

Optimising fitness for major vascular surgery

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PRACTICE

CLINICAL UPDATES

Optimising fitness for major vascular surgery

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What you need to know

Interventions such as increasing physical activity, optimising management of comorbidities, and smoking cessation can all improve outcomes after surgery

There is no guidance on when to introduce exercise interventions before surgery. Earlier is better (eg, at the time of referral)

Vascular conditions, including aortic aneurysm, are not a contraindication to low intensity aerobic exercise

Search strategy

We searched Medline and the Cochrane database for trials and clinical guidelines relating to abdominal aortic aneurysm surgery, lower limb bypass, and carotid endarterectomy. We considered guidelines from the National Institute for Health and Care Excellence (NICE), the European Society of Vascular Surgery, the European Society of Cardiology, and the Society of Vascular Surgery for key recommendations related to current vascular practice. Where possible, we relied on studies on major vascular surgeries, such as carotid endarterectomy, aneurysm repair, or peripheral limb revascularisation. If evidence was lacking, sources relating to other surgical specialities were used, and this has been stated in the text.

Major vascular surgeries, such as aortic aneurysm repair, carotid endarterectomy, and lower limb revascularisation, are increasingly common and carry a high risk. More than 200 million people are affected by peripheral arterial disease worldwide,¹ of whom 10-20% require surgery. In the UK, 1.2-1.5% of men over 65 have an abdominal aortic aneurysm, and more than 4000 repairs were performed in 2017.^{2,3} Between 7% and 18% of ischaemic strokes are attributed to carotid artery stenosis. About 4000 patients undergo carotid endarterectomy in the UK each year.^{4,5}

In this article, we review key preoperative interventions that can be started in primary care at the time of referral to a vascular surgeon. The decision whether a patient is fit for surgery will likely be made by the specialist vascular team following evaluation and imaging. However, early interventions initiated in primary care can potentially improve patient outcomes, even when there is uncertainty around a patient's suitability for surgery.

Why is it important?

Patients undergoing major vascular surgery frequently have comorbidities, such as older age, hypertension, existing cardiac disease, and a history of smoking. Optimising their fitness for surgery is challenging but can help the patient undergo surgery and improve outcomes. Cardiovascular risk factors are the most common comorbidities linked to long term mortality. Ischaemic heart disease is an important cause of death in patients who have had surgery for abdominal aortic aneurysm, and was responsible for more than 25% of deaths, compared with ≤6% for early surgical or aneurysm specific complications, in two large trials in the UK.⁶ The European Society for Vascular Surgery recently reported that up to 70% of patients with peripheral arterial disease or abdominal aortic aneurysm had multi site vascular disease.⁷ This was based on several cohort studies where either ultrasound or coronary angiography were used to detect carotid and cardiac disease in patients undergoing surgery for peripheral arterial disease. In a Swedish registry study with 66 189 patients diagnosed with peripheral arterial disease, nearly 30% of total healthcare costs were for management of cardiovascular disease, as hospitalisation or outpatient visits.⁸

Poor fitness is associated with a greater risk of perioperative mortality or major complications after surgery for abdominal aortic aneurysm for both endovascular and open repair in several

prospective observational studies.⁹⁻¹³ No data are available for lower limb or carotid surgery.

How is the patient's physical fitness for vascular surgery determined?

Physical fitness for surgery can be difficult to quantify. Cardiopulmonary exercise testing (fig 1) is a validated technique used to measure exercise capacity while monitoring cardiac and respiratory function in response to a physical challenge. Outputs from cardiopulmonary exercise testing include peak oxygen uptake (VO₂ peak) and anaerobic threshold (VO₂ AT). These have been shown to correlate with length of hospital stay, pneumonia, myocardial infarction, and mortality after repair of abdominal aortic aneurysm in several small studies.¹⁴⁻¹⁷ Patients with a lower anaerobic threshold may be declined surgery if the risk is deemed to outweigh the benefit. Coexisting frailty, symptomatic ischaemic heart disease, and reduced activity levels due to fear of exercising with an aneurysm or limb pain due to ischaemia tend to negatively affect the result of cardiopulmonary exercise testing.

What preoperative interventions can help improve outcomes of vascular surgery?

Optimisation for surgery can be broadly divided into improving physical fitness, modifying lifestyle factors, and managing coexisting medical conditions. There are no specific timelines; however, the earlier these measures are discussed with the patient and initiated before surgery the better.

Improving physical fitness

Reassure patients that vascular conditions, especially abdominal aortic aneurysm, are not a contraindication to low impact physical activity. In a small trial (124 patients), a supervised exercise programme for six weeks before surgery was associated with fewer postoperative complications and length of hospital stay following elective abdominal aortic aneurysm repair, although short term mortality was unaffected.¹⁸ Preoperative high intensity interval training involving short bursts of vigorous exercise interspersed with periods of low intensity recovery was found to be acceptable in patients with a large abdominal aortic aneurysm in a small trial (27 patients).¹⁹ A systematic review of exercise before abdominal aortic aneurysm repair found good patient compliance (70-94%) in five studies (120 patients), using programmes lasting between two and 12 weeks, and marked improvements in anaerobic threshold.²⁰

Refer patients to specific information resources (box 1) on how to maintain fitness with their condition. For patients with critical limb ischaemia and limited ability to mobilise and exercise, guidelines from the National Institute for Health and Care Excellence (NICE) for management of rest pain recommend referral to a specialist pain service.²¹ This may be suitable in patients who have been turned down for revascularisation for any reason, who need high doses of opioid analgesia, or in whom pain persists even after surgery (including amputation).

Box 1: Information resources for patients

- The Vascular Society for Great Britain and Ireland provides free patient information on all major vascular conditions, including advice on lifestyle changes and moderate exercise: <https://www.vascularsociety.org.uk/>
- The Pre-Op Optimisation Project is a free resource developed by a general practitioner. It covers a wide range of advice on how to reduce preoperative risk before surgery, with links to guidelines and information for doctors and patients alike: <http://www.preop.org.uk/>
- The Royal College of Surgeons of England has dedicated a section of its website to patients who are going to have surgery, with answers to common questions and clear advice when preparing for an operation: <https://www.rcseng.ac.uk/patient-care/having-surgery/things-to-consider-before-having-surgery/>

Optimising medical management

Antiplatelet therapy

Guidelines from NICE and European vascular taskforces^{22,23} recommend starting clopidogrel for suspected or known carotid and peripheral disease at the time of referral to vascular surgery. Aspirin is preferred in patients diagnosed with abdominal aortic aneurysm although updated guidelines are awaited.

Antiplatelet therapy with aspirin or another agent is protective in patients at risk of occlusive vascular events, such as myocardial infarction, stroke, angina, cerebral ischaemia, or peripheral arterial disease. A meta-analysis (287 randomised controlled trials, 135 000 patients) identified a 34% proportional reduction in myocardial infarction and a 26% reduction in cardiovascular related event or death for patients with ischaemic heart disease, peripheral arterial disease, or diabetes taking an antiplatelet versus controls.²⁴ Preoperative use of antiplatelets and statins was associated with improved 30 day mortality (odds ratio 0.76; 95% confidence interval 0.5 to 1.05; P=0.09) after major vascular surgery in a large retrospective study (14 489 patients). Continuing these medications at discharge improved five year survival (hazard ratio 0.5; 95% confidence interval 0.4 to 0.7; P<0.01).²⁵ The CAPRIE trial (19 185 patients with previous stroke, ischaemic heart disease, or peripheral arterial disease) noted a relative reduction of 8.7% (confidence interval 0.3 to 16.5%; P=0.04) in annual risk of ischaemic stroke, myocardial infarction, or vascular death with reduced gastrointestinal bleeding events in patients treated with clopidogrel (5.32%) compared with aspirin (5.83%).²⁶

Managing lipid levels

Prescribing a short course of a statin about a month before surgery has been associated with reduced cardiovascular events and deaths compared with placebo in patients undergoing aortic, carotid, and lower limb revascularisation surgery in two small randomised controlled trials.^{27,28} NICE guidelines recommend atorvastatin for patients with any cardiovascular disease (ie, peripheral arterial disease, stroke, and abdominal aortic aneurysm).²⁹ They also recommend baseline tests for total low density lipoprotein and high density lipoprotein cholesterol in all patients diagnosed with these conditions. If available, the results should be included in the referral letter to the vascular surgeon to prevent them being repeated. Test again three months after commencing treatment. An increase in dose may be required in patients already on a statin in whom recommended targets have not been met. For example, guidelines from the European Vascular Society recommend achieving a serum low density lipoprotein cholesterol of <1.8 mmol/L or a decrease of ≥50% of between 1.8 and 3.5 mmol/L for any patient with peripheral arterial disease.²²

Blood pressure control

Hypertension is often diagnosed at the same time as an acute vascular event, such as stroke, abdominal aortic aneurysm, or acute limb ischaemia. A subgroup analysis (567 men aged 50–79) of the American Aneurysm Detection and Management (ADAM) study found that abdominal aortic aneurysm growth increased by up to 0.02 cm per year for every 10 mm Hg increase in diastolic pressure (95% confidence interval 0.01 to 0.04; $P=0.01$).³⁰

Refer to NICE guidelines (CG127) on hypertension for blood pressure control targets based on the stage of hypertension, age, ethnicity, and comorbidities, such as diabetes, renal failure, and signs of end organ damage. Initiate treatment at the time of referral if indicated. The 2013 Cochrane review on blood pressure management in peripheral arterial disease (eight randomised controlled trials, 3610 patients) failed to show superiority of one antihypertensive agent over another in this population due to study heterogeneity. Furthermore, it did not find clear evidence that β -blockade should be avoided in the presence of peripheral arterial disease.³¹ Discuss with the patient lifestyle interventions, such as smoking cessation, reducing alcohol intake, weight loss, low salt intake (6 g/1 teaspoon a day), and regular exercise, which will help with blood pressure control and improve fitness for surgery.^{7,32}

Lung disease

Severe lung disease, such as chronic obstructive pulmonary disease (COPD), is associated with greater in-hospital mortality, respiratory complications, and slower recovery after abdominal aortic aneurysm repair, as seen in two large cohort studies in the USA and Taiwan.^{33,34}

NICE guidelines³⁵ present clear stepwise guidance on the diagnosis and management of COPD in primary care, including when to refer a patient for specialist advice. The vascular team can also refer the patient if there has been insufficient time to manage the patient in primary care. If COPD has been diagnosed in primary care, it is appropriate to initiate smoking cessation and inhaled and oral medication while waiting for a vascular review.

Anaemia

Detecting anaemia at the time of referral can indicate concomitant disease, and can enable early treatment to reduce the need for perioperative transfusion.

Anaemia in vascular patients is often complicated by associated comorbidity and use of antiplatelets. Evidence suggests that preoperative anaemia and need for perioperative transfusion are risk factors for poorer postoperative outcomes. In a large US registry study (2946 patients), about a quarter of patients undergoing vascular surgery required transfusion. Transfusion was associated with an increased risk of death (odds ratio 6.94, 95% confidence interval 3.22 to 14.92; $P<0.001$), myocardial infarction (odds ratio 7.96, 95% confidence interval 3.74 to 16.92), and postoperative pneumonia (odds ratio 7.43, 95% confidence interval 3.25 to 16.96; $P<0.001$).³⁶ The US national quality improvement database (941 496 adults undergoing non-cardiac general, vascular, and orthopaedic operations) found that patients receiving intraoperative transfusion had higher unadjusted morbidity and mortality, which increased in a dose dependent manner.³⁷ A meta-analysis (24 observational studies, 949 445 patients) showed that in non-cardiac surgery patients (vascular, orthopaedic, spinal, and upper gastrointestinal operations), preoperative anaemia was associated with increased need for perioperative transfusion, acute kidney injury (odds

ratio 3.75, 2.95 to 4.76; $P<0.001$), infection (odds ratio 1.93, 1.17 to 3.18; $P=0.01$), and mortality (odds ratio 2.87, 2.10 to 3.93; $P<0.001$).³⁸

Obtain a full blood count at the time of referral to the vascular team, and communicate the results when known. Commence treatment alongside referral to the vascular team using the local pathway for managing anaemia.³⁹

What other lifestyle modifications to consider?

Smoking cessation

Offer urgent referral to a smoking cessation service, even if surgery is imminent. Recommended interventions include behavioural support by a trained counsellor, nicotine replacement therapy, and medications such as varenicline and bupropion.^{40,41} Smoking cessation support is offered in hospital; however, the earlier patients stop before surgery, the greater the benefits.

Current smoking was associated with a 0.05 cm annual increase in aneurysm expansion rate in those under surveillance in the ADAM study (95% confidence interval 0.25 to 0.28; $P<0.001$).³⁰ Broadly speaking, cardiovascular risk reduces by up to a third within two to four years after stopping smoking, reducing to that of a non-smoker within 15 years.⁴² A pooled meta-analysis (six randomised trials, 448 patients) noted that smoking cessation using various interventions as little as two weeks before a range of major surgical procedures led to a 41% relative risk reduction in postoperative complications, including abdominal wound infection and breakdown (relative risk 0.76, 95% confidence interval 0.69 to 0.84; $P<0.0001$) compared with those who continued to smoke.⁴³ An observational study among 739 patients undergoing surgery for peripheral arterial disease found that those who stopped smoking within the year had lower all cause mortality (14% versus 31%; hazard ratio 0.40; 95% confidence interval 0.18 to 0.90) and improved amputation free survival at five years (81% versus 60%; hazard ratio 0.43, 95% confidence interval 0.22 to 0.86).⁴⁴

Frailty

Frailty describes reduction in physiological reserve and negatively affects tolerance and recovery from surgery. Frail people are at greater risk of postoperative complications and mortality, as seen in a large retrospective study in 23 207 patients undergoing repair of abdominal aortic aneurysm.⁴⁵ Defining frailty is challenging, but it is now included in the list of preoperative risk factors in the UK national vascular quality improvement audit, owing to evidence for its impact on postoperative recovery.

Validated tools for preoperative frailty assessment can help identify patients at high risk of complications with vascular surgery.^{46,47} In primary care, multimorbidity and frailty can be screened for opportunistically in at risk adults at the time of referral using a validated tool, such as the electronic frailty index. A falls assessment in patients with peripheral arterial disease, a cognitive assessment in those with carotid disease, and a medication review are advisable. The medication review is particularly pertinent, as many patients referred to a vascular surgeon will be started on an antiplatelet (and proton pump inhibitor) and statin, and are at risk of polypharmacy.

Referral is often the point at which a patient with known frailty risk factors begins to think about what matters to them—that is, quality of life over invasive treatment. Early discussion with the vascular surgeon can be useful to address risk factors and

help the patient and their family make informed decisions about treatment and postoperative care.⁴⁸

Education into practice

How would you discuss physical activity with patients being referred for a vascular condition based on reading this article?

How do you discuss the importance of smoking cessation with your patients? Will that change after reading this article?

For patients with a documented diagnosis of vascular disease at your practice, how many have had a blood pressure reading in the last 12 months? How many have had a lipid measurement in the last 12 months?

Questions for further research

- How can multidisciplinary programmes facilitate preoperative optimisation of patients to improve outcomes for abdominal aortic aneurysm repair, bypass, and major amputation?
- Are optimisation programmes best delivered in the community or in hospital?
- How feasible and acceptable are optimisation programmes to patients?
- Is earlier implementation associated with increased or reduced cost associated with reduced postoperative events?
- What is the impact of psychological preparation (if any) on patients undergoing major vascular surgery?

Additional educational resources for healthcare professionals

- The Royal College of Surgeons of Edinburgh has partnered with the antismoking charity *Action on Smoking and Health* to support surgeons in encouraging patients to quit smoking ahead of surgery and improve outcomes: <https://www.rcsed.ac.uk/news-public-affairs/reports-and-campaigns/smoking-and-surgery>
- Perioperative exercise testing and training society (POETTS) provides consensus guidelines and resources on exercise testing, and opportunities for training courses: <https://poetts.co.uk/home?newsid=8>
- The Preoperative Association provides a comprehensive list of preoperative guidelines for interested clinicians: <https://pre-op.org/preoperative-guidelines>
- NICE has developed a resource on preoperative pathways for patients undergoing major or complex surgery, linked to relevant guidelines and resources: <https://pathways.nice.org.uk/pathways/preoperative-tests#content=view-node%3Aanodes-major-or-complex-surgery>
- The British Geriatrics Society (BGS) has developed a programme called Fit for Frailty to support recognition of the frail patient and develop strategies for managing it. It recommends the Edmonton Frail Scale for assessing patients in the elective surgical setting. The programme aims to dispel the myths of frailty being an inevitable or static condition that cannot be improved on: https://www.bgs.org.uk/sites/default/files/content/resources/files/2018-05-23/fff_full.pdf

How patients were involved in the creation of this article

We consulted six patients who had undergone surgery for repair of abdominal aortic aneurysm, coronary artery bypass grafting, and major limb amputation for peripheral arterial disease at the Centre for Exercise and Health, Coventry, during the writing of this article. Patients with abdominal aortic aneurysm repair and coronary artery bypass grafting described feeling underprepared and weak, and had restricted their activity before surgery because of fears around causing abdominal aortic aneurysm rupture or a heart attack. Patients with peripheral arterial disease felt they had little time to prepare before their amputation, or were in too much pain to consider any physical exercise.

Patients recognised that smoking cessation, blood pressure control, and "best medical therapy" were important but they did not understand why these measures would make any difference in the short time between diagnosis and surgery. All felt that any physical activity before surgery would have needed to be supervised at least once for their own confidence.

This article has been written with this in mind, and describes key evidence for interventions by the general practitioner and patient at the moment of referral. We have shared some patient centred resources which can be given to, and used by, patients before seeing a vascular surgeon.

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Further details of *The BMJ* policy on financial interests is here: <https://www.bmj.com/about-bmj/resources-authors/forms-policies-and-checklists/declaration-competing-interests>

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Patient consent obtained for [fig 1](#).

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Figure

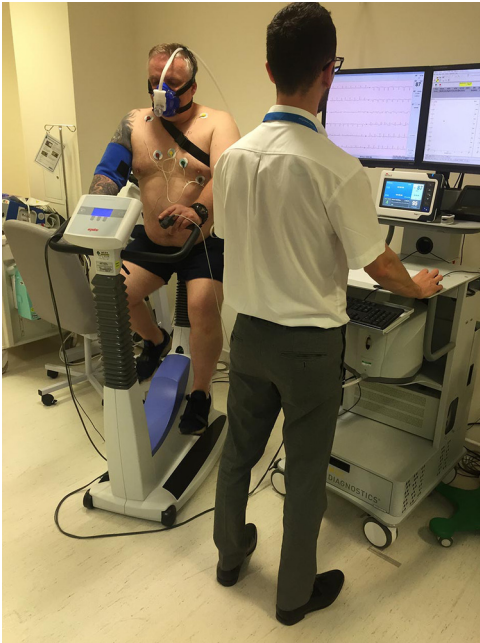


Fig 1 Cardiopulmonary exercise testing