practice across centres.

Adopting a non-surgical approach to managing AAA

There was a lack of consensus about the definition of someone not deemed suitable for (or declining) repair, how this is recorded, and the subsequent management pathway in lieu of repair. Participants reported organisational and clinical factors that may lead to overtreatment. This is likely compounded by limited MDT input from geriatricians and patient information leaflets presenting narrow information about repair techniques. Framing treatment information as choices, with explicit options, and presenting this information in parallel in an option-by-attribute format is less likely to bias peoples' preferences.[22] Preliminary data from the use of AAA decision support tools suggest that they may lead to people choosing less invasive, non-surgical options.[23] Creating a 'non-surgical' conservative management pathway within centres for those deemed unsuitable for repair would benefit the older, more frail, co-morbid population diagnosed with AAA.

Study advantages and limitations

Recruitment at centres was limited to those where the VERN collaborator was able to identify a named contact. The recruitment target was not met and interviews were difficult to secure, perhaps in part due to a stipulation in governance approval that relied on consultants taking part at a time that did not have an impact on their clinical duties. Adopting an interview approach to collecting survey data meant that answers supporting numerical rating scores could be fully explored.

However, some limitations are integral to the survey methods. The survey was aimed at clinical leads; in some centres the vascular lead nominated a member of their team to participate on their behalf. Their views may not be representative of all surgeons and the wider team working within each centre. Some of the items (eg, risk figure estimates and the use of patient materials to support decision-making) may be more susceptible to clinicians reporting on their own practice rather than wider delivery within their centre. Recording of patients discussed at a MDT is not a mandatory field in the NVR dataset. As such, there may be an underestimation of MDT activity due to absence of documentation. Data were not collected on the number of patients discussed at the MDT at each centre. This variation by centre may have an impact on the length of time taken to discuss each patient and the quality of the discussion, as mentioned by some clinicians in reference to more complex cases.

KEY MESSAGES

- There is unexplained variation in repair practices for AAA throughout the UK that cannot be explained by patient characteristics or case mix.
- An organisational survey was conducted in UK NHS vascular centres and found that, although MDTs were universally adopted, the skills mix, remit and delivery varied between centres.
- There was considerable variation in how treatment options, risk information and uncertainty is presented to patients to support a shared decision-making approach. These factors may in part explain why there is variation in AAA repair practice nationally.

Conclusions

Although MDTs were universally adopted, the skills mix, remit and delivery varied between centres and there was considerable variation in how treatment options, risk information and uncertainty is presented to patients to support a shared decision-making approach. These factors may in part explain why there is variation in AAA repair practice nationally.

Conflict of Interest: JD, LR and CH: National Institute for Health and Clinical Excellence Guideline Development Group for AAA. AH: Honoraria and lecture fees/consulting from medical devices/technology corporations including Shockwave Medical, Abbott Healthcare, Angiodroid biomedical company, Boston Scientific, Cook; educational grants from medical devices/technology corporations including Cook, Gore, Shockwave Medical, Inari, MedAlliance; research funding from Shockwave Medical, Abbott Healthcare, Boston Scientific, Angiodroid biomedical company, Medyria; member of National Institute for Health and Clinical Excellence Technology Appraisal Committee(s); salary supported by National Institute for Health Research. SH: has served on advisory panels for Edwards Lifesciences

within the past two years, received research funding from Abbott and is a Director Chair of the Board of the British Journal of Anaesthesia. LR: Patient Lay Member for National Institute for Health and Clinical Excellence on the AAA Patient Decision Aid project. SHR, HLB and AW: no conflicts of interest to declare.

Funding: Supported by funding from British Journal of Anaesthesia and Royal College of Anaesthetists.

Reviewer acknowledgement: *JVSGBI* thanks Gareth J Harrison, Consultant Vascular Surgeon & Clinical Lead (SMArt), South Mersey Arterial Centre and Rob Sayers, Glenfield Hospital Leicester, for their contribution to the peer review of this work.

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Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2024;3(4):239-244
http://doi.org/10.54522/jvsgbi.2024.137

www.jvsgbi.com

ORIGINAL RESEARCH

How do vascular surgery trainees optimise simulation-based learning? A qualitative study

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Received: 13th May 2024
Accepted: 10th July 2024
Online: 27th August 2024

Plain English Summary

Why we undertook the work: Surgeons need unique skills for their job, especially to perform operations. These are based on experience, but getting more experience is limited by how many patients they see. This can take many years, so there are other ways to make this faster. Practising with models or simulators can help. Simulators are used to help train surgeons, but we want to do it in the best possible way. There are a lot of factors that make simulation more effective. We wanted to find some of them.

What we did: We spoke to 10 hospital doctors who all wanted to be vascular surgeons, and who had worked with fully qualified vascular surgeons. We spoke to them one by one about learning with simulators, asking them all the same questions. The questions looked at what they liked in the training sessions, and what they found most useful.

What we found: All doctors said simulation was important, especially for practising operations. They liked when their teachers watched and told them what was good while they did it. A report at the end was also useful, but making simulators look real was not important to them. They wanted to practice what they do most often, nothing rare or complicated. They liked getting information before classes, or homework to help them learn as much as possible.

What this means: Getting the basics right was most valuable to them. Big operations that are done often are most important for training. They said: "Practise only the hardest parts of these operations, give homework before class, and have a lot of teachers". Teachers should talk to the training doctors during simulation, not just at the end. They welcomed as much feedback as possible.

Abstract

Background: Technical skills acquisition in modern surgical training is augmented by simulator-based education outside the operating room.

Aims: This research sought to explore and understand optimal learning conditions for vascular surgery trainees during simulation from their perspective.

Methods: Ten doctors at various stages of surgical training were recruited to participate from various training events. Semi-structured interviews were conducted individually on a date beyond initial recruitment. Topics included perceptions around how participants learn best from simulation and what they value, prioritise and require from simulation-based training. Initial data analysis was conducted shortly after initial interviews took place, and further interviews were conducted until data saturation was reached. Data were extracted using inductive thematic analysis.

Results: Participants believed simulation was important within surgical training, and that progression towards competence in core technical skills was particularly important. They appreciated direct consultant trainer supervision, contemporaneous bi-directional verbal feedback, and summative written feedback. Visual fidelity and complex/rare procedures were low on their priorities, with a strong desire to optimise fundamental skills acquisition. Participants also felt strongly about the benefits of advanced receipt of a detailed outline of session content and relevant reading material to maximise the educational benefit of training sessions.

Conclusions: Core operative skills and commonly encountered major operative cases should be prioritised in vascular technical skills training. In designing simulators, the main focus should centre on specific skill acquisition as a procedural component rather than aiming to replicate an entire procedure. A flipped classroom model of pre-reading, low student-to-trainer ratios, and detailed feedback from consultant trainers should be encouraged.

Key words: qualitative, interview, vascular surgery, training, simulation

Introduction

Vascular surgery has significantly evolved since the turn of the 20th century with a much wider repertoire of increasingly complex procedures expected of the modern surgeon, thus leading to increasing specialisation. Traditionally, vascular surgery was a sub-speciality within general surgery but it has now evolved into its own distinct speciality. In tandem, operative exposure and potential experience for trainees has reduced due to many factors, including increased number of trainees, an expectation for more direct consultant-delivered care and minimum rest periods, leaving newly qualified surgeons with less experience than their senior peers at entry to consultant-grade level; yet equally high expectations for standard of care are appropriately expected.[1]

In an effort to counteract this shift, various strategies have been adopted with a view to maintaining a high standard of surgical care, thereby compensating for reduced training opportunities. Skills workshops and simulation-based training have emerged as one such area in achieving this goal.[2,3]

One of the first comprehensive descriptions of modern simulation-based training in vascular surgery was outlined by Bismuth et al in 2012.[4] He detailed the development of a vascular surgery 'bootcamp' in use in the USA. This method of surgical training was developed based on models from simulator manufacturers, who run courses around the world in addition to developing simulation models. By their own admission, standards in vascular education had not been formally defined at that time so they sought to set their own. Over time, educational theory and curricula continue to evolve. The questions now tend not to be 'what' to learn rather than 'how' to learn.[5]

This paper explores technical skills simulation training from the trainee perspective. There exists many perspectives from the trainer, but how much the trainee benefits or what might help them further remains to be fully elucidated.[6] Using established qualitative methods, strategies to further enhance trainee skills and knowledge acquisition were explored. Much of this research is based on pre-Covid experiences and assumes training is delivered without pandemic-related restrictions.

Methods

The research team believed that, in the context of a rapidly evolving educational and clinical landscape, this study was best undertaken with a pragmatic approach (with an inclination towards constructivism) as many of the research answers sought are based on perspectives and opinions in the context of current resources, rather than fixed objective metrics.

This study used qualitative research methods through semi-structured interviews to gather data, an established research method employed when data sought is in the form of subjective opinion, perceptions and individual views.[7]

Non-consultant hospital doctors (NCHDs, also known as junior doctors) working in vascular surgery roles in Ireland, regardless of training scheme status, were recruited via gatekeepers using purposive sampling from multiple open training days and conferences and consent was obtained in writing. Such training days are mandatory for those on a formal training scheme, but those in non-training positions are also encouraged to attend. Clinical experience or seniority is not a barrier to participation in such events.

Independent gatekeepers (who had no other involvement in this research) issued open verbal invitations to groups attending these training sessions; volunteers then self-presented to an identified researcher for enrolment. The attendance profile, while inclusive of those not in training, predominantly comprised those on formal training pathways for whom such sessions are designed. All included participants identified a desire to pursue a career in vascular surgery.

An interactive discussion via telephone was later conducted with the first author and individual participants at a time convenient for them, lasting for up to 45 minutes. A theme sheet (see Appendix 1 online at www.jvsgbi.com)) was followed to guide discussion, but deviations from this template, where initiated by the participant, were followed for maximal data yield. All topics on the theme sheet were covered although, where deviation from the structure occurred, omitted topics were discussed at the end.

Discussions were recorded via voice recorders, which were transcribed verbatim into Word documents by the first author at the earliest opportunity. Participants were given the opportunity to review, edit or erase the transcriptions. No participants chose to amend the interview transcripts.

Data analysis took place on the anonymised transcripts using NVivo 12 to ensure that the processing of data was transparent and protected participant confidentiality. Initial analysis began following

the fourth participant's interview and continued in tandem with interviews thereafter. Thematic analysis was undertaken using a six-step framework (data familiarisation, coding, searching, reviewing and defining themes, then production of a report).[8] An inductive method of generating codes was used to maximise data yield.

Systematic processing of the transcripts was followed, with iterative analysis of data. Within eight interviews the yield of new codes was very low. A further two interviews took place to confirm the likelihood of approaching data saturation. No substantively new opinions or perspectives manifested in these final interviews, thus no further recruitment or interviews took place.

Results

One core surgical trainee (CST, undergoing basic training, pre-MRCS), one registrar (post-MRCS, not on training scheme) and eight Specialist Registrars (SpRs) took part in this research. There were 18 SpRs in Ireland at the time of writing. These are doctors who have completed basic surgical training and are undergoing formal training in vascular surgery through the national training scheme. A similar number of doctors not in training posts also work as registrars in vascular surgery. The number of CST trainees in vascular surgery at this time was no more than three. Each event during which recruitment was conducted hosted up to 20 doctors, with substantial overlap; many attended the majority of national educational events scheduled. These categories of doctors represent the full range of vascular surgery NCHDs in Ireland prior to qualification as a consultant surgeon. They mirror the experience of residents at all stages of the residency program in North America. They had a combined experience of over 25 years working full-time in vascular surgery, varying from 6 months to just under 5 years (mean 2.5±1.3). The gender split was seven males to three females; the current trainee split is approximately 6:4.[9] Individual participant names have been anonymised and are referred to as P1–P10.

Recruitment continued at educational days and conferences until apparent data saturation was reached and recruitment significantly dropped off (most attendees had already signed up). This was achieved after five events, which included almost all formal training days taking place over a 12-month period.

Good understanding of what is meant by vascular simulation was demonstrated, with user-generated definitions putting an emphasis on recreating "*a real-life scenario*" (P1) with "*models to replicate vascular procedures*" (P9) in "*a practice environment*" (P6) to "*improve technical surgical skills*" (P7) "*so the trainee can become familiar with them without risk to the patient*" (P3). The type of model or simulator was frequently not mentioned, but all agreed this could include physical models, interactive digital technology (such as endovascular simulators) or biological tissue (animal or cadaveric).

Six themes and 13 sub-themes were identified as shown in Table 1.

Table 1 Themes and sub-themes identified during qualitative analysis.

The Training Journey
Context to Simulation Training
Junior vs Senior Trainees
Additional Training, Experience and Courses
Gaining Value from Simulation
Emphasis on Key Skills
Physical Realism and Fidelity
The Impact of Realism and Fidelity on Learning
Learning Environment
Technical Skills Development
Expanding from the Basics, Surgical Styles and Alternative Strategies
Rare Procedures
Trainers
Training Ratios
Feedback
Pratical Elements
Organisation of Simulation Based Sessions
Preparation and Homework
Other Areas for Future Development

The training journey

Most participants highlighted the changing context of healthcare delivery in Ireland as a key consideration in the need for technical skills simulation. Exposure to practical experience is perceived to have fallen, especially for open surgery, and this was a significant concern for many.

It was felt that a reduction in live operative exposure was due to reduced "*working time with EWTD*" (P4) and that "*medico-legally it's harder to hand off cases to junior staff*." (P7) However, they were keen to stress that "*there's no real substitute for the real thing*" (P1); simulation needed to "*complement and add to real life operating*" (P8), not replace it.

Workshops needed to acknowledge training levels without needing to re-run for different levels of experience: "*If you're going to practice on something, start off easy, get it down, then move onto a better model, like a calcified aorta, for anastomosis, so you can perfect and practise the skills*." (P4)

Participants also all stated a perceived need to augment their training through extra paid courses: "*... the other ones you hear about from other people and you think they might be good…*" (P2)

Gaining value from simulation

Repeated deliberate practice of core skills was valued by participants and identified as very important. "*I think until you have the common skills, until it becomes second nature and you develop*

muscle memory, the complex skills probably aren't as important … knowing how to troubleshoot your way out of trouble… is more important." (P9)

Participants felt that the simulators themselves do not need to be high-fidelity to confer benefit, especially early on. *"I think you can gain something from each of them … it's the technique, so the tissue doesn't have to be very lifelike.*" (P10)

Ergonomics were highlighted as an overlooked area, as some felt positioning might be easier compared with real life, which may not be beneficial. "*… perhaps the positioning might be a little bit easier than in real life, with patient body habitus and things like that.*" (P8)

Other environmental factors such as the atmosphere generated by trainers was highlighted by participants and can be adapted depending on the goals of the session. "*The best part of the simulation is that you can afford to make a mistake, so it doesn't really matter.*" (P2)

There were some benefits described in relation to small groups as they afforded an opportunity for trainees to interact with their peers and highlight technical experiences from their training to date. Prior challenges were shared and solutions were proposed.

Technical skills development

With the passage of time, participants further develop their skills and find "*there are definitely little tips and tricks … which I wouldn't have known before.*" (P9)

These more subtle elements are the things not available elsewhere which participants really value. "*Very useful to learn new techniques and get different perspectives on the same thing.*" (P5)

Technical tips to enhance core skills were highly valued and were felt to be more important than moving on to more rare procedures, even if they are more interesting. "*I much prefer to go over doing a carotid 10 times while they're looking at you rather than looking at something weird and wonderful you're only going to see once or twice.*" (P7) "*… we don't need to be spending hours learning how to do something unusual.*" (P8)

Trainers

Most workshop faculty were practising surgeons. "*I would say 80% would be consultant surgeons, then the rest would be trainees, reps, and radiologists.*" (P8)

All but one participant reported that knowing them professionally helped them learn. "*It's a good thing, it doesn't make you more anxious, puts you at ease*." (P6)

Interviewees felt that small groups with lots of opportunities to practise technical skills created the best learning environment. "*I think having more than two trainees on a simulator (at any given time) is a little bit excessive*" (P7). "*I like it when you have a consultant watching while you are doing a procedure, I think that's where I learn the best.*" (P2) This allows for tailored feedback.

Summative feedback was also seen as useful, but only to compare with the next time. "*I would like to receive written summative feedback given to me after. This could be used as a standardised scoring system.*" (P4)

Practical elements

Participants felt that striking a balance between didactic talks to provide context and instructions for simulator use while maximising operative time on simulators was of utmost importance. Sessions with excessive didactic sessions describing personal experiences were felt to be less beneficial. "*Brief didactic instruction and then prolonged sessions on the simulator is where I gain the most out of it.*" (P10) "*If the program agenda is rigidly structured, you have to finish it in time, and the consultants are rushing you through everything, I don't think is beneficial.*" (P3)

All participants wished to receive pre-reading material to enhance the educational benefit of the day. "*Give them material in advance so they know what's coming up. Provide resources for the procedures, and the level they're expected to get.*" (P9)

Other areas for further development

Participants highlighted a wide variety of other procedures and skills they would like to learn, but no consistent patterns emerged. These included endovenous skills, ultrasound, rib resections, graft tunnelling, flaps and fistulas, among others.

Participants also wished for greater access to cadaveric material. They felt this was only available on fee-paying courses, which are often based outside Ireland thereby incurring additional costs. They did, however, also acknowledge the financial limitations of training budgets, necessitating additional external funding, often from participants themselves, for this type of educational experience.

Occasionally, more focused days based on training level was highlighted as potentially beneficial to complement the core skills days. "*… there's such a wide audience of every level, including SHOs, that they're a little broad.*" (P8)

Discussion

Core technical skills were acknowledged as one of the most important components of simulation training, reinforcing the view that ongoing acquisition and retention of technical skills competence extends for years, if not indefinitely. Similarly, skills degradation can happen relatively quickly. This is borne out in the literature, where core competence in certain procedure-specific skills is reached quickly but technical skills continue to evolve and develop during one's time as a consultant surgeon.[10] Learning about rarer procedures can also contribute to the overall motivation for attending a workshop; it encourages engagement and motivation during the more 'everyday' skills practice.[11]

Physical and tactile realism is frequently highlighted as an area in which technical simulation is limited.[12,13] However, many felt realism was not as important, provided the model was able to teach the specified learning objectives. In this regard, tactile fidelity was appreciated but acknowledged as a bonus, but simulated blood

flow in particular was highlighted.

No participant expressed a desire to be able to complete a procedure in its entirety, acknowledging simulator limitations and knowing which parts of a procedure need further practice – for example, anastomosis versus wound closure.

Using simulation within training was universally seen as positive, although participants were cautious not to overstate the potential benefits, especially if it was seen to replace rather than supplement training. This opinion was shared with British and American trained surgical trainees elsewhere, who are positive but warn about potential over-reliance on simulation, especially for certification of competence.[14,15]

For senior participants, the opportunity to see how trainers perform procedures in ways that are different from what they previously learned was seen as a significant positive component of simulation sessions. Under Kirkpatrick's educational framework, while approaching the level of mastery for a technique is demonstrated by unconscious competence (level 4), such experiences allow further acquisition of skills at conscious competence (level 3).[16–18] This can broaden the proficiency of a future independent surgeon so that they can approach a challenging case with a comprehensive skillset.[19]

Refining core skills was most highly valued by trainees as a worthwhile use of simulation time. The importance of maintaining core competencies is seen as essential, and can further develop over years. While competence can be achieved relatively quickly, mastery takes much longer, at a stage beyond entry to consultant level practice.[10]

While Ireland's small surgical population limits the viability of organising separate training days for different levels of experience, small group breakout sessions within training days serve to reconcile training needs according to levels of experience. While participants felt spending valuable simulator time on rare procedures was not the most efficient use of training time, they still did want to know about them. The degradation of certain technical skills over time likely influenced much of their perspective; it is well established that, in the absence of regular surgical practice, technical competency wanes.[20] Participants were keen to know how one might deal with rare situations even if they did not practise them in the simulation.

The question regarding the need for realism is a complex one. Balancing the use of synthetic models, which are durable, widely available, ethically accessible and re-usable, against the higher fidelity but 'single use' animal or cadaveric tissue can be challenging. The latter can pose significant ethical and health and safety challenges for the skills laboratory.[21] Participants expressed a desire for greater fidelity systems, but also acknowledged the practical limitations therein.

However, they did consistently wish for greater utilisation of models containing pulsatile 'vessels'. These systems are often available as part of an add-on to synthetic models, but cases have been described where pulsatile perfusion can also be established in cadaveric and animal models.[22] These can be effective, but often only last for a limited time before perfusing fluid leakage causes significant tissue degradation, reducing their useable lifespan.

Higher complexity models and greater use of biological material is often not feasible for a training scheme, either due to ethical, facility licencing, economics, or a combination of same. Such training may only be achievable in other jurisdictions and usually requires extrinsic funding, either through sponsorship or supplemental trainee contributions.

The participants appeared to need little external motivation in signing up to additional training independent of the standard curriculum, even when funded by the trainee, some of which can be refundable.[11] Part of the motivation for signing up to additional courses was stated to be based on access to cadaveric and animal tissue. Many felt they could not access training with high-fidelity tissue within the existing training structure.

Participants appreciated any feedback they received, with personalised insights into skills and techniques being particularly valuable. The use of summative scoring systems was much less prevalent and something they would be interested to see more of for benchmarking purposes. Universal scoring systems have proven challenging to develop, with Objective Structured Assessment of Technical Skills (OSATS) being one of the primary methods used in many different countries.[23–25]

In line with the concept of spaced learning and the flipped classroom, many participants expressed a desire for pre-reading and homework. They acknowledged the high quality of material during the session, but felt if difficult to retain due to the high volume. Advance reading and at-home re-enforcement of this information acquisition could promote greater retention and understanding.[26] This reflects components of the andragogical model of adult education.[27] Within this framework, self-motivation and purposeful learning is key and should be encouraged but requires input from course providers in advance.

Study limitations

This study was limited to the Irish system of surgical training. The educational context should be considered if applying these findings in other jurisdictions. The source of recruitment via conferences and training days disproportionately recruited those already on a training programme and under-represented doctors in 'non-training' posts. Training days are compulsory for those on a training scheme but optional for others.

The first author in this study undertook this research during academic time between 'non-scheme' and formal training appointments in vascular surgery. While we believe this provides an invaluable perspective and ability to empathise with participants' experience, it may also introduce certain bias or lack of external perspective due to similar shared experiences. In order to help mitigate these potential biases, an external researcher not involved in surgical training (JDS) took special care to observe for unconscious bias and retain more external objectivity.

KEY MESSAGES

- Hands-on simulation-based training focusing on core technical skills is the most valued form of simulation outside the operating room.
- Training for rare or overly complex procedures was not considered the most effective use of limited simulation training time.
- Live feedback on performance from senior colleagues is preferred.
- Participants wish to be as prepared as possible in advance; they appreciate advance information or homework to maximise educational benefit.
- Small groups with contemporaries are felt to be most beneficial.

Conclusions

As simulation-based training becomes ubiquitous and central to professional surgical education, the shape and delivery of such training needs to evolve.

Focusing on core skills with hands-on experience in small groups with professional trainers is highly valued. The current study identifies many areas for improvement including access to biological material and provision of pre-reading/homework to consolidate and maximise educational yield.

Exactly what to provide, and how best to provide it, remains an ongoing question for all education providers. There is never one right answer, but we can, with experience, audit and self-reflection, refine our strategies to increase educational effectiveness.

Conflict of Interest: The authors declare that there is no conflict of interest.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics: This study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki, RCSI ethical approval number: REC1711.

Contributions: SCM conducted the data collection and was assisted in processing the data by JDS. DOK was the overall supervisor and guided the project direction and research aims. AO'C and OT provided specialist support in the fields of vascular surgery and simulation, respectively. Writing of the manuscript was primarily undertaken by SCM and DOK, with significant modifications made by the other authors in respect of their areas of expertise.

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Reviewer acknowledgement: *JVSGBI* thanks Misha Sidapra, Hull York Medical School and Ellie Atkins, Norfolk and Norwich University Hospitals for their contribution to the peer review of this work.

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Journal of
VASCULAR SOCIETIES
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J.Vasc.Soc.G.B.Irel. 2024;3(4):245-249
http://doi.org/10.54522/jvsgbi.2024.144

www.jvsgbi.com

ABSTRACTS

VS ASM 2023 Prize/Highest Scoring Abstracts

The Vascular Societies' Annual Scientific Meeting 2023, in conjunction with the VSGBI, BACPAR, SVN and SVT, took place at The Convention Centre, Dublin, on the 22nd-24th November 2023. Here are the 2023 prize/highest scoring abstracts.

VS - Sol Cohen Prize

VO5 – Streamlined management pathways reduce major amputations in chronic limb-threatening ischaemia

Mr John Houghton[1,2], Anna Meffent[1], Miss Sarah Nduwayo[1], Imelda Black[1], Mr Andrew Nickinson[1], Amira Essop-Adam[1], Miss Sarah Jane Messeder[1,2], Natasha Bryant[1], Prof Laura Gray[1], Tanya Paynel[1], Mr Harjeet Rayt[2], Dr Victoria Haunton[3], Mr Robert Davies[2], Prof Rob Sayers[1,2]

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Introduction

Patient characteristics and patterns of disease in CLTI have changed markedly in recent years. Limb-salvage clinics and timely revascularisation are now recommended. This study aimed to compare contemporary major amputation incidence in CLTI patients to an historical cohort.

Methods

Single-centre observational study (NCT04027244). A prospective CLTI cohort was recruited between May 2019 and March 2022. An historical cohort presenting during 2013-2015 (inclusive) was identified retrospectively. The primary outcome was major amputation at one-year. Analysis was by Fine-Gray competing risks models (death as the competing risk) adjusted for propensity score, presented as subdistribution hazard ratios (SHR).

Results

A total of 928 patients were included (432 prospective; 496 historical). Proportions of patients presenting with tissue loss 72.2% vs 71.6%; p=.090) and rest pain 78.2% vs 81.9%; p=.098) were similar.

At one-year 48 patients (11.1%) in the prospective cohort and 124 patients (25.0%) in the historical cohort had undergone a major amputation (p<.001). The risk of major amputation was 57% lower in the prospective cohort compared to the historical cohort after adjustment for propensity score (SHR 0.43; 95% CI 0.29, 0.63; p<.001) (Figure 1).

Conclusion

Contemporary management strategies may have more than halved one-year major amputation incidence in patients presenting with CLTI.

VS - BJS Prize

VO35 – Evaluating the evidence for the impact of human factors science on operative performance in vascular surgery

Miss Fiona Kerray[1,2], Mr Rob Henson[2], Mr Andrew Tambyraja[1,2], Professor Steve Yule[1]

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Human factors science and ergonomics (HFE) has been included in surgical projects as diverse as system redesign, adverse event analysis and team training. A greater understanding of which HE elements are active in the operative setting is required to inform surgical education, improve individual and team performance, and enhance patient safety.

A systematic search of PubMed, Embase, MEDLINE, and PsycInfo databases was conducted following PRISMA guidelines. MeSH terms and keywords included "human factor*" "perform*" , and "vascular surg*". Eligible studies were organised according to the five Chartered Institute for Ergonomics and Human Factors (CIEHF) categories for analysis.

A total of 14 studies were included. All five CIEHF categories were represented [Table 1]. The most frequently occurring HE element considered was workplace design and assessment'. Measurable effects of physical, cognitive and organisational factors were reported on: work-related musculoskeletal disorders were prevalent, and operative team selection could influence outcomes. Methods to leverage HE when introducing novel tools and technology are described.

Human factors science/ergonomics is interwoven through every aspect of vascular surgery. Research evidence should be integrated into surgical training to enhance outcomes via optimising: (i) team selection; (in) environmental factors; and strategies to mitigate the physical and psychological effects of operating.

VS - Poster Prize

P10 – An update of a prospective comparison study of BlueDop as a novel assessment of pedal perfusion

Dr Lucy Fligelstone[1], Ms Annie Clothier[2], Ms Tracey Hutchings[2], Mr Kristian Glover[2], Ms Melissa Blow[3], Mr Brenig Gwilym[4], Mr David Bosanquet[5]

[1]Department of Surgery, Sunshine Coast University Hospital, Sunshine Coast, Australia, [2]Gwent Vascular Institute, Aneurin Bevan University Health Board, Newport, Wales, [3]Department of Podiatry, Aneurin Bevan University Health Board, Newport, Wales, [4]Department of Vascular Surgery, Swansea Bay University Health Board, Swansea, Wales, [5]South East Wales Vascular Network, Aneurin Bevan University Health Board, Cardiff and the Vale Health Board, Newport, Cardiff, Wales

Background

Limitations of ABPI include staff training and competency, restrictions from wounds and artificially elevated readings from incompressible vessels. "BlueDop" is a specialist probe which estimates ABPI by analysing doppler waveform at the ankle, without needing a tourniquet or the patient lying flat. The present study updates preliminary results presented at VSASM 2022 regarding the accuracy of BlueDop in assessing perfusion.

Method

175 Vascular and podiatry clinic patients had both ABPI+/-TBPI and BlueDop measurements recorded. Patient and user experience was assessed.

Results

122 patients had diabetes; 95 had CLTI, and 22 reported claudication. Patients preferred the BlueDop compared to ABPI and TBPI (mean difference = 0.544, $p<0.001$ and 0.579, $p<0.001$ respectively). BlueDop ABPI showed a significant weak correlation with cuff ABPI ($rs= 0.39$, $p=0.003$) but not cuff TBPI ($rs =0.22$, $p=0.4$). BlueDop has good predictive value to predict ABPI <0.8 (AUC=0.773) and <0.5 (AUC = 0.870).

Conclusion

BlueDop appears to have acceptable accuracy in diagnosing mild and severe PAD suggesting that it could be a suitable replacement when ABPI/TBPI are not obtainable.

VS - The Richard Wood Memorial Prize

VO47 – Comparing the effect of using virtual reality versus simulation in the management of acute surgical scenarios on academic buoyancy levels

Miss Manal Ahmad[2,3], Miss Mi-Tra Tran[1,2], Mr Kirtan Patel[2], Mr Orestis Argyrious[3], Professor Alun Davies[2,3], Mr Joseph Shalhoub[2,3]

[1]Faculty of Medicine, Imperial College London, London, United Kingdom, [2]Section of Vascular Surgery, Department of Surgery and Cancer, Imperial College London, London, United Kingdom, [3]Imperial NHS Healthcare Trust, London, United Kingdom

Background

Simulation is regularly used in surgical training to allow trainees to practice skills. Virtual reality (VR) offers immersive computer-generated medical and surgical training scenarios.
Performance can be hindered by stress, self-consciousness, anxiety, fear of criticism and self-perceived poor task execution. Academic buoyancy is a learner's ability to successfully deal with short-term, minor academic setbacks and can translate into long-term academic resilience. We aimed to compare academic buoyancy between junior doctors after managing an acute surgical scenario using VR and mannequin-based simulation.

Methods

Eighteen junior doctor volunteers were recruited and randomly allocated to VR or Simulation. Participants assessed and managed a 15-minute acute surgical scenario OSCE. Their academic buoyancy scale (ABS) scores were measured pre- and post-session

Results

ABS scores increased for both study groups. This was statistically significant for VR participants (ps0.01), suggesting that VR may provide a more comfortable environment for trainees to hone their clinical skills. VR participants also had higher overall simulation scores than mannequin-based simulation participants, however no correlation was found between ABS scores and overall simulation scores.

Conclusions

VR as a simulation modality benefits by improving short-term markers of confidence. Future research should establish whether spaced VR teaching sessions translate into improved long-term resilience.

VS – Venous Prize

VO88 – 5-year follow-up of a Randomised Controlled Trial of Endovenous Laser Ablation versus Mechanochemical Ablation for Superficial Venous Incompetence (LAMA Trial)

Dr Arthur Lim[1], Mr Abduraheem Mohamed[1,2], Ms Louise Hitchman[1,2], Ms Misha Sidapra[1,2], Mr Bharadhwaj Ravindhran[1,2], Mr Ross Lathan[1,2], Mr George Smith[1,2], Prof Ian Chetter[1,2], Mr Daniel Consultant[1,2]

[1]Department of Vascular Surgery, Hull University Teaching Hospitals, Hull, United Kingdom, [2]Academic Vascular Surgical Unit, Hull York Medical School, Hull, United Kingdom,

Introduction

Despite a lower anatomical occlusion rate at 1-2 years; patients treated with mechanochemical ablation (MOCA) report equivalent improvements in clinical and Quality of life (QoL) measures when compared to thermal ablation. This study reports the 5-year outcomes of a randomised controlled trial of endovenous laser ablation (EVLA) vs MOCA.

Methods

Patients with unilateral, symptomatic superficial venous incompetence were equally randomised to either MOCA or EVLA. Reported outcomes included anatomical occlusion, clinical recurrence, need for reintervention and disease-specific QoL measured by Aberdeen Varicose Vein Questionnaire (AVVQ).

Results

At 5-years, 57/75 (76%) and 52/75 (69%) patients attended follow up in the MOCA and EVLA groups respectively. Anatomical occlusion following MOCA was significantly lower than EVLA (46.8% vs 91.5%; p<0.001). Clinical recurrence occurred in 21/47 (44.7%) following MOCA and 23/47 (48.9%) following EVLA; p=0.298. Reinterventions were 15/71 (21.1%) following MOCA and 6/71 (8.5%) following EVLA; p=0.033. There was no significant difference in median (i.q.r) AVVQ between groups, 3.7 (0-9) vs 3.3 (1-6); p=0.786.

Conclusion

Five-year anatomical occlusion following MOCA is significantly lower than EVLA. No significant difference in QoL outcomes were observed between groups, however, the MOCA group required a higher number of reinterventions.

SVN - James Purdie Prize

Qualitative exploration of the care pathway for patients with venous leg ulceration

Miss Layla Bolton Saghdaoui[1], Miss Smaragda Lampridou[1], Ms Sarah Onida[1], Dr Rachael Lear[1], Professor Alun Davies[1], Professor Mary Wells[1]

[1]Imperial College Healthcare Nhs Trust / Imperial College London

Introduction

Venous ulceration (V) guidance recommends early application of compression therapy and referral for specialist assessment by a vascular service within two weeks. Unfortunately, only a small proportion of eligible patients receive timely assessment and referral.

Method

Semi-structured interviews with nurses were conducted to explore their experiences caring for and referring patients with VU to see a vascular specialist. OSR N-VIVO was used for inductive thematic analysis of verbatim transcripts.

Results

Eighteen nurses, representing primary and secondary care, participated. Six themes emerged: 'MDT Working; Communication; Organisational Limitations; Skills and Confidence; 'The Cinderella Condition'; Self-management. While equally significant, all themes interlink. Gaps between primary and secondary care are amplified by poor MDT collaboration, ineffective communication systems and organisational limitations, including inadequate data sharing. Staff shortages and limited training opportunities mean junior nurses lack knowledge and confidence in providing care. This encourages 'task-based' rather than holistic care. To address staff shortages, support for self-management is seen as a positive way forward. Overall, staff acknowledged that VU is not prioritised in the context of other competing conditions and pressures.

Conclusion

Both organisational and behavioural barriers impact nurses' ability to provide care. These barriers must be addressed when attempting to develop care pathways.

SVT - Best Scientific Presentation

Service evaluation of an ultrasound service for renal artery stenosis

Miss Alexandra Croucher[1], Mr Ben Freedman[1], Dr Jonathan Dick[1]
[1]King's College Hospital NHS Foundation Trust, London, England

Introduction

The STAR, ASTRAL and CORAL randomised control trials are a weight of evidence in favour of medication alone over revascularisation for the vast majority of patients with native renal artery stenosis (RAS). The lack of evidence supporting intervention combined with an anecdotal low positive finding rate and even lower intervention rate justified a service evaluation with a view to improving referral criteria for renal artery duplex scans.

Method

All renal artery duplex scans performed in 2022 were retrospectively reviewed and analysed by outcome and referrer specialty. Positive findings were defined by a maximum PSV of >1.8m/s and/or damped intrarenal waveforms.

Results

Out of 930 performed scans: 651 were negative; 45 could not assess for RAS due to poor views of the renal arteries and kidneys; 190 found no severe stenosis but could not exclude moderate stenosis; and 42 were positive. Of these patients, only two had angioplasty.

The largest contributing referring group was Renal Medicine (27%), followed by General Internal Medicine (24%), Cardiology (10%), and Acute Internal Medicine (<10%).

Conclusion

There is potential to streamline the service by improving patient selection for renal duplex scans. Referral criteria which selects for patients phenotypes that improve after revascularisation could be introduced.

SVT - Best research proposal

A retrospective study assessing the clinical significance of pre-operative carotid ultrasound screening prior to cardiac surgery

Miss Anice Aidi[1]
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Carotid disease is a risk factor for stroke during/after cardiac surgery. Therefore, all patients are scheduled for a carotid ultrasound scan for the detection of carotid artery stenosis (CAS) as part of their surgical work-up. This study aims to address if it is necessary to scan all patients and if there is potential to identify certain factors which can be used to screen only those at high-risk of CAS.

962 patients who had a scan prior to cardiac surgery from 2017- 2022 were retrospectively reviewed. The prevalence of CAS and their surgical follow-up was recorded. Statistical analyses were conducted on 2 risk factors (sex and age) to determine if there was an association with the presence of CAS (>50%).

The results showed a low prevalence (12.3%) of patients that had CAS and of this, a high proportion (84%) of these patients who were not treated for their CAS prior to cardiac surgery, despite the extent of their disease. Males and those 265 years old were found to be significant independent predictors for patients having CAS.

Selectively screening only high-risk patients reduces the screening load and has the potential to save the NHS time and resources from unnecessary scans.

BACPAR - best poster abstract

P75 - The effect of an adaptive trainer on an exercise group within a limb centre environment and the benefit expressed by patients; a pilot study

Mrs Anne Harrill[1]

[1]Bristol Centre For Enablement, North Bristol NHS Trust, Bristol, UK

Recommended activity levels for adults each week is 150 minutes of moderate intensity physical activity and 2 days of muscle strengthening activity. Following the Covid pandemic it was evident that patients attending the centre were struggling to motivate themselves and be confident to exercise. Funding was secured from Limb Power through the Tackling Inequalities Fund and a pilot created that involved 12 lower limb amputee patients attending in groups of 4, each for 6 consecutive weeks. The course was delivered by an Adaptive Personal Trainer and modified each week depending on the needs and progress of each participant. Each participant was a limb user although exercises could be adapted if they were unable to don their prosthesis. The patients included trans tibial and trans femoral amputees both unilateral and bilateral. Also included SAKL and MPK users.At the end of the 6 sessions patients completed a feedback questionnaire. Some were willing to be filmed participating and 2 were happy to give video feedback. The presentation would include videos, a summary of exercises and clarification on the role that adaptive training can play in the treatment of lower limb amputees.

BACPAR - Joint best speaker prize

B02 - Limb loss; let's talk about it. The Glasgow experience

Miss Laura Brady[1], Mr Damien McGovern

[1]NHS, Glasgow, Scotland

Having an amputation is a life altering event and often our patients and referrers are ill informed about life after amputation. This has resulted in patients attending our clinics with unrealistic expectations and inaccurate information. Our team recognised this and investigated different methods to help address these issues.

As a result, we now have an established pre amputation clinic where we are able to have open and honest conversations with patients prior to amputation, where possible. This clinic has proven to be particularly beneficial for patients who are considering amputation versus limb salvage in order to help them make an informed choice.

We have invested time in providing training sessions for our refers and AHP colleagues on how to approach earlier discussions about the possibility of amputation to ensure the information provided is accurate.

Through this process our team have had the opportunity to work more closely with our Orthopedic, Oncology and Trauma colleagues which has improved patient pathways.

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J.Vasc.Soc.G.B.Irel. 2024;3(4):250-256
http://doi.org/10.54522/jvsgbi.2024.143

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ROULEAUX CLUB ANNUAL ESSAY COMPETITION

Rouleaux Club Winning Essays 2022

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. Following the November 2022 VS ASM, we are delighted to publish the winning essays.

STUDENT CATEGORY

Should the threshold for elective AAA repair be raised to 7 centimetres?

Hailey Rees, *University of Dundee*

An abdominal aortic aneurysm (AAA) is a degenerative condition caused by the abnormal dilatation of the abdominal aorta.[1] In the UK, there is a prevalence of 1.3% of men with an AAA over the age of 65 years, and a death rate of 3,000 patients every year.[2,3] As the mortality from a ruptured abdominal aortic aneurysm approaches 80-90%, the single goal of elective surgical repair is the prevention of this complication.[4] In contemporary UK practice, a national screening programme facilitates the identification of patients with an abdominal aortic aneurysm and has been demonstrated to reduce deaths from aortic aneurysm rupture.[3,19] In current practice, aortic diameter remains the primary trigger to consider elective repair with the "threshold" for elective aneurysm repair in asymptomatic aneurysms being an aortic diameter of 5.5cm and above.[3,5] Whilst this "threshold" is based on a series of randomised control trials (including UK Small Aneurysm Trial and Aneurysm Detection and Management Trial[6,7]), which demonstrated reduced risk of rupture and patient mortality, it remains (to an extent) arbitrary. This is due to limited data comparing the effects of surveillance in aortic diameters >5.5cm to that of surgical intervention, and whether the risk of aneurysm rupture is significant enough to warrant surgical repair at smaller diameters.[8] Therefore, it comes into question whether or not the current repair threshold by studious default should be raised to larger diameters such as that of 7cm.

In current literature, determining the risk of AAA rupture in correlation with pre-operative aortic diameter has proven to be significantly challenging.[5] The general consensus within clinical practice is an increasing aortic diameter would increase a patient's risk of rupture and mortality.[8] Whilst this remains true, it is important to consider the relative risk of rupture with increasing diameter and whether this risk is significant enough to justify operative management at larger diameters. Grima *et al*., aimed to determine the relationship between mean diameter of intact AAAs (iAAA) for elective repair with rupture rates (rAAA) in 9 different countries.[5] This incorporated a wide variation in mean aortic diameter, most of which, beyond the recommended threshold (μ = 6.2cm in males, μ = 5.9cm in females).[5] Results found no statistical significance between reported mean iAAA diameter and rAAA repair rate. A meta-analysis by Parkinson *et al.*, investigated untreated aneurysms in patients declared unfit for surgical repair with percentage risk of rupture per year. It was concluded that cumulative risk of rupture was 3.5% in aneurysms 5.5-6.0cm in diameter, 4.1% between 6.1-7.0cm, and 6.3% for >7.0cm. Despite showing a generalised increase in rupture rate with increasing diameter, the rupture rates were lower than which is commonly reported in literature.[9] However, determining at which size the rupture risk is significant enough remains unclear. Reported by Lo *et al.*, the size of an AAA at point of rupture in male patients was 7.9cm and for females, 7.1cm.[17] Retrospectively, such studies demonstrate the relative risk of rupture in patients with aortic diameters above the recommended threshold could be managed conservatively under surveillance without surgical intervention. This is due to the lack of statistically significant relationships between high rupture rates in larger aneurysms and the low mortality rates in aneurysms measuring 6.1-7.0cm.

Evidence to the contrary deems mortality risk of larger aneurysms too great for the clinical threshold to be raised above 5.5cm. A retrospective study by Noronen *et al.*, analysed mortality rates in patients with aneurysms that met elective repair criteria but not operative criteria.[8] Of the 798-patient cohort, they found with increasing aneurysm diameter, there was a decrease in cumulative survival more so in aneurysms sized ≥6.1cm. Furthermore, the median time of aneurysm rupture reduced by 50% when aortic diameter reached >6.1cm demonstrating a more probable likelihood of rupture in larger aneurysms.[8] It has also been commonly reported in many studies that patients with an AAA are likely to die from other causes, than they are by aneurysm rupture. Noronen *et al.*, further analysed causes of death in accordance with

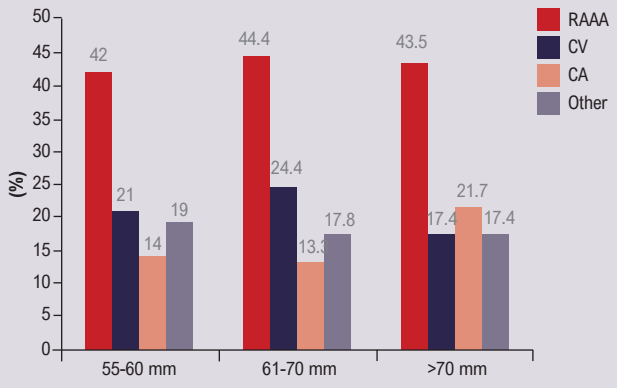
aortic diameter as shown in Figure 1.[8] Independent of aortic diameter, the leading cause of death was that of aneurysm rupture. Therefore, it could be suggested that elective repair in larger aneurysms would provide significant benefit to patients and reduce mortality secondary to rupture. By reducing disease burden through early intervention when diameters meet current guidance, the likelihood of rupture is reduced before the risk poses too great a threat or deemed surgically untreatable.

Emergence of the COVID-19 pandemic profoundly affected services supplied by the UK National Health Service. This led to substantial delay in elective AAA repairs.[11] New guidance by the UK National Joint Vascular Implementation Board came to light to postpone elective AAA procedures and re-evaluated the diameter threshold for repair.[18] This decision involved balancing risks around COVID-19 and operative mortality, with rupture risk.[12] Recommendations published were to delay elective repair by 12 months in aneurysms measuring 5.5-6.0cm, and 6 months if 6.0-7.0cm.[11] McGuinness *et al*., evaluated through probabilistic sensitivity analysis, the potential harm delayed AAA repair could have on patients.[12] This study reported a probability of survival increase with immediate operative management in aneurysms sized 5-6.9 cm, compared with delayed repair. Moreover, aneurysms >7cm reported similar, however the survival probability distribution was lower compared to aneurysms of 5-6.9cm.[12] Therefore, a delay in elective repair of aneurysms could pose increasing risk of harm to patients with larger aneurysms. However, reported aneurysm sizes met both the current threshold criteria for elective repair and larger. Evidently, despite surgical interventions improving probability of survival, patients were living with much larger aneurysms before repair, and showing increasing benefit of surgical management at these diameters.

It could be argued that had there been no delay in surgical intervention, this could further improve probability survival at smaller aneurysm sizes. It is important however, to put this probability into perspective and quantify the risk larger aneurysms at 7cm have on mortality. Kim *et al.*, evaluated the impact delayed services had on patient mortality and the change of elective threshold to 7cm during the pandemic.[11] This study noted a delay of 1 year for elective repair contributed a modest increase in mortality of 0.4% compared to two years, where mortality increased to 1.9% (Figure 2). The risk of rupture increased in a similar fashion exhibiting a 0.7% increase in mortality after one year and 3.1% at two years (Figure 2).[11] This established patients could potentially live under surveillance at larger diameters with a relatively low risk of rupture and mortality, but within a shorter time period of 2 years.

Another consideration is the post-operative risk of elective repair and whether operative management at the recommended threshold is causing patients more harm than good. Comparing effects of surveillance versus elective repair of aneurysms <5.5.cm as demonstrated by the UKSAT, ADAM, CAESAR and EVAR 2 trials, researchers could not demonstrate any benefit for early elective repair when compared with surveillance alone.[1,6,7,13,14] Such literature provided evidence to support the current threshold. Despite this, there is limited evidence to support elective repair over surveillance in larger aneurysms closer to that of 7cm. Whilst patients undergoing operative management are at risk of complications such as infection or haemorrhage, the EVAR 1 trial demonstrated that EVAR exhibited inferior late survival benefit compared with OAR.[15] Patients with larger aneurysms of >6.0cm also tend to be older, have reduced surgical fitness and unfavourable neck anatomy. Zarins *et al*., investigated the effects of EVAR after a 5-year period in both small (<5.0cm) and large (>6.0cm) aneurysms. Results of this study found patients with

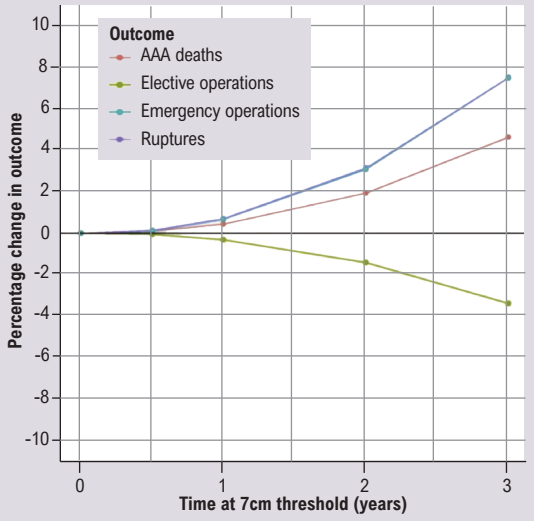
Figure 1 Causes of death in reference to aortic diameter.



RAAA = Ruptured Abdominal Aortic Aneurysm, CV = Cardiovascular, CA = Cancer.

Sourced by Noronen *et al*[8]

Figure 2 Change in outcome (%) over varying time at an increased 7cm threshold.



Sourced by Kim *et al*[11]

larger aneurysms, showed an increased risk of aneurysm rupture and mortality, surgical conversion and suffered more aneurysm-relate deaths post-EVAR compared to the small aneurysm cohort.[16] Whilst this in hindsight would favour the recommended threshold, it could be argued that increasing this threshold to 7cm would prolong the incidence of post-operative complications as this would be offered further down the line. However, finding the balance between surgical fitness of a patient, with the benefits of surgical repair against mortality and rupture rates is difficult to quantify.

Considering factors discussed, the implications larger aneurysms could have on patient's lives remains challenging. It comes into question whether patients are undergoing unnecessary operative repair at smaller diameters. Such parameters could increase risk of secondary repairs and complications compared to monitoring when the risk of rupture is not as high as previously thought. However, many patient factors have to be carefully considered when clinicians offer elective repair. More research is required to establish long-term effects of surveillance and repair in larger aneurysms to support a change in threshold. This would provide evidence to build risk assessment criteria by incorporating a patient's clinical risk factors with their risk of mortality over varying time.

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DOCTOR CATEGORY

Should the threshold for elective AAA repair be raised to 7 centimetres?

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Introduction

Determining the threshold for elective AAA repair is a balance between rupture risk with likely mortality and elective operative risk. Repair options include open surgical repair (OSR) and more recently endovascular aortic repair (EVAR). The clinical landscape of AAA is ever changing with decreased rates of ruptured AAA (rAAA) and improved operative outcomes. As such the balance between surveillance and intervention must be reassessed over time with particular focus on whether intervention only improves AAA-related mortality and not all-cause mortality which is especially pertinent in an aging population. In parallel, we may begin to observe a shift away from a single metric to ensure inclusivity to all patient demographics and strive for personalised medicine.

Current practice and evidence

The European Society of Vascular Surgery (ESVS) published guidance on the management of AAA, including the indications for elective repair (Table 1).[1]

Table 1 ESVS guidelines summarised for elective AAA repair.

	Recommendation	Class of Evidence	Level of Evidence
22	AAA diameter ≥ 5.5cm in men	I	A
23	AAA diameter ≥ 5.0cm in women	IIb	C
24	Rapid AAA growth ≥ 1cm/year	IIa	C
25	Symptomatic AAA	I	C

The thresholds established for elective intervention in men are founded on the results of four clinical trials. With comparison to surveillance for aneurysms <5.5cm in diameter, the UKSAT and ADAM trials evaluated OSR. The CAESAR trial and PIVOTAL study evaluated EVAR.[2–5] A review concluded that none of the trials individually or collectively found a significant difference in outcomes between surveillance or intervention for long term survival or quality of life. Based on lack of clinical benefit and greater cost of intervention over surveillance the minimum threshold for men has since been well-established at 5.5cm for elective repair.

The origin of the 5.5cm threshold for men originates from studies from the early 2000s that found that the rAAA rate was associated with AAA diameter and importantly, a high AAA-related mortality rate for patients with an AAA diameter >5.5cm (Table 2).[6] Notably, the mortality rate in patients with an AAA diameter of 5.5-5.9cm (9.4%) was approximately 10-fold higher than that of patients with an AAA diameter of 4.0-5.5cm as reported in the UKSAT and ADAM trial. However, this is not an accurate comparison as the patient demographics are unequal, for example co-existing incidence of hypertension (66.2% vs 40%), and the clinical trials excluded patients not fit for surgery.

Table 2 Data extracted from Lederdle 2002 where probable rupture rate included definite and likely cause of death being a rAAA.

	AAA Rupture Rate
Initial AAA Diameter	12 months
5.5 - 5.9 cm	9.4%
6.0 - 6.9 cm	10.2%
(6.5 - 6.9 cm)	(19.1%)
≥ 7.0 cm	32.5%

A review of 11 studies found much lower rAAA rates by AAA diameter in patients unfit for surgery in contrast to earlier reports such as the ADAM trial (Table 3).[3,7] It is likely the rupture rate has decreased over the past few decades likely due to changing patient demographics and better management of comorbidities (Table 3).[8] As the rupture rate and risk of AAA-related mortality is seemingly lower than that of non-AAA related causes, this calls into question whether the current elective threshold should be increased. One of the included studies monitored the progress of patients turned down for elective AAA repair over 10 years. There was little difference in the rate of rupture and non-rupture related death in patients with an AAA of 5.5-5.9cm while differences were noticed in patients with an AAA >6cm by 6 months.[9]

Table 3 Data extracted from Parkinson 2015 and ADAM trial (AAA diameter groups have been matched to be closely related between the different studies)

	Ruptured AAA Incidence by Diameter			Incidence of Death from non-AAA related cause
Initial AAA Diameter	Yearly Rupture Rate	ADAM Trial 1997	EUROSTAR Registry 2000	
5.5 - 6.0 cm	3.5%	9%	3.3%	9.9%
6.1 - 7.0 cm	4.1%	10%	9.4%	8.9%
> 7.0 cm	6.3%	33%	24%	12.3%

Whether outcomes of elective repair are dependent on aneurysmal size will also influence the threshold for elective repair. A retrospective study found that those with smaller aneurysms

(<5.5cm) were more likely to survive at the 1 year (93% vs 88%) and 6 year (64% vs 47%) timepoints even after adjusting for age and sex.[10] Multiple reports of comparisons of elective repair for outcomes of small (<5.5cm) or large AAAs and have found reduced odds for all-cause mortality, in addition to freedom from complications for small aneurysms.[11-14] This collection of evidence suggests that the decision to increase the elective repair threshold is not only dependent on risk of rupture but also the differing clinical outcomes when operating on larger aneurysms.

Contrastingly, improvements in perioperative management of elective and rAAA repair would allow for a decrease or increase in the elective threshold respectively. Improvements in repairing rAAAs could mean that patients can be kept under surveillance for longer to reach a higher elective threshold in the knowledge that if a rupture did occur the likelihood of success is acceptable. Patient post-op and perioperative mortality post emergency rAAA repair has decreased significantly, based on data from the NSQIP database over the 2005–2011 period.[15] It is possible the increased widespread use of EVAR and new techniques have contributed to this shift. A retrospective study of 152 rAAA and 467 elective AAA repair patients found that rAAA patients had a significantly higher 30 day mortality rate (32.9% vs 3.4%) but after this period a similar change in survival rate over time (Table 4).[16] Improvements to perioperative outcomes in rAAA repair, specifically to match that of elective AAA repair would suggest increasing the elective repair threshold. However, it still remains that around half of patients with rAAA do not make it to hospital for emergency repair.[17]

Table 4 Survival rate over time in patients treated with intact or rAAA

Survival rate	3 year	5 year
Intact AAA	78%	65%
rAAA	48%	41%

Studies have reported conflicted results for the use of use of antiplatelets and beta blockers to benefit survival in elective repair.[18,19] Statin use however has been shown to reduce elective AAA operative risk and improve long term survival.[20] However, there is no evidence of medical intervention that can prevent AAA growth.[21] Further improvements to elective outcomes may indicate a decrease in threshold would be appropriate.

National screening

UK and Sweden screening programmes invite men over 65 years old for an ultrasound assessment using a 5.5cm threshold. While the Chichester (UK) study did not find a significant decrease in AAA related mortality, the Sweden screening programme did so successfully.[22,23] A 2014 review of 4 screening studies in different locations found that AAA screening did not reduce all cause mortality at any time point in the 15 years of data collection available.[24] However, when additional follow up data from the Western Australia trial was subsequently included there was small but significant reduction in all cause mortality (RR 0.986) and AAA-related mortality.[25] NHS AAA screening is cost effective with a reported £7370 per quality-adjusted life-year (QALY) gain which is comfortably within the NICE threshold.[26,27] However, with decreasing AAA prevalence, methods to maintain cost-effectivness such as lengthening surveillance intervals has been evaluated but it is unclear if the marginal benefit is sufficient to change clinical practice.[28] Increasing the elective repair threshold would likely decrease cost of elective surgeries but at the expense of an increased rAAA rate.

Demographic pitfalls of current practice

A major limitation of the studies discussed in this article is that their patient demographic is predominantly western men. The RESCAN meta-analysis found that women have up to 4 times increased likelihood for rAAA compared to men and at a smaller average diameter (5.0 vs 6.0cm).[29,30] The AAA diameter is also inferior to the aortic size index (ASI, a ratio between AAA diameter and body surface area) for women in predicting rAAA.[31] The ASI for women is higher than that of men for both intact and rupture AAA repair. Therefore, the discussion regarding thresholds for elective repair in women should be expanded to use a more appropriate metric. Women have a significantly higher mortality than men following elective AAA repair and are less likely to be eligible for EVAR.[32–34] Due to lack of data, it is not possible to clearly determine the risk of rAAA in women stratified by AAA diameter or ASI and so further studies are required to inform future practice.[35] Similarly, current thresholds may not be appropriate for ethnic minorities who experience increased incidence of perioperative and postoperative complications.[36,37] It is unclear whether this is due to socioeconomic factors such as access to high volume vascular centres or genetic factors that could account for increased incidence of comorbidities. Nonetheless, recognising these differences would include considering increasing the threshold of elective AAA repair in these demographics.

Personalised thresholds

A step towards personalised medicine in AAA has included the British Aneurysm Repair (BAR) Score, a multivariate model for elective AAA repair by OSR or EVAR (Table 5).[38] It provides an estimate of the risk of in-hospital mortality based on data from the National Vascular Database. The Aneurysm Repair Decision Aid

Table 5 Risk of in-hospital mortality post elective AAA repair.

Age	Female Sex	Serum Creatinine > 120
Cardiac Disease	Abnormal ECG	Previous aortic surgery or stent
White Cell Count	Serum sodium	AAA diameter
ASA grade	Type of Repair	

(ARDA) is another tool that uses patient data from the RESCAN project with an aim to inform if elective AAA repair is optimal for an individual patient.[39] It takes into consideration factors such as advancing age, AAA growth and comorbidities. The broad recommendations of this tool suggest earlier repair in younger and fitter patients and in contrast surveillance in elderly patients with comorbidities. These multifactorial tools, if validated, will likely replace individual scores such as the AAA diameter for determining if elective AAA repair is appropriate.

Conclusions

The elective threshold would be best considered on a case-by-case basis. Population-based analysis has provided strong recommendations but widespread applicability is questionable. Furthermore, the changing landscape of AAA incidence and repair means the conclusions of older studies must be reconsidered. The use of a more sophisticated scoring system will likely replace the single metric of AAA diameter but in the interim it is unlikely the threshold will be increased to as high as 7cm from 5.5cm but trials should be carried out to evaluate alternative thresholds.

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Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2024;3(4):257-258
http://doi.org/10.54522/jvsgbi.2024.146

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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 Association of Chartered Physiotherapists in limb Absence Rehabilitation (BACPAR)

www.bacpar.org
@BACPAR_official

he BACPAR Executive committee is planning for its next Executive committee meeting in September at which we will start to consider our plans for delivery of the 2025 BACPAR programme. We will also review how the BACPAR objectives have been met through it's work to date in anticipation of the AGM in November.

Themes for the 2024 programme have been shared with the membership - through our Social Media accounts and in discussion at regional meetings to encourage strong attendance and participation.

Themes for the BACPAR programme are as follows;

- acute/ pre amputation/ reconstruction and prevention of amputation
- Non- NHS roles in limb loss
- Rehabilitation
- Prosthetics.

Abstract submission has been encouraged to add to these themes and other Physiotherapy related subjects in limb absence rehabilitation and we look forward to reviewing the submissions now submission is closed.

Dr Miranda Asher continues to represent BACPAR on the *JVSGBI* editorial board as part of her role as one of BACPAR's research officers (ROs). The ROs will be looking to recruit to a working group for the review of the BACPAR Outcome Measures toolbox.

https://www.bacpar.org/Data/Resource_Downloads/ToolboxofOutcomeMeasures.pdf in the coming months.

BACPAR looks forward to ongoing collaboration with the Vascular Societies in research, service development, patient information and MDT education.

Louise Tisdale

UK National Interventional Radiology Trainee Research (UNITE) Collaborative

www.unitecollaborative.com.
@IRadResearch

The UNITE Collaborative is the UK national interventional radiology research collaborative. We were founded in 2021 and have undertaken multiple projects in the field of vascular & interventional radiology since then. This year has been an exciting one for the group with the recruitment of a new committee and a massive increase in our activity with plenty of upcoming projects!

CAASP Study accepted for publication in BJS Open!

The Collaborative Acute Aortic Syndrome (CAASP) is a joint project run by UNITE and VERN that looks into the current diagnostic pathways for aortic dissection and factors contributing to delays in diagnosis. Over 30 collaborators from 10 UK centres have contributed to this study and make this achievement happen, and this marks a huge step forward for trainee-led research in IR.

Dragon's Den pitch competition is OPEN - win up to £1500

This year, UNITE is running a project pitch competition at the British Society of Interventional Radiology (BSIR) meeting in Brighton. We are giving trainees the opportunity to submit a project and pitch it on the day in front of our panel of dragons. The top entries will present on the day and the winner will win a prize of up to £1500 and the opportunity to run their project on a national scale. Full details are available on our website www.unitecollaborative.com.

Save the date - annual IR Research Day on Friday 13th December

The UNITE Collaborative & BSIR's flagship research meeting is back for 2024. This year we will be bigger and better with an incredible speaker line up who will talk about hot topics, including AI in interventional radiology, how to set up a research group and frontiers in embolisaiton. The Interventional Radiology Research Day will take place on Friday 13th December 2024 at the Royal College of Radiologists in London.

The Vascular and Endovascular Research Network (VERN)

www.vascular-research.net
@VascResearchNet

The last few months have been busy for VERN with some studies coming to a close and others starting or in the development phase.

We are very pleased to share with readers that a manuscript reporting the Collaborative Acute Aortic Syndrome Project (CAASP) study has been accepted for publication in the British Journal of

Surgery, and a manuscript reporting the Vascular Interventions and Surgery in Trauma Audit (VISTA) is near being ready for submission for peer-review. We are proud to have collaborated with other research networks for both of these studies – the UK National IR Trainee Research Collaborative and the National Trauma Research and Innovation Collaborative. The Surgical Site Infection in Major Lower Limb Amputation (SIMBA) project is in the latter stages of data collation and analysis. Thank you to all collaborators who contributed to centre setup and data collection - we hope to update you soon.

Blood loss, anaemia and haemostasis in vascular surgery (BLAST) was launched recently and there has been an excellent response, numerous centres have launched and data collection is well under way. The centre recruitment period remains open until the end of December 2024 so please do visit the website and register your interest in participating (https://vascular-research.net/blast/). Last month, we closed the survey for the Arm Ischaemia Study (ARMIES) and are very grateful to all respondents for their time in completing the survey. This was undertaken in preparation for an observational study of acute upper limb ischaemia, details for which will be shared on our social media platforms in the near future.

Last year's Dragons Den winner, Joseph Cutteridge, is busy working on his project exploring a simplified surgical site infection severity grade, the committee are collaborating with him on study design. We are also excited for this year's Dragons Den session which will be held during the Vascular Societies' Annual Scientific Meeting! If you have a project proposal to collaborate with us and want a chance to win funds to support the research, submit your 300 word abstract no later than the 9th of September 2024 to vern.arterial.disease@gmail.com.

We are eagerly looking forward to meeting colleagues and friends again in November.

Brenig Gwilym
VERN president

News from the Circulation Foundation

www.circulationfoundation.org.uk **@CircFoundation**

CIRCULATION FOUNDATION
The Vascular Charity

#TheBodyWalk

September is Vascular Awareness Month, and the Circulation Foundation's #TheBodyWalk is a national campaign to raise awareness of vascular disease, fund vital research, and support patients. We're inviting everyone to help us raise funds and support individuals coping with serious circulatory problems.

The circulatory system is incredibly long - if you were to lay out all the arteries, veins, and capillaries in one adult end to end, they would stretch about 60,000 miles (100,000 kilometers).

Our Goal: Walk, run, cycle, and/or swim a total of 60,000 miles during September.

Our Progress: Since starting in 2020, we've completed 40,764 miles and raised £23,774!

Click here for more information and how to sign up: The Body Walk 2024 | Circulation Foundation (enthuse.com)

Circulation Foundation on social media

Also, keep a close watch on the Circulation Foundation social media channels, we will send out a post every day of the September Vascular Awareness Month

Neeraj Bhasin
Chair, Circulation Foundation

VASCULAR SOCIETY

The Vascular Society for Great Britain and Ireland

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.

Benefits of Membership

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

The advantages of membership of the Vascular Society include:

- The VSGBI represents vascular specialists working in the UK and Ireland, as well as welcoming overseas members and helps drive policy through its relations with Royal Colleges, other related professional Societies (e.g. BSIR) and the Department of Health. Members have access to the Executive and Council who prepare and enable these policies.
- 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.
- The VSGBI organises specialist courses and meetings delivered locally, together with an annual meeting with scientific and political updates.
- The VSGBI publishes virtual educational resources which are available to members.
- The VSGBI publishes a quarterly journal, the *Journal of the Vascular Societies Great Britain and Ireland*, which is available to its members.
- The VSGBI publishes policy documents and quality improvement resources which are available on its website.
- ESVS Membership. VS members can enjoy ESVS membership at a discounted rate, and benefit from ESVS membership benefits.
- The VSGBI together with HQIP and the clinical effectiveness unit (CEU) at the RCS England maintains the National Vascular Registry. NVR is the principal outcomes registry for the UK and for the AAA Screening Programmes (England, Wales, Scotland and Northern Ireland).
- 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.
- The Society is an associate partner of the BJS. This entitles VS members to a reduced BJS subscription
- The Society is actively supporting vascular research though the James Lind Alliance Priority Setting Partnership, Specialist Interest Groups (SIGs), funding of three RCS England Surgical Speciality Leads (SSLs), funding of Clinical Fellows (England and Scotland) and the Vascular Research UK website (https://www.vascular-research.co.uk/).

SIGN UP FOR VSGBI MEMBERSHIP

If you are not already a member to find out more email admin@vascularsociety.org.uk or visit https://www.vascularsociety.org.uk/about/membership/benefits.aspx

MEMBERSHIP CATEGORIES INCLUDE:

FULL MEMBERSHIP – £300 PER YEAR
Consultant or Specialist Vascular Surgeon.

ASSOCIATE MEMBERSHIP – £140 PER YEAR
Consultant Specialist in another speciality, SAS or locally employed (unless preparing for CESR), Scientist, Medical Associate Professional (PA or SCP) or Podiatrist.

SPECIALIST AFFILIATE – £140 PER YEAR
Speciality trainee (holding national training number) or locally employed doctor training with aim of CESR.

NON-SPECIALIST AFFILIATE – NO FEE
Medical student, Foundation doctor or Core surgical trainee considering a career as a vascular surgeon.

RECIPROCAL – NO FEE
Council members of the Affiliated Vascular Societies: SVN, CSCVS, BSIR, Rouleaux, BACPAR and Venous Forum

SENIOR – £45

OVERSEAS – £115

The Vascular Society of Great Britain & Ireland c/o Executive Business Support Ltd
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Journal of
VASCULAR SOCIETIES
GREAT BRITAIN & IRELAND

J.Vasc.Soc.G.B.Irel. 2024;3(4):260
http://doi.org/10.54522/jvsgbi.2024.147

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Reviewer acknowledgement (Volume 3)

As we come to the end of our third year of publication and our twelth issue of *JVSGBI*, we would like to thank our reviewers for taking the necessary time and effort to review the manuscripts published in Volume 3. 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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Anyone interested in joining our team of reviewers, please email your name, place of work and your area of expertise to: editorialoffice@jvsgbi.com

Journal of
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We are a peer-reviewed, open-access journal and we encourage new, relevant and interesting content to support the treatment and care of vascular patients

The *JVSGBI* is published quarterly online at
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CALL FOR PAPERS

We are inviting contributions of the following article types:

EDITORIALS Original articles that present an important issue and conclusions that reach an advance in understanding

ORIGINAL RESEARCH Written by the researchers who actually undertook the study. This will include the hypothesis and purpose of the study, research method and results.

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DEBATE Present an argument or discussion on a relevant topic, presenting a well-argued viewpoint and represents the "pro" and "con" format

Q&A Submit your questions and a member of the Editorial Board will be asked to provide a solution or explanation into the question raised

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Submit your manuscripts and any enquires to: editorialoffice@jvsgbi.com

VASCULAR RESEARCH UK

A platform for Communication, Collaboration and Dissemination of high-quality research into vascular conditions

WWW.VASCULAR-RESEARCH.CO.UK
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CONNECTING THE VASCULAR RESEARCH COMMUNITY

Who we are

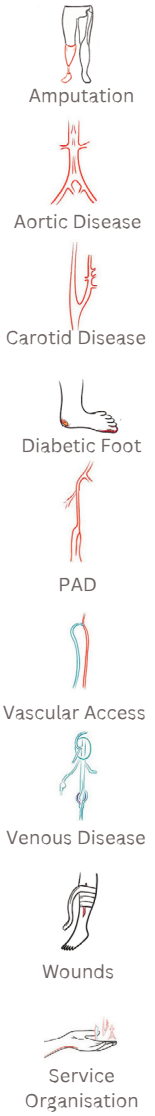
Vascular Research UK was founded in November 2022 by the UK Vascular Surgical Specialty Research Leads.

It was established as a platform to support Communication, Collaboration and Dissemination, providing healthcare professionals, researchers and patients with the latest information and evidence for high-quality research into vascular conditions.

Aims

Vascular Research UK is dedicated to improving the quality and accessibility of research. Our aim is to be a leading resource, helping to ensure that the latest evidence is used to inform clinical practice and the development of services.

Whether you're a healthcare professional, a researcher, or a patient, we want to ensure that everyone has access to the latest evidence in an accessible format and to promote awareness of vascular conditions to the wider public and policy makers.



How do we do this?

VRUK provides information completely free of charge to anyone with an interest. It provides easy access to a variety of content through a website and Youtube channel which will include; information and presentations about new and ongoing trials, expert insights on vascular conditions, and interviews with leading vascular experts.

You can also get involved with the special interest groups (SIGS) supporting research development, funding and delivery in the nine subspecialist areas of vascular practice.

How can I support VRUK?

With the VRUK platform we want to facilitate and promote greater understanding and collaboration among researchers, healthcare providers, patients and policy makers, to drive progress in high quality evidence and to disseminate research which is relevant worldwide.

Please subscribe to the YouTube channel and click to receive notifications. If you like content then please promote and share it. This will help us to build the channel and ensure that the content we produce reaches as many people as possible.

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VASCULAR SOCIETY
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RESEARCH

Annual Specialist Registrar Educational Programme (ASPIRE Digital)

VASCULAR SOCIETY OF GREAT BRITAIN AND IRELAND

ASPIRE Digital
Annual Specialist Registrar Educational Programme

WEBINAR SERIES

The Annual Specialist Registrar Educational Programme (ASPIRE) supports the education and development of trainee vascular surgeons throughout their eight years of training, which in turn compliments the national curriculum. The Vascular Society Education and Training Committee develops, manages and delivers the ASPIRE programme.

The Vascular Society GB&I continue to deliver education via the ASPIRE Digital platform. This has resulted in an overwhelming response, and provided a growing resource of education for vascular surgeons.

Each of the recorded sessions are included on the Vascular Society members' website. Here's a list of sessions that are readily available for members of the VS website:

- Management of the Diabetic Foot Attack
- Surgical management of CLTI
- Battle for claudication - exercise vs angioplasty
- Current Management of Acute Aortic Syndrome
- Principles of major lower limb amputation
- How to write a paper
- Strategies for Vascular Trauma
- EVAR planning
- Concept of angiosomes
- Tips and tricks for safe open AAA repair
- Renal Access
- Mesenteric ischaemia
- Carotid Disease Management - Symptomatic and Asymptomatic
- Upper limb ischaemia
- Management of the infected groin
- Managing the rupture AAA - building a team approach
- TOCS
- Why should I consider a career in academic vascular surgery?
- Management of acute / chronic deep venous disease
- Open management of complex AAA
- Options for treating superficial venous reflux
- Endovascular management of complex aortic disease v2
- Iliac intervention - How I do it
- NOTS in vascular surgery
- Radiation Safety in the Hybrid Suite
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- Key aspects from the new European Venous Guidelines
- Paediatric Vascular Surgery
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- Everything you need to know about to manage AAA except how to fix them
- ASPIRE Digital Fellowships - How to get one, what to get out of it
- Management of the left subclavian artery in complex aortic interventions
- The foot in diabetic foot disease - biomechanics and operative approaches to manage clinical problems
- New Developments in Vascular Access
- Thoracic Aortic Disease
- Through Knee Amputation

ALL YOU NEED TO KNOW

To access the above resources, visit the Education section on the Vascular Society members' website www.vascularsociety.org.uk