

Guidelines

Association of Anaesthetists guidelines: safe vascular access 2025

Andrew J. Johnston, Matthew J. Simpson, Victoria McCormack, Andrew Barton, James Bennett, Anil Chalisey, Jeremy Crane, Stefanie Curry, Helen Laycock, Dhupal Patel, Teikchoon See, John Shubhaker, Kathryn Singh and Sarah Thornton

Summary

Introduction Safe vascular access is integral to anaesthetic and critical care practice. However, despite technological and procedural advances, it remains a frequent source of adverse events and patient harm. Ensuring a safe and effective approach to the selection, insertion and care of vascular access devices should be a priority for all practitioners.

Methods This updated consensus statement builds upon previous iterations of safe vascular access guidelines. An expert, multidisciplinary, multi-society working party agreed on major themes and conducted a review of literature and best practice to build a comprehensive body of work. This was followed by a two-round Delphi process to agree on specific recommendations and to inform these concise guidelines.

Results We agreed successfully 15 recommendations encompassing operational, training and clinical issues with an emphasis on a holistic approach to vascular access and long-term vessel health. These recommendations were divided into six major themes, covering: process (vascular access teams and responsiveness key performance indicators); device selection; insertion, including the use of safety standards, ultrasound, catheter tip position and vein/catheter ratios; the management of anticoagulation therapy, catheter-related thrombosis and coagulopathies; specific patient groups, including patients requiring renal replacement therapy, following mastectomy and axillary lymph node resection and the use of peripheral vasoconstrictors; and training in advanced vascular access.

Discussion It is hoped that these guidelines, together with the larger body of work, will improve the care of patients who require vascular access, embed a more holistic approach to vascular access and lifetime vein preservation, and support staff and hospitals with vascular access service development.

For full author affiliations, see end of article

Plain Language Summary may be found on [PubMed](#) and in the [Supporting Information](#).

Correspondence to: Andrew J. Johnston

Email: andrew.johnston5@nhs.net

Accepted: 16 June 2025

Keywords: central venous catheter; complication management; peripheral venous cannula; safety; vascular access

This is a consensus document produced by expert members of a Working Party established by the Association of Anaesthetists. It has been seen and approved by the Board of Trustees of the Association of Anaesthetists.

Re-use of this article is permitted in accordance with the Creative Commons Deed, Attribution 4.0, which does not permit commercial exploitation.

Recommendations

- 1** Hospitals should establish dedicated vascular access specialist teams with a designated clinical lead. Anaesthetists are in a strong position to lead on this multidisciplinary approach to the provision and development of vascular access services.
- 2** Vascular access specialist teams should work with other stakeholders to ensure appropriate hospital and community vascular access standards and to monitor these standards against locally agreed key performance indicators, using regular audit and review. Responsiveness indicators should be included to ensure timely and expert insertion.
- 3** A comprehensive and holistic approach to vascular access for all patients is paramount. This entails thorough vein and lifestyle assessments; tailored discussions and consent procedures; safe insertion practices; meticulous documentation; early identification and management of complications; and timely removal of devices, all aimed at preserving long-term vein health.
- 4** Every patient should have timely access to the insertion of commonly used vascular access devices. For patients classified as having difficult intravenous access, consideration should be given to early involvement of specialised vascular access teams for long-term access solutions.
- 5** The integration of Local Safety Standards for Invasive Procedures (LocSSIPs) into vascular access procedures is essential, including mechanisms to prevent retained guidewires and minimise complications. Steps should include: appropriate consent and procedural verification; team brief; sign-in; time-out; safe insertion with reconciliation of equipment; sign-out; and handover, debrief and documentation. Lines or dilators that have been placed in an artery inadvertently and are ≥ 6 Fr should be left in place and their safe removal discussed urgently with interventional radiologists or vascular surgeons.
- 6** Real-time ultrasound guidance should be employed for all central vein access and other applicable access sites to enhance the success and safety of procedures; a 'scouting' ultrasound should take place immediately before the procedure using sterile ultrasound gel. When ultrasound is necessary for peripheral cannulation, consideration should be given to using a long peripheral catheter or midline over a short peripheral catheter to mitigate the risk of extravasation injury.
- 7** To preserve vessel health, catheters should ideally occupy no more than one-third of the cross-sectional area of the vessel, with at least one-third of the catheter situated intraluminally. Selecting the appropriate vein to maintain a haemodilution ratio of ≥ 3 (three parts blood to one part drug) helps minimise vein wall damage from irritant agents. Larger, high-flow veins provide better dilution and are preferred for such drugs.
- 8** Optimal positioning for upper body central venous catheter tips includes the lower third of the superior vena cava, cavo-atrial junction or high right atrium; this ensures maximum blood flow and dilution and reduces the risk of vessel injury and thrombosis. The movement of peripherally inserted central catheters into the body with arm adduction should be considered. Real-time imaging or ECG guidance should be used for long-term catheters. Lower body catheter tips should ideally be sited in the inferior vena cava, with long-term catheter tips positioned above the level of the renal veins.
- 9** Recommendations are given for the management of patients undergoing anticoagulation therapy or those with underlying coagulation disorders. Local protocols should be developed, aligning with national guidance. Different sizes and types of vascular access device require different safety thresholds. In general, no treatment is required before an uncomplicated insertion of a peripherally inserted central catheter or non-tunnelled central venous catheter.
- 10** The presence of a central venous catheter is a major predisposing factor to venous thrombosis. Regarding catheter-related central venous thrombosis, if the catheter remains necessary, in good position, uninfected, functional and not jeopardising the limb, it may be left in situ, with the patient receiving anticoagulation as per local protocols.
- 11** In patients with chronic kidney disease who may require renal replacement therapy, consideration of vein preservation and long-term vein health is vital. Protection of veins that may be required for the creation of an arteriovenous fistula (such as the basilic and cephalic vein) is particularly important.
- 12** Mastectomy and axillary lymph node resection are not considered absolute contraindications for short-term ipsilateral vein cannulation. Peripherally inserted central catheter insertion and axillary/subclavian vein insertion should be avoided in arms at risk or with evidence of lymphoedema.

- 13** Potent peripheral vasoconstrictors such as noradrenaline may be infused for short durations through appropriately positioned short peripheral catheters and at dilute concentrations. Strict protocols should be followed.
- 14** Training in postinsertion care, maintenance, flushing techniques and early complication recognition should be mandatory for all healthcare providers who work with vascular access devices.
- 15** Training schemes in advanced vascular access should be developed at a national level; where appropriate, these should be open to non-medical staff.

What other guidelines currently exist?

This updated consensus statement builds upon the safe vascular access 2016 guidelines [1]. Other documents of relevance include the American Society of Anesthesiologists 2020 Practice Guidelines for Central Venous Access [2]. However, there is no formal consensus document that covers the scope of this guideline.

Why were these guidelines developed?

Since the publication of the 2016 guidelines, there have been significant developments in the field of vascular access. These developments include the availability of an increasing variety of vascular access devices, such as midlines and long peripheral cannulas [3, 4]; an increasing emphasis on the concept of long-term vein health [5–8]; and changes to the processes, pathways and services affecting vascular access [9]. These guidelines cover these areas and provide wide ranging recommendations that we hope will ensure expert, consistent and standardised care across different healthcare settings and providers. The guidelines also highlight areas of fundamental importance to vascular access safety, such as optimal device choice; insertion technique; positioning and care of vascular access devices; and recommendations that aim to reduce complications and improve safety.

How does this statement differ from other guidelines?

There is currently no existing guidance covering the scope and focus of this document. This document is supplemented with a larger body of work that offers a more comprehensive and general review of vascular access (see online Supporting Information Appendix S1).

Introduction

Vascular access is the most common invasive procedure undertaken in secondary care, with short- and longer-term

vascular access vital to modern medicine. Despite its importance and the risks of significant morbidity and mortality [10–12], it is often poorly resourced, lacking clear pathways and quality indicators and falls frequently between various specialties, with anaesthetists, radiologists, nephrologists, surgeons and oncologists playing a major role [13].

Historically, the focus of vascular access has been on the mechanics of device insertion rather than a unified and holistic approach that covers the selection, insertion, care and removal of devices and which prioritises minimising complications and preserving vessels for long-term use. This fragmented approach can result in unnecessary complications, poorly chosen devices and limited consideration for future access needs, particularly in patients with chronic illnesses requiring repeated interventions [5–8].

A consistent issue in clinical practice is the absence of clear lines of responsibility for vascular access care. While many specialties are involved in device placement, the postinsertion care, troubleshooting and complication management often lack defined ownership [9]. This contributes to delayed interventions, suboptimal maintenance and increased patient harm. Addressing this requires not only better-defined pathways but also cultural change, recognising vascular access as a specialty, with cross-disciplinary collaboration and appropriate resource allocation.

There is a growing recognition of the need to prioritise lifetime vein health, particularly for patients with cancer, renal disease or chronic illness, for whom venous preservation is essential [14]. Decision-making should be guided by the principle of ‘the right device, in the right vessel, at the right time’, with consideration of both the current and future needs of the patient. This includes using central access appropriately; avoiding repeated cannulation of the same vein; and preferring larger vessels for irritant or vesicant agents to reduce the risk of phlebitis and thrombosis. Having one single device placed early in treatment pathways, that fits with the patient’s lifestyle and can be used for the duration of the treatment, is preferable to repeated short-term devices [7].

The aim of these guidelines is to build upon iterations published previously [1] and to provide further recommendations in areas such as process design; insertion technique; postinsertion care; and workforce training. Additional guidance is offered in areas of controversy or variability in practice, such as vascular access after axillary lymph node clearance; the use of peripheral noradrenaline; and the management of patients with coagulopathies or with catheter-related venous

thrombosis. Underpinning all recommendations is a commitment to offer patients expert and timely care, and to prioritise lifetime vein health.

Recommendations are also provided in areas that the Working Party considers to be vital to modern and safe practice, including responsiveness; quality metrics; device selection; the use of real-time ultrasound; and catheter tip position. In doing so we seek to move vascular access practice towards greater consistency, reduced harm and improved patient outcomes, whilst promoting a culture of vein preservation and shared clinical responsibility.

Methods

We developed these guidelines by bringing together a group of experts from a variety of backgrounds and specialties, including: anaesthetists; intensivists; surgeons; nephrologists; radiologists; nurses; and clinical scientists. Supporting organisations included the Association of Anaesthetists, Royal College of Anaesthetists, Intensive Care Society, National Infusion and Vascular Access Society and Vascular Access Society of Britain and Ireland.

The Working Party reached consensus on the major areas of vascular access to be considered, and these were then developed by several sub-groups using a process of literature review and expert opinion. The focus was not to 'grade evidence' but to provide a comprehensive review and expert opinion. This process formed the full version of the safe vascular access 2025 guidelines (see online Supporting Information Appendix S1).

Following this, two members of the Working Party (AJ/MS) proposed initially 14 key recommendations, which emerged as themes of major importance from the full version. Recommendations underwent a two-round Delphi approach [15] to assess the content, clarity and importance of each recommendation, in which all members participated. These recommendations were used to inform the final document, which was written by AJ/MS, with the final version being agreed by all members of the group.

Results

Fifteen recommendations were agreed by the Working Party and form the basis of this document. These concise recommendations should be read alongside the full version of the document (see online Supporting Information Appendix S1).

Process

All acute hospitals should provide appropriate emergency and urgent insertions of peripheral cannulas (arterial and

venous), intra-osseous access and temporary central venous access devices (CVAD). Vein health should be preserved and patients with difficult intravenous access should be escalated promptly, preferably to vascular access teams. Hospitals should establish dedicated vascular access specialist teams with a designated clinical lead. The Working Party recommends a model that has a designated clinical/physician lead; anaesthetists are in a strong position to lead on this multidisciplinary approach. It is recognised that dedicated vascular access teams within a healthcare system can have a positive effect on multiple services and pathways (Table 1) [9, 16, 17].

Various service models exist depending on local workload, facilities and skillsets. These may range from the bedside insertion of long peripheral cannulas and midline catheters to a dedicated facility that is able to manage a full range of advanced vascular access procedures [9]. Teams are often multidisciplinary, and the procedures undertaken are often based on competency rather than traditional professional roles; many hospitals have successfully trained non-medical staff to insert a wide range of vascular access devices and to manage many of the associated complications [9]. Vascular access specialist teams are positioned ideally to co-ordinate and manage patient databases, govern education and training, and serve as the primary contact for managing complications. For patients classified as having difficult intravenous access, consideration should be given to the early involvement of specialised vascular access teams for long-term access solutions. Patients with complex, lifelong or long-term vascular access requirements (e.g. patients with intestinal failure) benefit from having a detailed 'passport' that lists vascular access history, describes venous anatomy and highlights previous complications.

Vascular access specialist teams should work with other stakeholders to ensure appropriate hospital and community vascular access standards and pathways and to monitor these standards against locally agreed key performance indicators, using regular audit and review. These indicators should include complications such as catheter blockages; dislodgement; fracture; infection; and catheter related venous thrombosis. Responsiveness quality indicators are vital to ensure that patients get timely access to the insertion of commonly used vascular access devices. The Working Party suggests some 'responsiveness' key performance indicators for vascular access teams (Table 2).

Device selection

Clinicians face a vast and often confusing array of options, but choosing the right device for individual patients is

Table 1 Benefits of a specialist vascular access team.

Benefits	Description
Holistic approach to vascular access that encompasses	Patient assessment, device insertion, complication management and device removal Education Clinical governance Service development and research Improved support of community vascular access services
Centralised expertise and training opportunities	Enhanced access to specialised knowledge and oversight of skill development Support for ward-based teams in the maintenance of their skills and competencies
Improved long-term vein health	Focus on maintaining the integrity and health of veins for the entirety of a patient's life
Reduced complication rates	Lower the overall incidence of problems associated with vascular access
Improve patient experience	Better overall satisfaction and comfort for patients throughout their healthcare journeys
Reduced duration of stay	Shorter hospital admissions, reducing risk of healthcare-acquired infections
Facilitates hospital discharge	Enabling smoother and more efficient discharge processes
Outpatient therapy	Supporting treatments that can be administered outside the hospital setting either in primary care or day-case units, e.g. outpatient antibiotic therapy

Table 2 'Responsiveness' key performance indicators for vascular access teams.

Procedure	Inpatients	Outpatients
PICC and temporary vascular access device insertion	90% inserted within 2 working days from referral	90% inserted on the requested day
Tunnelled CVAD/ portacath insertions	Insertion within 2 weeks from referral	90% inserted on the requested day
Non-urgent CVAD removals (tunnelled CVAD and portacath)	90% removed within 2 working days from referral	90% removed on the requested day
Urgent requests (insertions and removals)	90% of patients (inpatients and outpatients) to be treated within one working day from referral	

PICC, peripherally inserted central catheter; CVAD, central venous access device.

crucial for device longevity, device functionality, complication rates and patient satisfaction (Table 3).

The Working Party recommends that patients should have access to all commonly used vascular access devices, including short and long peripheral cannulae; midline catheters; temporary central venous catheters; peripherally inserted central catheters (PICCs); tunnelled central venous catheters; and portacaths. Expertise should be available to access commonly used veins, such as upper and lower arm veins; internal jugular vein; subclavian/axillary vein; and femoral veins. Where required, computed tomography-rated or power-injectable devices that can withstand the pressures up to 300 psi and flow rates up to 5 mL.s⁻¹ needed for contrast injection should be considered.

Pathways for care and decision making should be established using models (Fig. 1). Long peripheral catheters

(6–15 cm in length) and midline catheters (typically > 15 cm in length) are inserted usually through large upper arm veins (basilic, brachial or cephalic) with the tip lying outside of the central veins [3, 4]. Although the blood flow at the tip of these catheters is higher than that found in peripheral veins, it is not sufficient to allow infusions of vesicants/irritants other than for short-term or emergency use. Long peripheral catheters and midline catheters are rarely sufficient for regular phlebotomy. Recent evidence is that for systemic anticancer therapy, portacaths are more effective and safer than both Hickman lines and PICCs [19]. Portacaths should be available to all patients who would benefit [19].

Providers should make provision for the timely insertion and care of all commonly used vascular access devices; there should be minimal variation in these

Table 3 Factors influencing choice of vascular access device.

Consideration	Description
Vein anatomy and vessel blood flow	Tools such as the rapid central vein assessment offer a systematic approach to identifying vein-specific characteristics that influence site selection [18]
Number of lumens required and device material	Select a device with the fewest necessary lumens to reduce the risk of infection, catheter breakage and air embolism. A dedicated lumen is recommended for parenteral nutrition. Power devices are advantageous for patients who need repeated imaging with intravenous contrast
Infusate characteristics	Consider the pH, osmolality and whether the infusate is an irritant, vesicant or cytotoxic drug, as these factors will inform device choice
Urgency of vascular access	The urgency of insertion may inform the availability of device type because of the need for appropriate expertise, facilities etc. Central venous access should be obtained in a safe manner, using standard safety precautions, as soon as is practically possible
Duration of intended treatment	The duration of treatment may influence device selection as regulated by the Medicines and Healthcare products Regulatory Agency (MHRA), with only Class 2b devices used for treatments exceeding 30 days
Patient choice, demographics, lifestyle and previous vascular access history	Robust digital recording and auditing tools can quickly identify a patient’s previous vascular access device history and past insertion complications For long-term CVADs, patient preference is crucial for a successful treatment journey. Quality of life measures, including the impact of the CVAD on hygiene routines; sleep; mobility; work; exercise; hobbies; body image; and socialising, should be assessed routinely

CVAD, central venous access device.

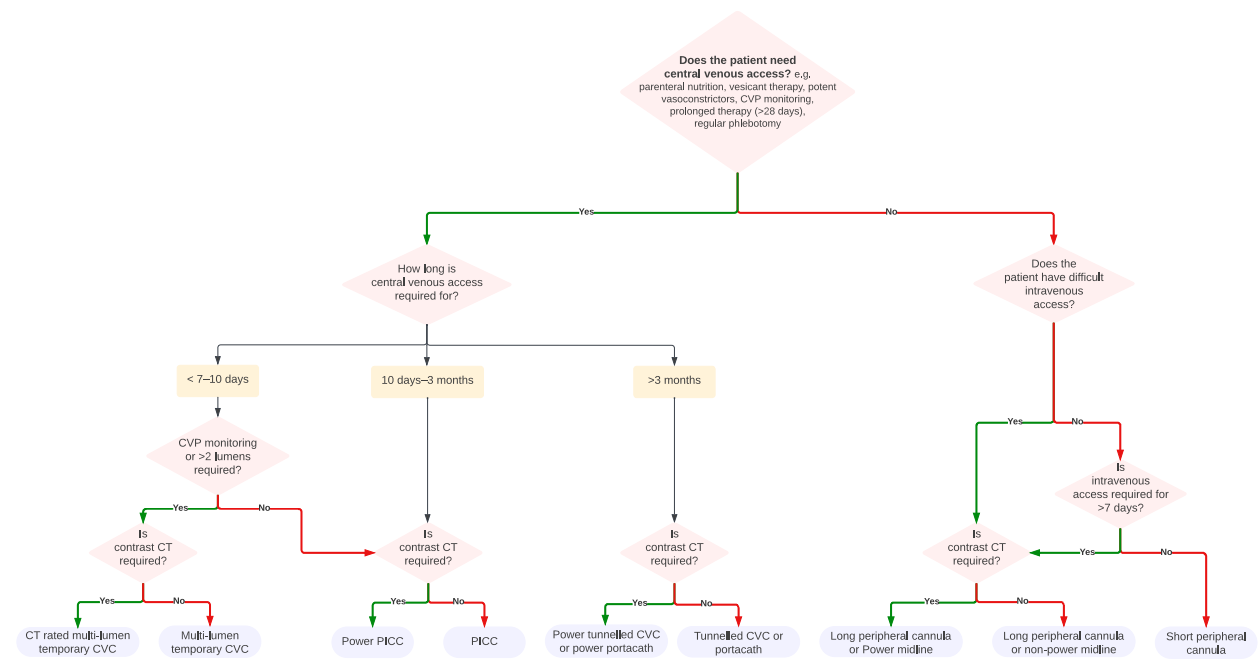


Figure 1 Decision-making tree for selecting a vascular access device. CVP, central venous pressure; CVC, central venous catheter; CT, computed tomography.

practices between hospitals and geographical areas. The use of hub-and-spoke models of care and referral to specialist centres will help broaden provision. Recognition of risk factors for difficult intravenous access and a

co-ordinated effort to preserve long-term vein health at all stages of life should be an established part of all patient care and should be central to a wider vascular access service.

Table 4 The National Safety Standards for Invasive Procedures (NatSSIPs) sequential step standards ('NatSSIPs eight') that should be implemented for invasive procedures.

Procedure stage	Description
Consent and procedural verification	Before starting, the correct procedure must be verified by a full review of the records/patient to ensure consistency of the clinical record; diagnosis; treatment plan; investigation results; written consent (where applicable); surgical site check; and confirmation by/with the patient. Up-to-date radiology and diagnostic tests should be reviewed. If the device has to be inserted into a specific site/side, then the site for the procedure must be marked
Team brief	A safety briefing must be undertaken before the start of any vascular access device insertion. Where the device insertion forms part of a larger procedure (e.g. during major surgery), this should form a specific part of the full safety briefing
Sign-in	Verify the patient's identity, ensure the correct procedure is planned, and confirm that all necessary preparations have been made before any procedure begins
Time-out	Pause and conduct a final verification of key details immediately before the procedure begins. This is a crucial moment to catch any potential errors or omissions
Safe and efficient use of implants	Avoid complications such as infections or implant failure through proper handling and techniques. Optimise clinical outcomes and patient health. Minimise issues such as misplacement or breakage by following best practices. Use resources cost-effectively. Adhere to regulatory standards. Maintain accurate records for traceability and future reference
Reconciliation of items to prevent retained foreign objects	Guidewire retention is categorised as an NHS Never Event and most cases are due to human error [22]. All possible procedures should be put in place to prevent retained guidewires, including operator vigilance; guidewire counts; mandatory witnessed documentation of guidewire removal; and where available, the use of guidewire anti-retention devices. A verbalised "Wire-out, Shout-out" with a witness repeating "Wire-out" shout has been effective in some Trusts in the UK
Sign-out	Ensure all procedural documentation is complete, account for all instruments and materials, and confirm the postoperative plan before the patient leaves the operating/procedure room
Handover, debrief and documentation	Ensure continuity of care, enhance patient safety and maintain comprehensive records

Insertion

The original National Safety Standards for Invasive Procedures (NatSSIPs) were published in 2015 as an NHS England initiative defining the key elements required to deliver safe care for patients undergoing invasive procedures, including central venous access [20]. The aim is to ensure that teams consistently, and in a standardised manner, follow the critical safety steps to minimise risks and errors, thereby reducing avoidable harm.

The revised version, NatSSIPs2, has been produced by the Centre for Perioperative Care and consists of two inter-related sets of standards: organisational standards, which are clear expectations of how health providers and external bodies can support the delivery of safe invasive care; and sequential standards, which are the procedural steps undertaken by individuals and teams providing care to patients undergoing invasive procedures [21]. The 'NatSSIPs eight' are a set of eight sequential step standards which should be implemented for all invasive procedures in all settings (Table 4).

It is made clear in NatSSIPs2 that some invasive procedures may require less detailed checks that are

proportionate to the processes involved; the insertion of a peripheral cannula is one such procedure. Each organisation should develop their own Local Safety Standards for Invasive Procedures (LocSSIPs) representing their local system based on this document; a version has been produced by the UK Intensive Care Society and Faculty of Intensive Care Medicine (Fig. 2) [23, 24].

Ultrasound-guided vascular access has been endorsed globally and its routine use has been recommended by many professional organisations when the technology is affordable [25, 26]. Given the widespread availability and low cost of ultrasound in the UK, this should be used routinely for all CVADs and upper arm catheters, and early in other procedures (arterial and peripheral venous) if difficult; this is in line with international consensus recommendations [27, 28]. Practitioners performing central venous access regularly should be trained in ultrasound-guided access to the axillary/subclavian vein [29]. When ultrasound is required for peripheral cannulation, the Working Party recommends that a long peripheral catheter or midline is inserted into the upper arm. These have a longer dwell time (usually up

INVASIVE PROCEDURE SAFETY CHECKLIST: CVC Insertion



BEFORE THE PROCEDURE			TIME OUT			SIGN OUT		
Patient identity checked?	Yes ☐	☐	Verbal confirmation between team members before start of procedure			Able to aspirate blood from all lumens and flush all lumens?		
Appropriate consent completed?	Yes ☐	☐	Team members identified and roles allocated?			Yes ☐	☐	Correct injection site caps / connectors used?
All equipment available?	Yes ☐	☐	Is patient position optimal?			Yes ☐	☐	Correct dressing applied?
Correct type/size of line available?	Yes ☐	☐	Operator to confirm, during procedure, that guidewire is removed			Yes ☐	☐	Guidewire confirmed as removed?
Is there a coagulopathy (drugs and lab tests)?	Yes ☐	No ☐	Ultrasound available and set up			Yes ☐	☐	Chest X-ray required?
Known drug allergies?	Yes ☐	No ☐						Yes ☐
Are infection control precautions in place?	Yes ☐	No ☐						Yes ☐
Is help required?	Yes ☐	No ☐						Yes ☐
								N/A ☐
								If Chest X-ray required, is line position satisfactory?
								Yes ☐
								Pneumothorax excluded?
								Yes ☐
								Placement confirmation – use two methods
								CVP waveform present?
								Yes ☐
								Venous pressure
								mmHg
								Ultrasound confirms CVC placement?
								Yes ☐
								Paired venous and arterial blood gases?
								Yes ☐
								Arterial pO2.....kPa
								CVC pO2.....kPa

Procedure Date:
Time:
Operator:
Assistant:
Supervisor:

Patient Identity Sticker:

Signature of responsible clinician completing the form

Figure 2 An example of a Local Safety Standards for Invasive Procedures (LocSSIP) checklist for central venous catheter insertion.

to 4 weeks) and are less likely to kink or cause extravasation injuries because more of the catheter is sited intra-luminally [4].

In the UK, given the ease of access to ultrasound, the Working Party believes it is not practical for staff to continue to be trained to become fully competent in all landmark techniques. The only situations where ultrasound cannot be used consistently are extensive air emphysema and lack of availability of a device in emergencies. An understanding of landmark techniques is useful for rare occasions when ultrasound is not available or not able to be used. Landmark techniques will still be used in countries where ultrasound is not available.

The consensus view of the Working Party is that a 'scouting' ultrasound should take place immediately before the procedure using sterile ultrasound gel [30]. The insertion should then be done under real-time ultrasound imaging to visualise the needle tip entering the vein and then to confirm, as far as possible, by scanning proximally that the wire remains intravenous and does not transfix any other vessels prior to dilatation of the insertion site.

Operators need to be trained adequately, be sufficiently experienced and should use a high-resolution ultrasound device. It takes considerable time and practice to become fully competent in such techniques. National guidance on training has neither quantified this nor provided recommendations on appropriate standards and how these need to be achieved. However, procedural volume is likely to be an important predictor of reduced adverse events, and this is supported by data showing that increased experience of CVAD placement improves both catheter and patient-related outcomes [31]. Local centres may wish to implement their own training strategies, including direct observation of a pre-specified number of lines; a CVAD 'passport' requiring consultant sign-off; bedside teaching; and simulation. A low threshold for senior supervision is appropriate for larger gauge lines (> 9 Fr); subclavian and femoral lines (which are undertaken less commonly); or where anatomy is considered difficult.

To preserve vessel health, catheters should ideally occupy no more than one-third of the cross-sectional area of the vessel, with at least one-third of the catheter situated

intra-luminally. Additionally, selecting the appropriate vein to maintain a haemodilution ratio of ≥ 3 (three parts blood to one part drug) helps minimise vein wall damage from irritant agents. Larger, high-flow veins provide better dilution and are preferred for such drugs.

The cross-sectional area of the targeted vein is crucial for selecting the appropriate device size. Where possible, the catheter to vessel ratio, which indicates the space the device occupies within the vessel, should adhere to the 'rule of thirds': only one-third of the vein's area (catheter to vessel ratio $< 33\%$) should be occupied by the catheter, leaving two-thirds unobstructed [32, 33]. Tables are available to help visualise and select the correct vascular access device size based on thrombosis risk; in practice, matching the gauge (Fr) of the device with the vessel's diameter in millimetres, typically results in a catheter to vessel ratio of approximately 11%, aiding the goal of ensuring the smallest suitable catheter is inserted into the largest identified vessel. The impact of changes in position, hydration and respiratory dynamics on vein diameter, and therefore on catheter to vessel ratio, requires further exploration.

Although no studies specify the optimal catheter length within the vein, most short peripheral catheters are 2–5 cm long and with vein cannulation at a depth of 3–4 cm using ultrasound, only a minimal length of the short peripheral catheter would be within the intraluminal space, leading to a higher failure rate. It is recommended that at least one-third of the catheter length should be intraluminal, with long peripheral catheters being advantageous.

Dilution of medications by blood flowing within the veins protects the vein wall from damage. It is therefore good practice to consider the intended infusion rate of medications, particularly those that are known irritants. Ultrasound assessments have shown that the optimal haemodilution ratio, to prevent direct vein wall irritation, is above 3:1 (i.e. 3 parts blood to 1 part drug) [34]. Although calculations are not always practical for every vascular access insertion and infusion, selecting an appropriate site for the catheter tip with a higher blood flow is recommended for continuous infusions of irritant or vesicant drugs. Alternatively, adjusting the infusion rate based on the tip location, and thus its dilution potential, is appropriate.

Optimal positioning for upper body central venous catheter tips includes the lower third of the superior vena cava, cavo-atrial junction or high right atrium. Real-time imaging or ECG guidance should be used for long-term catheters. Appropriate catheter alignment and tip position are essential for safe placement of venous catheters. A poorly positioned catheter tip may increase the risk of

complications, e.g. thrombosis, erosion and pericardial tamponade. The position of the tip is not fixed relative to the central circulation, moving with respiration and patient position. In the case of PICCs, there is significant movement into the body with arm adduction, and this should be considered when positioning, especially if the PICC is inserted with the arm in an abducted position [35].

Upper body CVADs should be positioned with the tip parallel to the vessel wall and below the level of the azygous vein, usually in the lower superior vena cava or the upper right atrium for maximum blood flow [36, 37]. The upper right atrium is not defined formally but is usually considered to be within 2 cm of the cavo-atrial junction [37]. In emergency and acute situations, it may be justifiable to use a CVAD (including a temporary dialysis line) that has a tip which sits outside this region, where the benefits are felt to outweigh the risks. For short-term use (e.g. in the operating theatre) an upper-body central venous catheter can be used without confirmation of tip position provided it was a straightforward insertion done under ultrasound control; blood can be aspirated easily; there is no resistance to flushing with saline; and pressure-transduction shows a venous waveform.

The approximate distance from the puncture site to the cavo-atrial junction in adults is: 13–15 cm for the right internal jugular; 17–20 cm for the left internal jugular; 17–20 cm for the right axillary vein; and 20–24 cm for the left axillary vein. Catheters of appropriate length should be selected.

Useful chest radiograph landmarks include immediately lateral to the right trachea-bronchial junction just superior to the right main bronchus; this is where the azygous vein arches over the right main bronchus to join the superior vena cava. Another useful landmark is two vertebral bodies or 4 cm below the carina; this is the approximate level of the cavo-atrial junction [38]. The tip should ideally sit between the lower border of the right main bronchus and the high right atrium.

Lower body CVADs should preferably be positioned with the tip in the inferior vena cava (the inferior vena cava arises from the confluence of common iliac veins, corresponding to the L4/5 level). Traditionally, catheters of at least 20 cm are used and a radiograph is not used to confirm position; 25 cm catheters are more likely to have a tip that sits in the inferior vena cava and may be advantageous [39]. Long-term catheters should be positioned above the renal veins (above L1).

Electrocardiography and electromagnetic guidance are used increasingly to guide catheter tip positioning [40]. Fluoroscopy with contrast remains the gold standard for

confirming placement with imaging, especially for long-term vascular access or when vascular access is predicted to be difficult.

Lines or dilators that have been placed in an artery inadvertently and are ≥ 6 Fr should be left in place and their safe removal discussed urgently with interventional radiologists and/or vascular surgeons [2]. Other misplaced lines may require evaluation using imaging followed by discussion with vascular access specialist teams, interventional radiologists and surgeons before removal.

Coagulopathies, anticoagulation and catheter-related venous thrombosis

Local protocols should be developed for the management of patients undergoing anticoagulation therapy or those with underlying coagulation disorders, aligning with national guidance [41]. Patients having a CVAD inserted or removed do not need routine laboratory blood tests unless the condition or treatments are likely to impair coagulation, liver function or bone marrow function. There is insufficient evidence to support the routine correction of haemostatic defects before non-complex CVAD insertion and the incidence of significant bleeding events is low even in patients who are coagulopathic [42]. In the presence of a coagulopathy, a more experienced operator should insert the CVAD under ultrasound control, ideally at an insertion site that allows easy compression of vessels. Femoral access may have a lower risk in this situation.

Bleeding risks of insertion and removal vary with the site, type and size of device and operator experience. The risks of correction (e.g. infection, lung injury, thrombosis and transfusion associated circulatory overload) may exceed those of local bleeding, and it may be preferable to give blood products if problems occur, rather than prophylactically [43]. The guidance on the management of coagulopathies and thrombocytopaenia (Tables 5 and 6) should be interpreted in the context of patient factors, operator factors and local guidelines. Individuals may choose to use additional tests, such as thromboelastography and platelet mapping. Local policies should be developed for the management of complex patients as appropriate.

There is no standardised threshold for platelet transfusion before CVAD insertion. The lack of a robust evidence base, concern regarding transfusion reactions, and the role of ultrasound-guided insertion in mitigating bleeding risk have led to a variety of platelet count cut-offs ranging from $20 \times 10^9 \cdot l^{-1}$ [41] to $50 \times 10^9 \cdot l^{-1}$ [1]. This was addressed in the PACER trial, which examined whether withholding prophylactic platelet transfusion before CVAD

insertion in patients with platelet counts between $10\text{--}50 \times 10^9 \cdot l^{-1}$ and on ICU or haematology wards, was non-inferior to the administration of a prophylactic single unit platelet transfusion to reduce the risk of catheter-associated bleeding [44]. Results showed that non-inferiority was not met, and patients who did not receive a prophylactic platelet transfusion, but had severe thrombocytopenia, experienced more CVAD-related bleeding compared with those who received platelets. Transfusion reactions were low. It is important to note that the highest incidence of bleeding was seen in patients on the haematology ward, in those with a platelet count of $10\text{--}20 \times 10^9 \cdot l^{-1}$, and in those undergoing tunnelled catheter placement. Clinician discretion based on experience and patient factors should always be applied in determining a threshold.

The Working Party noted the recommendations and thresholds for transfusion provided in the British Society of Haematology guidelines [41]. However, the Working Party reached a different consensus, that lower platelet counts are acceptable before transfusion should be necessary (Tables 5 and 6). Local policies should be developed for the management of complex patients as appropriate. Patients who are known to increment poorly after platelet transfusion will need discussion with haematology specialists. Patients with thrombotic thrombocytopenic purpura or heparin-induced thrombotic thrombocytopenia should not be given platelets without discussion with haematology specialists [41].

Antiplatelet drugs, such as aspirin and clopidogrel, do not normally need to be stopped before the insertion and removal of CVADs. Prophylactic doses of anticoagulants do not normally need to be stopped before the insertion and removal of CVADs.

Treatment doses of anticoagulants can usually be continued during the insertion of PICCs and uncomplicated temporary central venous catheters, and during the removal of PICCs and temporary central venous catheters up to 8.5 Fr. Treatment doses of anticoagulants should normally be stopped before the following: insertion of temporary lines for complex patients with anatomical difficulties and multiple punctures; removal of temporary central venous catheters above 8.5 Fr; and insertion and removal of tunnelled CVADs and portacaths. The exact timing of cessation will depend on renal function, bleeding risk and local policy. Recommendations include stopping low molecular weight heparin (e.g. enoxaparin and dalteparin) for 24 h; stopping apixaban, rivaroxaban, edoxaban for 24–48 h; and stopping dabigatran for 24–72 h [45].

Table 5 Coagulation and platelet recommendations for insertion of central venous access devices. Midlines and long peripheral cannula to be managed as per PICCs.

Type of line insertion	Laboratory results	Recommendation	Platelet count recommendation
Uncomplicated PICC and uncomplicated non-tunnelled CVAD	PT < 18 s INR < 1.5 APTT < 42 s APTT _r < 1.5	No treatment is normally required before procedure	No specific platelet count requirement
Uncomplicated PICC and uncomplicated non-tunnelled CVAD	PT ≥ 18 s INR ≥ 1.5 APTT ≥ 42 s APTT _r ≥ 1.5	No treatment is normally required before procedure	No specific platelet count requirement
PICC, non-tunnelled CVAD – complex patients*	PT ≥ 18 s INR ≥ 1.5 APTT ≥ 42 s APTT _r ≥ 1.5	Consider correcting coagulopathy Options include FFP (usually 10–15 ml.kg ⁻¹); vitamin K; prothrombin complex concentrate; and specific clotting factors	≥ 30 × 10 ⁹ .l ⁻¹
Tunnelled line (Hickman, portacath etc.)	PT < 18 s INR < 1.5 APTT < 42 s APTT _r < 1.5	No treatment is normally required before procedure	≥ 30 × 10 ⁹ .l ⁻¹
Tunnelled line (Hickman, portacath etc.)	PT ≥ 18 s INR ≥ 1.5 APTT ≥ 42 s APTT _r ≥ 1.5	Consider correcting coagulopathy Options include FFP (usually 10–15 ml.kg ⁻¹); vitamin K, prothrombin complex concentrate; and specific clotting factors	≥ 30 × 10 ⁹ .l ⁻¹

PICC, peripherally inserted central catheter; CVAD, central venous access device; PT, prothrombin time; INR, international normalised ratio; APTT, activated partial thromboplastin time; APTT_r, activated partial thromboplastin time ratio; FFP, fresh frozen plasma.

*Complex patients include those with difficult anatomy, multiple lines/punctures, obesity, etc.

Table 6 Coagulation and platelet recommendations for removal of central venous access devices. Midlines and long peripheral cannula to be managed as per PICCs.

Type of line removal	Laboratory results	Recommendation	Platelet count requirement
PICC, non-tunnelled CVAD, tunnelled CVAD	PT < 18 s INR < 1.5 APTT < 42 s APTT _r < 1.5	No treatment is normally required before removal	≥ 10 × 10 ⁹ .l ⁻¹
PICC, non-tunnelled CVAD ≤ 8.5 Fr	PT ≥ 18 s INR ≥ 1.5 APTT ≥ 42 s APTT _r ≥ 1.5	No treatment is normally required before removal	≥ 10 × 10 ⁹ .l ⁻¹
Non-tunnelled CVAD > 8.5 Fr, tunnelled line (Hickman, portacath etc.)	PT ≥ 18 s INR ≥ 1.5 APTT ≥ 42 s APTT _r ≥ 1.5	Consider correcting coagulopathy Options include FFP (usually 10–15 ml.kg ⁻¹); vitamin K; prothrombin complex concentrate; and specific clotting factors	≥ 30 × 10 ⁹ .l ⁻¹

PICC, peripherally inserted central catheter; CVAD, central venous access device; PT, prothrombin time; INR, international normalised ratio; APTT, activated partial thromboplastin time; APTT_r, activated partial thromboplastin time ratio; FFP, fresh frozen plasma.

The presence of a CVAD is a major predisposition to thrombosis, with PICCs having a higher incidence than other central venous catheters [46, 47]. Thrombosis is

avoided using an insertion technique designed to limit damage to the vein, including ultrasound guidance; choice of a catheter with the smallest calibre possible [48];

minimising the catheter-to-vein ratio; and positioning the tip of the catheter at or near to the cavo-atrial junction [49]. The femoral vein has a higher rate of thrombosis than the internal jugular vein and axillary/subclavian vein [50, 51]. The evidence for relative thrombosis rates between the internal jugular vein and axillary/subclavian vein is equivocal [52, 53].

Left-sided catheters may have a higher rate of thrombosis than right-sided catheters [54]. Peripherally inserted central catheters have a higher rate of venous thrombosis than centrally inserted catheters [55]. In general, for catheter-related central venous thrombosis, if the catheter is still required, in a good position, not infected, working and the limb is not threatened, then the line can be left in situ and the patient should be anticoagulated; local protocols should be developed. Anticoagulation for at least 3 months is recommended [54, 56].

Specific groups

Chronic kidney disease

There are increasing numbers of patients with chronic kidney disease being considered for or already receiving, renal replacement therapy. In these patients, consideration needs to be given for long-term vascular access for haemodialysis. Up-to-date guidelines for vascular access stress a 'life-plan' for vascular access with an arteriovenous fistula being the chosen form of vascular access whenever possible, due to the superior long-term outcomes it confers to the patient requiring dialysis as compared with other forms of access [14].

It is important to try and preserve those vessels that are used for creating an arteriovenous fistula, as damage to these vessels (predominantly the cephalic vein at the anterior elbow crease) decreases the likelihood of a successful arteriovenous fistula. As such, in this group of patients, unnecessary venepuncture and peripheral vein cannulation should be avoided as much as possible. If needed, wherever possible, the veins of the dorsum of the hand should be used for siting of short peripheral cannulas and taking of bloods. Use of the basilic vein for peripherally inserted central catheter (PICC) insertion should be avoided, if feasible, as this is one of the main veins used in the creation of upper limb fistulae [14]. Catheterisation of central veins for reasons other than renal replacement therapy should also be avoided, due to the risk of stenosis or loss of patency. Other situations to be avoided include radial artery access for coronary interventions and venous placement of pacemakers. In the former situation, femoral

access is the preferred approach, and in the latter, consideration should be given to leadless pacing.

Mastectomy and axillary lymph node resection

Approximately 20% of patients living with breast cancer are at risk of developing breast cancer-related lymphoedema. Of these cases, 70% occur within 2 years of surgery, 90% within 3 years and an additional 1% per year thereafter [57]. Known risk factors for development of lymphoedema include mastectomy; chemotherapy; radiotherapy (especially to the axilla); obesity; and axillary lymph node clearance but does not include sentinel lymph node biopsy or minimal lymph node dissection. Large cohort studies have found no significant association between commonly recommended risk reduction strategies (such as avoiding non-invasive blood pressure monitoring, phlebotomy or intravenous infusions in the ipsilateral arm) and the development of lymphoedema. Recommendations to avoid vascular access completely and indefinitely on the surgical side are no longer necessary nor practical, particularly for those more than 3 years postoperatively [58].

Lymphoedema can lead to poor tissue perfusion, impaired immune function and increased risk, frequency and severity of infections, so arms with obvious lymphoedema should be avoided for vascular access except in emergency situations [57, 58]. Peripherally inserted central catheter insertion and axillary/subclavian vein insertion should be avoided in arms at risk or with evidence of lymphoedema.

To prevent the distress of multiple failed attempts and persistent vein health deterioration on the contralateral arm, it is recommended to discuss the lack of evidence with patients, outline the risks vs. benefits and choose the best upper extremity vein for cannulation regardless of side. By limiting the number of attempts and using a sterile technique, the risk of infusion-associated complications such as infiltration, extravasation, phlebitis and infection can be reduced and ultimately preserve long-term vein health.

Potent peripheral vasoconstrictors

Traditionally, powerful vasoconstrictors such as noradrenaline and adrenaline were only administered via central venous catheters, primarily because of concerns regarding reduced availability through local vasoconstriction and the potential for extravasation injuries. More recently, there has been a growing interest in peripheral vasopressor administration (primarily noradrenaline) to expedite administration and potentially avoid central venous access [59, 60]. Most studies are

Table 7 Working party recommendations for administering peripheral noradrenaline.

Aspect	Description
Administration duration	Noradrenaline can be administered peripherally for short periods (< 12 h)
Cannula placement	A small gauge cannula (20–22 g) should be inserted into a large vein above the wrist and below the antecubital fossa. A second free cannula should be available
Patient monitoring	Patients should be monitored carefully and should be able to report pain or discomfort
Dilution concentration	Dilute concentrations should be used (e.g. noradrenaline 4 mg in 250 ml 5% glucose). These should be determined locally
Maximum dose	The maximum dose for peripheral noradrenaline is 0.2 µg.kg.min ⁻¹
Extravasation protocol	If extravasation occurs, administration should be immediately transferred to another appropriately sited cannula. Local procedures for extravasation injury should be developed. Possible options include topical glyceryl trinitrate paste and subcutaneous phentolamine

Table 8 Working party recommendations for training standards based on achievement of core competence.

Training aspect	Description
Didactic learning	A period of didactic learning including aspects of anatomy and physiology; ultrasound physics; image acquisition; interpretation and optimisation; vascular access device selection and indications; procedural considerations; risk and complication management; and infection prevention and control strategies
Simulation models	Training for ultrasound-guided vascular access procedures should be conducted in a simulated setting using high-fidelity simulation models, dynamic ultrasound needle guidance techniques and practised maximum sterile precautions. Residents should show adequate competency in simulation training before attempting supervised vascular access procedures with patients
Supervised practice	Patient assessment, consent, decision making and clinical procedures should be supervised appropriate to the level of training. Competency with one specific device or in one specific vessel should not equate to global competency
Assessment	There is no gold standard assessment method to establish competency in vascular access procedures and care. A combined formative and summative assessment, including evaluation of knowledge and clinical proficiency using a standardised assessment tool, is recommended

limited by being single-centre; however, when administered according to strict protocols, extravasation injuries are uncommon (2–6%) and relatively mild [59, 60]. Potent peripheral vasoconstrictors, such as noradrenaline, may be infused for short durations through appropriately positioned short peripheral catheters and at dilute concentrations, with strict protocols followed (Table 7).

Training

Regular and thorough education and training in vascular access device usage and aftercare can significantly reduce or prevent many issues and complications. All healthcare providers who handle such devices should undergo regular mandatory training in standard inspection; assessment; aseptic non-touch technique and flushing regimes; basic problem-solving; and the early identification and appropriate escalation of complications.

The vascular access device exit site, along with every connection, should be monitored for signs of infection or

mechanical problems such as kinking or detachment or dislodgement, and there should be clear guidelines for changing dressings, securement devices and bungs. These practices should be standard in ongoing aftercare to preserve the longevity of the device and, ultimately, the health of the vessels.

Currently, no comprehensive training scheme exists which covers all aspects of advanced vascular access. The Working Party recommends that a systematic evidence-based curriculum is developed at a national level, supported by appropriate cloud-based education tools. Practical training can take place locally, perhaps utilising a hub-and-spoke model. Training in, and provision of, vascular access should be open to all appropriately qualified members of staff and should be competency-based rather than based on role or title. The Working Party recommends training standards based on achievement of core competence (Table 8).

Discussion

These guidelines and recommendations have been made using the best available contemporary evidence and pragmatic expert consensus involving multiple stakeholders. Core to the guidelines is the need for modernised vascular access services and provision where the patient is at the heart and lifetime vein preservation is prioritised. Short- and longer-term vascular access is vital to modern healthcare, and it is envisaged that these guidelines will move practice towards greater consistency, reduced harm and improved patient outcomes. Our guideline has limitations. We synthesised data qualitatively and did not perform any statistical analysis, neither did we attempt to grade recommendations. The entire breadth and depth of vascular access cannot be fully captured in concise guidelines and our recommendations are necessarily selective and should be considered alongside full guidance. Some recommendations were adapted from guidance produced by others. Our recommendations may also not be applicable to other healthcare systems; however, our aim was to generate a UK-centric guideline.

Author affiliations

Andrew J. Johnston,¹ Matthew J. Simpson,² Victoria McCormack,³ Andrew Barton,⁴ James Bennett,⁵ Anil Chalisey,⁶ Jeremy Crane,⁷ Stefanie Curry,⁸ Helen Laycock,⁹ Dhupal Patel,¹⁰ Teikchoon See,¹¹ John Shubhaker,¹² Kathryn Singh,¹³ and Sarah Thornton,¹⁴

1 Consultant, Intensive Care Medicine and Anaesthesia, Addenbrooke's Hospital, Cambridge University Hospitals NHS Trust, Cambridge, UK and Chair of the Working Party

2 Consultant, Anaesthesia, The Leeds Teaching Hospitals NHS Trust, Leeds, UK

3 Consultant, Anaesthesia and Intensive Care Medicine, Manchester Royal Infirmary, Manchester and Association of Anaesthetists Council, UK

4 Nurse Consultant IV Therapy and Vascular Access, Frimley Park Hospital, Frimley, and National Infusion and Vascular Access Society, UK

5 Consultant, Anaesthesia, Birmingham Children's Hospital, Birmingham, UK

6 Consultant Nephrologist, Cambridge University Hospitals, Cambridge, UK

7 Consultant Transplant and Vascular Surgeon, Hammersmith Hospital, London and President Vascular Access Society of Britain and Ireland, UK

8 Lead Critical Care Scientist, Royal Papworth Hospital, Cambridge, and Intensive Care Society, UK

9 Consultant, Anaesthesia, Great Ormond Street Hospital, London, UK

10 Specialty Registrar, Anaesthesia and Intensive Care Medicine, Cambridge University Hospitals, Cambridge, UK

11 Consultant Radiologist, Cambridge University Hospitals, Cambridge, UK

12 Locum Consultant Anaesthetist, Moorfields Eye Hospital, London, and Association of Anaesthetists Council, UK

13 Specialty Registrar, Department of Anaesthesia, Imperial College Healthcare NHS Trust, London, and Resident Doctors Committee, Association of Anaesthetists, UK

14 Consultant Anaesthesia and Intensive Care, Bolton NHS Foundation Trust, Bolton and Royal College of Anaesthetists, UK

Acknowledgements

AJ is working with industry on the design, development and intellectual property rights of a vascular access safety device. HL is an Editor of *Anaesthesia*. No other competing interests declared.

References

1. Bodenham A, Babu S, Bennett J, et al. Safe vascular access 2016. *Anaesthesia* 2016; **71**: 573–85. <https://doi.org/10.1111/anae.13360>.
2. Practice guidelines for central venous access 2020: an updated report by the American Society of Anesthesiologists Task Force on central venous access. *Anesthesiology* 2020; **132**: 8–43. <https://doi.org/10.1097/aln.0000000000002864>.
3. Swaminathan L, Flanders S, Horowitz J, Zhang Q, O'Malley M, Chopra V. Safety and outcomes of midline catheters vs peripherally inserted central catheters for patients with short-term indications: a multicenter study. *JAMA Intern Med* 2022; **182**: 50–8. <https://doi.org/10.1001/jamainternmed.2021.6844>.
4. Qin KR, Nataraja RM, Pacilli M. Long peripheral catheters: is it time to address the confusion? *J Vasc Access* 2019; **20**: 457–60. <https://doi.org/10.1177/1129729818819730>.
5. Infection Prevention Society, National Infusion and Vascular Access Society, Medusa, Royal College of Nursing. UK Vessel Health and Preservation 2020 framework. 2020. <https://www.rcn.org.uk/workingwithus/-/media/Royal-College-Of-Nursing/Documents/Working-with-us/Endorsements/Vessel-Health-and-Preservation-2020-Framework> (accessed June 5, 2025).
6. Hallam C, Weston V, Denton A, Hill S, Bodenham A, Dunn H, Jackson T. Development of the UK vessel health and preservation (VHP) framework: a multi-organisational collaborative. *J Infect Prev* 2016; **10**: 65–72. <https://doi.org/10.1177/1757177415624752>.
7. Moureau NL. *Vessel Health and Preservation: The Right Approach for Vascular Access*. Cham: Springer, 2019: 1–303. <https://doi.org/10.1007/978-3-030-03149-7>.
8. Moureau NL, Trick N, Nifong T, et al. Vessel health and preservation (part 1): a new evidence-based approach to vascular access selection and management. *J Vasc Access* 2012; **13**: 351–6. <https://doi.org/10.5301/jva.5000042>.
9. Barton A. The Benefits of a Nursing Led Vascular Access Service Team: A White Paper to outline a standardised structure and approach for the NHS to deliver vascular access services in every hospital. 2022. <https://nivas.org.uk/contentimages/main/>

- NIVAS-White-paper-for-standardisation-of-vascular-access-teams-within-the-NHS_FINAL-27.06.22.pdf (accessed November 18, 2023).
10. Walsh EC, Fitzsimons MG. Preventing mechanical complications associated with central venous catheter placement. *BJA Educ* 2023; **23**: 229–37. <https://doi.org/10.1016/j.bjae.2023.02.002>.
 11. McGee DC, Gould MK. Preventing complications of central venous catheterization. *N Engl J Med* 2003; **348**: 1123–33. <https://doi.org/10.1056/nejmra011883>.
 12. Ullman AJ, Marsh N, Mihala G, Cooke M, Rickard CM. Complications of central venous access devices: a systematic review. *Pediatrics* 2015; **136**: 1331–44. <https://doi.org/10.1542/peds.2015-1507>.
 13. Johnson D, Bodenham A. Provision of long-term venous access procedures by UK anaesthetists: a postal survey. *Anaesthesia* 2004; **59**: 770–4. <https://doi.org/10.1111/j.1365-2044.2004.03836.x>.
 14. Lok CE, Huber TS, Lee T, et al. KDOQI clinical practice guideline for vascular access: 2019 update. *Am J Kidney Dis* 2020; **75**: S1–S164. <https://doi.org/10.1053/j.ajkd.2019.12.001>.
 15. Moore PG, Lingstone HA, Turoff M. The Delphi method: techniques and applications. *J R Stat Soc Ser A (Gen)* 1977; **140**: 257–8. <https://doi.org/10.2307/2344913>.
 16. Carr PJ, Higgins NS, Cooke ML, Mihala G, Rickard CM. Vascular access specialist teams for device insertion and prevention of failure. *Cochrane Database Syst Rev* 2018; **3**: CD011429. <https://doi.org/10.1002/14651858.cd011429.pub2>.
 17. Wells C, Zhang Z, Chan C, Brito A, Kohli-Seth R. Impact of a peripheral vascular access service on device use. *Am J Crit Care* 2021; **30**: 295–301. <https://doi.org/10.4037/ajcc2021425>.
 18. Spencer TR, Pittiruti M. Rapid Central Vein Assessment (RaCeVA): a systematic, standardized approach for ultrasound assessment before central venous catheterization. *J Vasc Access* 2019; **20**: 239–49. <https://doi.org/10.1177/1129729818804718>.
 19. Moss JG, Wu O, Bodenham AR, et al. Central venous access devices for the delivery of systemic anticancer therapy (CAVA): a randomised controlled trial. *Lancet* 2021; **398**: 403–15. [https://doi.org/10.1016/s0140-6736\(21\)00766-2](https://doi.org/10.1016/s0140-6736(21)00766-2).
 20. NHS England. National Safety Standards for Invasive Procedures (NatSSIPs). 2015. <https://www.england.nhs.uk/patientsafety/wp-content/uploads/sites/32/2015/09/natssips-safety-standards.pdf> (accessed June 6, 2025).
 21. The National Safety Standards for Invasive Procedures (NatSSIPs). <https://cpoc.org.uk/guidelines-resources-guidelines/national-safety-standards-invasive-procedures-natssips> (accessed November 17, 2023).
 22. NHS Never Events List 2018. <https://www.england.nhs.uk/wp-content/uploads/2020/11/2018-Never-Events-List-updated-February-2021.pdf> (accessed November 17, 2023).
 23. Invasive procedure safety checklist: Central venous catheter Insertion. https://www.ficm.ac.uk/sites/ficm/files/documents/2023-11/CVC_checklist_oct23_2.pdf (accessed February 12, 2024).
 24. Windsor C, Hersey P, Akhtar W, Bamford P, Patil J. Update to the Local Safety Standards for Invasive Procedures (LocSSIPs) – central venous catheter insertion, intercostal drain insertion, tracheostomy, bronchoscopy, intubation. *J Intensive Care Soc* 2025. Epub 29 May. <https://doi.org/10.1177/17511437251327552>.
 25. Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF. Ultrasound guidance versus anatomical landmarks for subclavian or femoral vein catheterization. *Cochrane Database Syst Rev* 2015; **1**: CD011447. <https://doi.org/10.1002/14651858.cd011447>.
 26. Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF. Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization. *Cochrane Database Syst Rev* 2015; **1**: CD006962. <https://doi.org/10.1002/14651858.cd006962.pub2>.
 27. Lamperti M, Bodenham AR, Pittiruti M, et al. International evidence-based recommendations on ultrasound-guided vascular access. *Intensive Care Med* 2012; **38**: 1105–17. <https://doi.org/10.1007/s00134-012-2597-x>.
 28. Saugel B, Scheeren TWL, Teboul JL. Ultrasound-guided central venous catheter placement: a structured review and recommendations for clinical practice. *Crit Care* 2017; **21**: 225. <https://doi.org/10.1186/s13054-017-1814-y>.
 29. Bodenham A, Lamperti M. Ultrasound guided infraclavicular axillary vein cannulation, coming of age. *Br J Anaesth* 2016; **116**: 325–7. <https://doi.org/10.1093/bja/aev445>.
 30. UK Health Security Agency. Good infection prevention practice: using ultrasound gel. 2025. <https://www.gov.uk/government/publications/ultrasound-gel-good-infection-prevention-practice/good-infection-prevention-practice-using-ultrasound-gel#:~:text=sterile%20ultrasound%20gel%20in%20single,access%20or%20fine%20needle%20aspirate> (accessed May 11, 2025).
 31. Alexandrou E, Spencer TR, Frost SA, Mifflin N, Davidson PM, Hillman KM. Central venous catheter placement by advanced practice nurses demonstrates low procedural complication and infection rates – a report from 13 years of service. *Crit Care Med* 2014; **42**: 536–43. <https://doi.org/10.1097/ccm.0b013e3182a667f0>.
 32. Sharp R, Cummings M, Fielder A, Mikocka-Walus A, Grech C, Esterman A. The catheter to vein ratio and rates of symptomatic venous thromboembolism in patients with a peripherally inserted central catheter (PICC): a prospective cohort study. *Int J Nurs Stud* 2015; **52**: 677–85. <https://doi.org/10.1016/j.ijnurstu.2014.12.002>.
 33. Spencer TR, Mahoney KJ. Reducing catheter-related thrombosis using a risk reduction tool centered on catheter to vessel ratio. *J Thromb Thrombolysis* 2017; **44**: 427–34. <https://doi.org/10.1007/s11239-017-1569-y>.
 34. Foor JS, Moureau NL, Gibbons D, Gibson SM. Investigative study of hemodilution ratio: 4Vs for vein diameter, valve, velocity, and volumetric blood flow as factors for optimal forearm vein selection for intravenous infusion. *J Vasc Access* 2022; **25**: 140–8. <https://doi.org/10.1177/11297298221095287>.
 35. Forauer AR, Alonzo M. Change in peripherally inserted central catheter tip position with abduction and adduction of the upper extremity. *J Vasc Interv Radiol* 2000; **11**: 1315–8. [https://doi.org/10.1016/s1051-0443\(07\)61308-6](https://doi.org/10.1016/s1051-0443(07)61308-6).
 36. Stonelake PA, Bodenham AR. The carina as a radiological landmark for central venous catheter tip position. *Br J Anaesth* 2006; **96**: 335–40. <https://doi.org/10.1093/bja/aei310>.
 37. Johnston AJ, Bishop SM, Martin L, See TC, Streater CT. Defining peripherally inserted central catheter tip position and an evaluation of insertions in one unit. *Anaesthesia* 2013; **68**: 484–91. <https://doi.org/10.1111/anae.12188>.
 38. Baskin KM, Jimenez RM, Cahill AM, Jawad AF, Towbin RB. Cavoatrial junction and central venous anatomy: implications for central venous access tip position. *J Vasc Interv Radiol* 2008; **19**: 359–65. <https://doi.org/10.1016/j.jvir.2007.09.005>.
 39. Kellum JA, Lameire N, Aspelin P, et al. KDIGO clinical practice guideline for acute kidney injury. *Kidney Int Suppl* 2012; **2**: 1. <https://doi.org/10.1038/kisup.2012.1>.
 40. Johnston AJ, Holder A, Bishop SM, See TC, Streater CT. Evaluation of the Sherlock 3CG tip confirmation system on peripherally inserted central catheter malposition rates. *Anaesthesia* 2014; **69**: 1322–30. <https://doi.org/10.1111/anae.12785>.
 41. Summary of Guidelines for the Use of Platelet Transfusions. <https://b-s-h.org.uk/media/17121/summary-bcsh-platelet>

- [guideline-appendix-1-final-reviewed-may-2019.pdf](#) (accessed November 18, 2023).
42. Hall DP, Estcourt LJ, Doree C, Hopewell S, Trivella M, Walsh TS. Plasma transfusions prior to insertion of central lines for people with abnormal coagulation. *Cochrane Database Syst Rev* 2016; **9**: CD011756. <https://doi.org/10.1002/14651858.cd011756.pub2>.
 43. Cabrini L, Pappacena S, Mattioli L, et al. Administration of blood products to prevent bleeding complications associated with central venous catheter insertion in patients at risk: a systematic review. *Br J Anaesth* 2017; **118**: 630–4. <https://doi.org/10.1093/bja/aex060>.
 44. van Baarle FLF, van de Weerd EK, van der Velden WJFM, et al. Platelet transfusion before CVC placement in patients with thrombocytopenia. *N Engl J Med* 2023; **388**: 1956–65. <https://doi.org/10.1056/nejmoa2214322>.
 45. Harrop-Griffiths W, Cook T, Gill H. Regional anaesthesia and patients with abnormalities of coagulation: the Association of Anaesthetists of Great Britain & Ireland the Obstetric Anaesthetists' Association regional Anaesthesia UK. *Anaesthesia* 2013; **68**: 966–72. <https://doi.org/10.1111/anae.12359>.
 46. Chopra V, Anand S, Hickner A. Risk of venous thromboembolism associated with peripherally inserted central catheters: a systematic review and meta-analysis. *Lancet* 2013; **382**: 311–25. [https://doi.org/10.1016/s0140-6736\(13\)60592-9](https://doi.org/10.1016/s0140-6736(13)60592-9).
 47. Puri A, Dai H, Giri M, Wu C, Huang H, Zhao Q. The incidence and risk of venous thromboembolism associated with peripherally inserted central venous catheters in hospitalized patients: a systematic review and meta-analysis. *Front Cardiovasc Med* 2022; **9**: 917572. <https://doi.org/10.3389/fcvm.2022.917572>.
 48. Evans RS, Sharp JH, Linford LH, et al. Reduction of peripherally inserted central catheter-associated DVT. *Chest* 2013; **143**: 627–33. <https://doi.org/10.1378/chest.12-0923>.
 49. Pittiruti M, Hamilton H, Biffi R, MacFie J, Pertkiewicz M. ESPEN guidelines on parenteral nutrition: central venous catheters (access, care, diagnosis and therapy of complications). *Clin Nutr* 2009; **28**: 365–77. <https://doi.org/10.1016/j.clnu.2009.03.015>.
 50. López-Briz E, Ruiz Garcia V, Cabello JB, Bort-Martí S, Carbonell Sanchis R. Heparin versus 0.9% sodium chloride locking for prevention of occlusion in central venous catheters in adults. *Cochrane Database Syst Rev* 2022; **7**: CD008462. <https://doi.org/10.1002/14651858.cd008462.pub3>.
 51. Parienti J-J, Mongardon N, Mégarbane B, et al. Intravascular complications of central venous catheterization by insertion site. *N Engl J Med* 2015; **373**: 1220–9. <https://doi.org/10.1056/nejmoa1500964>.
 52. Timsit J-F, Farkas J-C, Boyer J-M, Martin JB, Misset B, Renaud B, Carlet J. Central vein catheter-related thrombosis in intensive care patients. *Chest* 1998; **114**: 207–13. <https://doi.org/10.1378/chest.114.1.207>.
 53. Trerotola SO, Kuhn-Fulton J, Johnson MS, Shah H, Ambrosius WT, Kneebone PH. Tunneled infusion catheters: increased incidence of symptomatic venous thrombosis after subclavian versus internal jugular venous access. *Radiology* 2000; **217**: 89–93. <https://doi.org/10.1148/radiology.217.1.r00oc2789>.
 54. Debourdeau P, Farge D, Beckers M, et al. International clinical practice guidelines for the treatment and prophylaxis of thrombosis associated with central venous catheters in patients with cancer. *J Thromb Haemost* 2013; **11**: 71–80. <https://doi.org/10.1111/jth.12071>.
 55. Allen AW, Megargell JL, Brown DB, Lynch FC, Singh H, Singh Y, Waybill PN. Venous thrombosis associated with the placement of peripherally inserted central catheters. *J Vasc Interv Radiol* 2000; **11**: 1309–14. [https://doi.org/10.1016/s1051-0443\(07\)61307-4](https://doi.org/10.1016/s1051-0443(07)61307-4).
 56. Kearon C, Akl EA, Ornelas J, et al. Antithrombotic therapy for VTE disease: CHEST guideline and expert panel report. *Chest* 2016; **149**: 315–52. <https://doi.org/10.1016/j.chest.2015.11.026>.
 57. McDiarmid S, Larocque G. Time to rethink vascular access in patients with breast cancer. *Br J Nurs* 2020; **29**: S32–8. <https://doi.org/10.12968/bjon.2020.29.14.s32>.
 58. Jakes AD, Twelves C. Breast cancer-related lymphoedema and venepuncture: a review and evidence-based recommendations. *Breast Cancer Res Treat* 2015; **154**: 455–61. <https://doi.org/10.1007/s10549-015-3639-1>.
 59. Munroe ES. A case for the evidence-based use of peripheral vasopressors. *Chest* 2024; **165**: 236–8. <https://doi.org/10.1016/j.chest.2023.09.015>.
 60. Yerke JR, Mireles-Cabodevila E, Chen AY, et al. Peripheral administration of norepinephrine: a prospective observational study. *Chest* 2024; **165**: 348–55. <https://doi.org/10.1016/j.chest.2023.08.019>.

Supporting Information

Additional supporting information may be found online via the journal website.

Appendix S1. Association of Anaesthetists Safe Vascular Access Guidelines 2025 (full version).

Plain Language Summary.