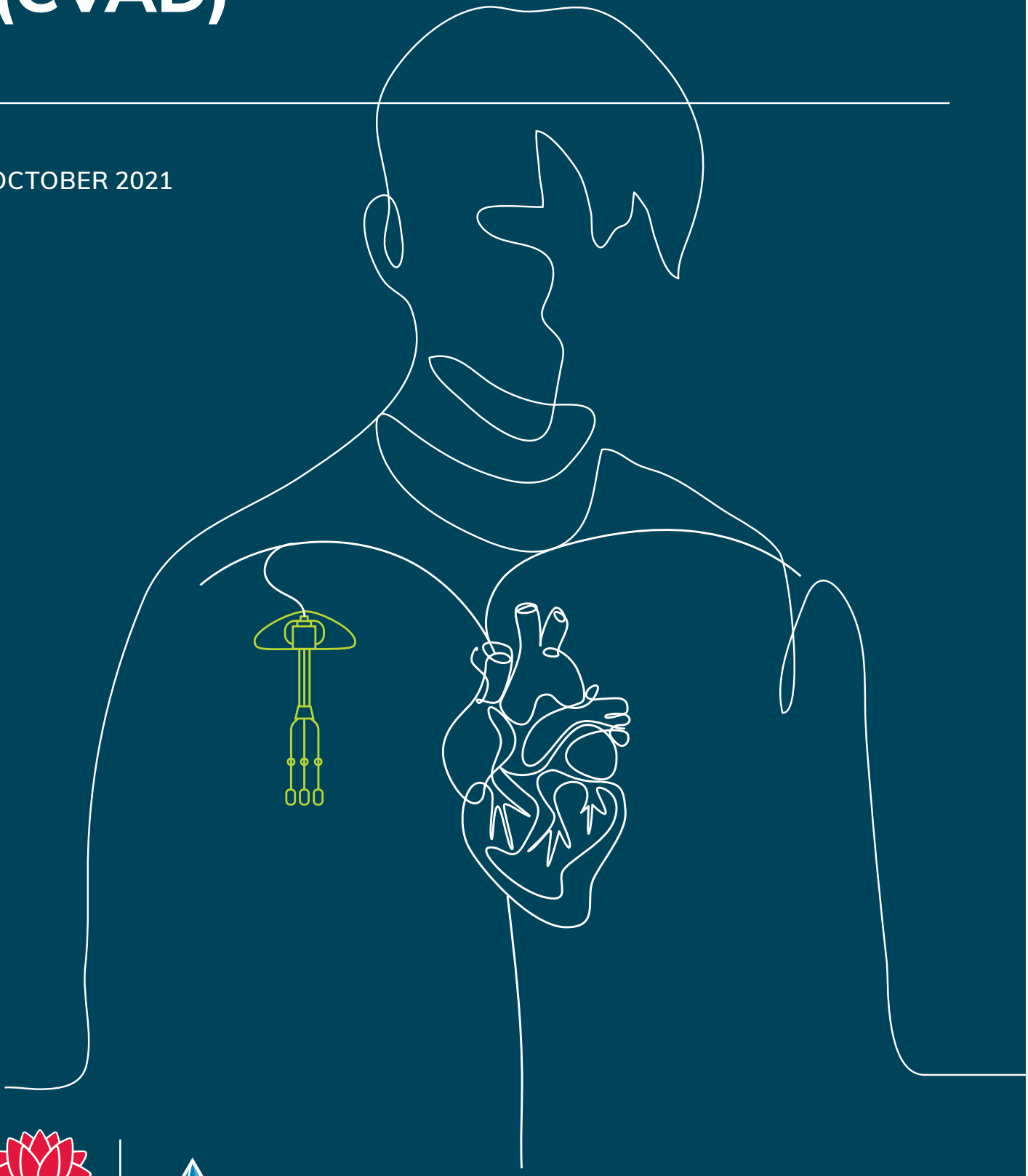
CLINICAL PRACTICE GUIDE

Central venous access devices (CVAD)

OCTOBER 2021



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Preferred citation: NSW Agency for Clinical Innovation. *Central venous access devices (CVAD): Clinical practice guide*. Sydney: ACI; 2021

SHPN (ACI) 210755
ISBN 978-1-76081-899-9

Version: V2; ACI_3607 [09/21]

Trim: ACI/D219/1087

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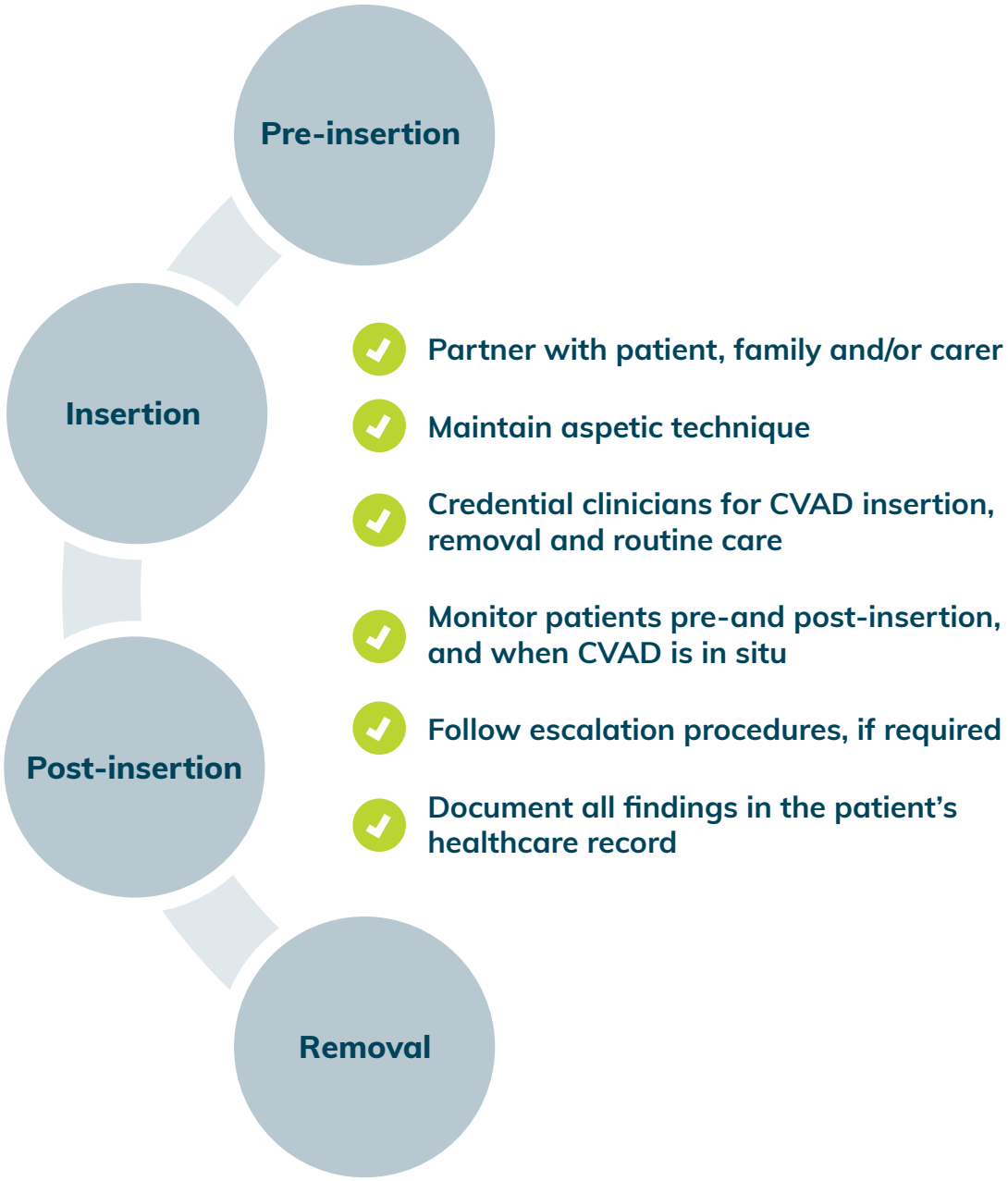
Management of a central venous access device at a glance

Care of the patient requiring a central venous access device (CVAD) may be highly complex, due to the risk of infection and air embolism to the patient. This guide has been developed to ensure that patients with a CVAD receive safe and high-quality care at all stages of their healthcare journey.



Introduction

This clinical practice guide has been developed by Intensive Care NSW (ICNSW) to support local health districts and hospitals to develop local procedures and guidelines that map to their specific patient population.

This document provides guidance for all clinicians managing patients with a central venous access device (CVAD). It is not designed exclusively for use within intensive care units (ICUs), as not all patients requiring CVADs are cared for in ICUs.

CVADs are a means of providing fluid management, medications and nutrition to both critically ill patients and patients with specific needs, e.g. cytotoxic medications, parenteral nutrition, poor vascular access and long-term medication infusions.

CVADs provide direct access to the patient's bloodstream. This creates a serious risk of infection due to the potential for microorganisms to be introduced during insertion or while the device is in situ. Device-related infections are associated with increased morbidity and mortality, prolonged hospital stay and additional healthcare costs.[1] CVADs also carry a risk to patients of air embolism during both insertion and removal.[2]

This guide focuses on areas where evidence-based practice have been shown to improve patient outcomes. It has been structured to focus on different stages of treatment for a patient with a CVAD, including:

- pre-insertion
- insertion
- post insertion
- removal.

It additionally considers issues which are common across the stages of CVAD insertion through to removal, including:

- the importance of partnering with patients, family and carers and informed consent
- maintaining aseptic technique and following infection prevention protocols
- credentialing of clinicians to perform the advanced skills associated with insertion, removal and care of a patient with a CVAD
- documentation within the patient record.

Method

To inform this guide, a literature review was completed in October 2018. Databases searched included PubMed and grey literature searches of key organisations such as the National Institute for Health and Care Excellence (NICE), the National Health and Medical Research Council (NHMRC), and NSW and Australian pillar organisations. Search terms included medical subject heading and title words for 'catheters' AND 'central' AND 'venous' AND 'guidelines' OR 'systematic reviews'. This review was limited to high-level evidence (randomised controlled trials, systematic reviews and meta-analysis). A supplementary PubMed search on haemodialysis vascular access devices was run on 31 January 2019. A review of current literature was run in January 2021, with references updated to reflect changes in international guidance documents.

A supplementary evidence review was undertaken by clinicians in the working groups for subsections of the guides.

This guide was reviewed formally in 2021 by a working group, including 23 expert medical, nursing and allied health representatives, from a range of local health districts (LHDs) across NSW. Sub-working groups were formed to work on individual sections of the guide and met via teleconference weekly for four weeks. The whole working group met twice for six-hour, face-to-face workshops, and twice for two-hourly teleconference meetings. These meetings were held to reach consensus on recommendation statements. Consensus was reached on all recommendations included within this guide.

To assess the current state, ICNSW reviewed central venous access data from the Clinical Excellence Commission's (CEC) Incident Information Management System. 429 reported central venous access incidents from January 2016-October 2018 were reviewed for themed incidence.

Partnering with patients

Patient involvement

Involving patients in their own healthcare is key to ensuring they understand their health status, healthcare needs, treatment options, and how they can contribute towards achieving better health for themselves.[3] Traditionally patients, their carers or family members have not been involved in CVAD decisions.[4] However, engagement and increased patient CVAD knowledge is beneficial as it may lead to decreased CVAD-associated risks and complications.[5] Patient engagement may be achieved through the provision of complementary written information (in multiple languages) in addition to face-to-face discussions where patients can discuss their healthcare options.[3]

Table 1: Recommendation summary table - patient involvement

Recommendation	Source
Consultation with patients, their carers or family members should be sought (if possible) to ensure the most suitable CVAD plan of care is chosen.	NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6]
Provide patients, their carers or family members with information in appropriate formats and languages.	Australian Commission on Safety and Quality in Health Care (ACSQHC). 2014[3]

Informed consent and patient safety

Collaborative discussions between patients, carers or family members and clinicians should occur to enable the patient to make informed decisions and provide valid written consent for the CVAD insertion. If patients do not have capacity to provide valid consent, clinicians should request consent from the patients' next of kin in the first instance or seek guidance from the Guardianship Act of 1987.[7] If a CVAD is required during an emergency or life-threatening situation, the clinician should refer to public health organisational policy for advice.[6] Documentation of valid consent should be made in the patient's health record.[8]

NSW Health *Clinical procedure safety policy directive (PD2017_032)* identifies the insertion of a CVAD as a Level 2 procedure (without sedation) or Level 3 procedure (with sedation) and signals that the insertion of a CVAD carries significant patient risks.[9] The purpose of the policy is to recognise points in the procedure where 'time out' must be taken to reduce the risk of adverse incidents by improving communication amongst team members and the patient.

Table 2: Recommendation summary table – informed consent

Recommendation	Source
It is the responsibility of the clinician inserting the CVAD to ensure that informed patient consent is obtained.	Gorski, Hadaway, Hagle, et al. 2021[6]
Patient safety 'time out' procedures should be followed for each CVAD insertion.	CEC. 2017[9]

Pre-insertion

Indications for the insertion of a CVAD (decision-making)

The decision to insert a CVAD should only be implemented when all other alternative methods for delivering treatment, e.g. oral medication, have been considered.[5] To avoid unnecessary CVAD insertions, the use of a pre-insertion decision-making tool should be used by clinicians to support their recommendation for a CVAD insertion.

To promote appropriateness of care, decision support tools are useful in reminding clinicians of the risks associated with CVADs. Indications for a CVAD insertion should be documented in the patient's healthcare record.[2]

Table 3: Recommendation summary table – indications for insertion of CVAD

Recommendation	Source
Initial consideration should be given as to whether intravenous therapy is required or if other routes of delivering therapy could be used.	Royal College of Nursing. 2016[4] NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6]

Device and site selection

Choosing the right CVAD and site for insertion is a complex decision that requires the clinician to consider multiple factors. Decision-making includes consideration of the prescribed therapy, expected duration of treatment, vascular characteristics, as well as the patient's age, cognition, medical history, infusion therapy history and preference for CVAD site location.[6]

Fluid osmolarity

Solutions with a high osmolarity are irritants to vessels, therefore prolonged infusions of hyperosmolar solutions should not be infused through a vascular device with a tip terminating in a peripheral vein. If this occurs, inflammation and damage to the vessel wall will lead to complications such as phlebitis, thrombosis and occlusion.[4] In comparison, correct CVAD tip placement within the distal superior vena cava or cavo-atrial junction facilitates appropriate haemodilution of irritating and vesicant solutions, and minimises the risk of these complications occurring.[10]

Vessel selection

Determination of blood vessels and their pathways helps the clinician identify suitable veins for catheterisation and guides device selection.[10] Ultrasound guidance can support the selection of a vein with optimal characteristics, e.g. size, depth, pathway with minimal risk of arterial or nerve injury, as well as assessing vein patency and any anatomical variations. This is associated with increased first attempt insertion success and a reduction in the incidence of insertion related complications.[10]

Approaches developed by the Italian Group for Venous Access Devices that include the rapid assessment of the central veins (RaCeVA), are protocols that can be used to evaluate vessels and surrounding structures.[10] RaCeVA is a systematic, standardised approach for ultrasound assessment before central venous catheterisation.[11]

For midlines and peripherally inserted central catheter (PICC) insertions, the selection of a vein which facilitates a catheter-to-vein ratio of 45% or less has been shown to decrease the risk of thrombosis formation in upper extremities.[6] Use of the smallest device required (or least number of lumens) to deliver appropriate therapies in the largest vessel will aid in the reduction of complications related to haemodilution, catheter-related thrombosis and device malfunction or failure.

The following are taken into consideration when deciding on device and site for CVAD.

- Availability of a skilled workforce to insert and maintain a CVAD
- Patient characteristics, e.g. cognitive function, lifestyle choices, body image
- Anticipated patient events, e.g. rapid fluid resuscitation necessitating large diameter lumens, bone marrow transplantation, the need for contrast media delivered at high pressure to produce radiologic images
- Specific therapy needs, e.g. if therapy is expected to be intermittent, continuous or required for an extended period (months-years), multiple concurrent therapies requiring more than two lumens
- Factors that may hinder CVAD insertion, e.g. vascular abnormalities, coagulopathy, anti-platelet medications, severe respiratory compromise, presence of a permanent pacemaker or implantable cardioverter defibrillator, obesity, previous surgery including lymph node dissection or removal, CVAD insertion or infection at proposed insertion site
- Insertion of a CVAD should also be avoided in areas where open wounds, infection and insufficient vasculature exist as well as in areas where other procedures are planned.[6, 12]

Device selection

Several types of CVADs are available for use in clinical practice. The Cancer Institute of NSW has produced a clinical resource that depicts the most common and popular CVADs used in NSW:

Cancer Institute of NSW's Central venous access devices clinical resource

The device chosen will differ based upon a variety of patient needs, vessel health, intended use and predicted dwell time. Table 4 provides a summary of the options.

Table 4: Central venous access devices – device selection options

Device	Therapy	Expected duration	Considerations for site selection	Patient safety considerations
Midline catheter Inserted into a peripheral vein of the upper arm via the basilic, cephalic, or brachial vein with the terminal tip located at the level of the axilla.	Used to infuse solutions with an osmolarity less than 900mOsm.	14 days to four weeks[6, 13]	The upper arm is preferred, or secondarily the region of the antecubital fossa, using the basilic, cephalic, or brachial veins, with the basilic vein preferred.[4, 6] A catheter-to-vein ratio that is equal to or less than 45% is recommended.[6]	Avoid in patients with a history of thrombosis, hypercoagulability, end-stage renal disease requiring vein preservation, and decreased vascular flow to the extremities.[6]
Peripherally inserted central catheter (PICC)	• Long term vascular access device • Used to infuse solutions of any osmolarity • Use a power injection PICC if delivery of contrast media at high pressure is required[4] • May not be suitable if more than two lumens are needed for therapy requirements • Not recommended for rapid fluid resuscitation – short large bore peripheral intravenous catheter or intra osseous route better suited for this purpose.	Up to six months[13]	Select the median cubital, cephalic, basilic, or brachial veins with sufficient size for cannulation. A catheter-to-vein ratio that is equal to or less than 45% is recommended.[6]	Increased risk of catheter-associated venous thrombosis with PICCs, particularly in patients with cancer and those who are critically ill.[6, 10] Avoid PICCs in patients with chronic kidney disease due to the risks of central vein stenosis and occlusion, as well as resultant venous depletion preventing future fistula construction.[6, 14]

Device	Therapy	Expected duration	Considerations for site selection	Patient safety considerations
Non tunneled, non-cuffed central venous catheter (CVC)	Used to infuse solutions of any osmolarity. Use a power injection CVC if delivery of contrast media at high pressure is required.	Less than 10 days[13]	To minimise the risk of catheter-related thrombosis and/or infection, the subclavian vein is favoured in adult patients, rather than the jugular or femoral veins.[13]	For patients with chronic kidney disease, consider the risks of central vein stenosis and venous occlusion when the subclavian vein is used.[13]
Non tunneled, non-cuffed haemodialysis or apheresis catheter	Use a power injection PICC if delivery of contrast media at high pressure is required.[4]	Less than one week[15]	Ideally the internal jugular vein should be used, femoral veins are often chosen, as tip confirmation on chest X-ray is not required.[15]	Cannulation of the subclavian vein is not recommended due to the risk of stenosis and hampering of future fistula placement in that extremity.[14, 15]

Table 5: Recommendation summary table – device and site selection

Recommendation	Source
Clinicians should use an evidence-based list of indications for CVAD use when selecting the most appropriate CVAD.	Gorski, Hadaway, Hagle, et al. 2021[6] Moureau. 2019[10]
Clinicians should use ultrasound guidance to estimate vessel location, diameter and depth.	Gorski, Hadaway, Hagle, et al. 2021[6] Moureau. 2019[10]
For midlines and PICCs, choose a vessel with a catheter-to-vein ratio of 45% or less.	Gorski, Hadaway, Hagle, et al. 2021[6] Moureau. 2019[10]

Infection prevention strategies

A central line associated blood stream infection (CLABSI) is a laboratory-confirmed blood stream infection in a patient who had, or still has, a CVAD in place.[16] The number of infections related to CVADs has significantly reduced in the past decade due to the adoption of evidence-based CVAD practices. However, CLABSI still contributes to extended hospital stays, and increased morbidity and mortality amongst patients in NSW.[17]

The presence of multiple lumens, connectors, ports, and high catheter-to-vessel diameter increases thrombosis formation, as well as risk of infection. Attention to minimising these components can decrease the rates of CLABSI.

Infusion of lipid-based solutions such as parenteral nutrition, significantly increases the risk of infection, hence these should be infused through a designated lumen which may increase the lumens required. Catheters impregnated or coated with anti-microbial agents or antibiotic combinations have been shown to reduce infection rates particularly within ICUs or when other strategies have not been effective.[5, 18] These catheters are not recommended in patients who are sensitive to anti-infective substances, e.g. chlorhexidine, silver sulfadiazine, rifampicin, or minocycline.[6]

Table 6: Recommendation summary table – considerations for potential risk of infection

Recommendation	Source
Minimise the number of lumens, connectors, ports and diameter of the CVAD as much as possible.	Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13] CEC. 2019[1]
Parenteral nutrition or other lipid-based solutions should be infused through a dedicated lumen.	NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13]
At health organisations where CLABSI rates are high, or where patients are at an increased risk of infection, a CVAD coated with protective technologies or an antimicrobial-impregnated CVAD should be used.	NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13]

Clinical competency to insert a CVAD

The insertion of a CVAD is an invasive medical procedure which is associated with significant patient risk. Health organisations should have a credentialing process in place that supports training of clinicians to perform this advanced skill. The credentialing process should include adequate supervision of clinicians in training, and regular review of clinician credentials.[2, 5, 19]

Table 7: Recommendation summary table – clinical competence for CVAD insertion

Recommendation	Source
Credentialing processes for insertion of CVADs should be embedded into clinical practice.	NHMRC. 2019[5] CEC. 2015[2]

Environmental, equipment and monitoring requirements

CVAD insertion should only be performed in an environment where aseptic technique can easily be implemented and maintained.[19] There are no definitive studies which suggest what constitutes the most appropriate environment. At a minimum, a suitable environment would demonstrate:

- adequate lighting and space around the patient for ease of movement
- electrical safety support
- access to continuous cardiac monitoring
- immediate access to resuscitation equipment and drugs
- ability to place the patient on a tilting bed with height adjustment
- access to competent, skilled staff able to assist during the procedure and recovery.

A standardised equipment kit that contains all necessary components for a CVAD insertion has the potential to reduce procedural errors and incidence of complications.[6] Additional items may be added according to the health organisation's guidelines.

All patients should have monitoring of continuous cardiac rhythm and pulse oximetry during CVAD insertion procedures.[20] Supplemental oxygen should be immediately available for some patients, and it may be prudent to administer oxygen by nasal cannula, prior to covering the patient's head with any drapes.[20]

Table 8: Recommendation summary table – environment, equipment and monitoring

Recommendation	Source
CVAD insertion should only be performed in areas where sterile technique can be easily maintained.	Centers for Disease Prevention and Control (CDC). 2011[18] American Society of Anesthesiologists. 2020[21]
A standardised CVAD insertion equipment kit should be considered.	Gorski, Hadaway, Hagle, et al. 2021[6] The Joint Commission. 2013[22]
All patients should be haemodynamically monitored prior to, and during, CVAD insertion with pulse oximetry, continuous cardiac rhythm and blood pressure monitoring attached.	Working group consensus

Insertion

CVAD insertion care bundle

Bundles of care are a group of interventions that, when implemented together, have the potential to increase patient safety.[5] The central line bundle consists of five components that are known to reduce the risk of CLABSI in patients. The components of this bundle are:

- hand hygiene
- maximal barrier precautions during insertion
- use of chlorhexidine as a skin antisepsis
- optimal catheter site selection
- daily review of CVAD necessity with prompt removal if unnecessary.[23]

Ensuring asepsis throughout the process of CVAD insertion is technically complex, but critical in order to reduce the risk of infection.[23]

Consistent with the World Health Organisation's (WHO) *Five moments for hand hygiene*, there are many occasions during insertion of a CVAD where the clinician is required to perform hand hygiene, e.g. before patient contact, before and after inserting a CVAD, accessing or removing a CVAD, after patient contact or after contact with patient surroundings.[24]

Immediately prior to inserting a CVAD, further hand hygiene should be performed. This could be done by either of the following methods:

- Performing a 'surgical scrub' for two minutes, which involves removing debris underneath fingernails and cleaning hands and forearms using antimicrobial soap and water
- Using an alcohol based hand rub (ABHR) that has persistent antimicrobial activity and is allowed to dry.[25]

Table 9: Hand hygiene for device insertion

Acitivity		Hand cleaning product*	Duration of hand wash*
Aseptic procedure	Insertion of peripheral intravenous catheter	ABHR*	30-60 seconds
		Liquid antimicrobial soap and running water	40-60 seconds
	Peripheral arterial catheter	ABHR*	60 seconds minimum
		Liquid antimicrobial soap and running water	2 minutes
	Insertion of CVAD, midline and umbilical catheters	Liquid antimicrobial soap and running water	Refer to manufacturer's instructions. Note: Prior to surgical rub, wash hands, forearms and nails using a non-medicated soap and running water.
		Alcohol based surgical hand rub*	

* Manufacturers recommendations should be followed for the amount of solution and duration.

Source: NSW Health *Policy directive: Intravascular access devices (IVAD) infection prevention and control PD2019_040*[1]

Maximal barrier precautions include wearing a nonsterile hat, mask and eye protection, and sterile gloves and gowns. Make sure a wide sterile field exists over the patient by using a sterile body drape to safely contain and protect all procedure equipment as aseptic. If using ultrasound during CVAD insertion, ensure a long sterile cover is placed over the ultrasound probe.[4, 5, 13, 26]

In addition to adopting maximal barrier precautions, sterile fields should be prepared as close as possible to the time of use, as environmental dust and other particles may exponentially settle over the sterile field over time.[27]

Prior to the application of skin antisepsis, the skin at the insertion site may need to be physically cleaned with soap and water if it is visibly soiled. Excess hair at the insertion site may need to be removed using single patient-use scissors or disposable-head surgical clippers. Razors are not recommended due to the increased risk of breaking the skin and introducing infection.[5, 26]

Evidence has shown that cleaning skin with 2% chlorhexidine gluconate in 70% isopropyl alcohol is effective in reducing rates of CLABSI. A single-use applicator to apply the antiseptic should be considered. Utilise a back-and-forth motion with the applicator for at least 30 seconds and then allow the antiseptic to dry.[4, 26] If hypersensitivity or allergic responses to chlorhexidine gluconate are known or observed, povidone-iodine in alcohol can be used as an alternative.[5, 13]

When adherence to aseptic technique cannot be ensured, i.e. catheters inserted during a medical emergency, the catheter should be replaced as soon as practicable, within 24 hours.[18]

Table 10: Recommendation summary table – CVAD insertion care bundle

Recommendation	Source
A care bundle should be implemented when inserting a CVAD.	Royal College of Nursing. 2016[4] NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13]
Visibly soiled skin should be cleaned with soap and water prior to applying antiseptic solution.	Infusion Nurses Society. 2021[26]
Single patient-use scissors or disposable-head surgical clippers should be used to remove excess hair at the insertion site if required.	NHMRC. 2019[5] Infusion Nurses Society. 2021[26]
Sterile fields should be prepared as close to the time of use as possible.	Association of periOperative Registered Nurses (AORN). 2006[27]
Hands and forearms should be decontaminated using antimicrobial soap and water for two minutes to perform a 'surgical scrub' OR alcohol-based hand rub and allowed to dry.	CDC. 2020[25]
Maximal barrier precautions should include hat, mask, eye protection, sterile ultrasound probe cover, sterile gloves, sterile gowns, and a large sterile drape to cover 85% of the patient (where practicable).	Royal College of Nursing. 2016[4] NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13] Infusion Nurses Society. 2021[26]
2% chlorhexidine gluconate in 70% isopropyl alcohol should be used to clean skin and allowed to dry.	NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13] CEC. 2008[1] Infusion Nurses Society. 2021[26] Mimoz, Lucet, Kerforne, et al. 2015[28]
A single-use applicator to apply skin antiseptic should be used in a back-and-forth motion for at least 30 seconds.	Royal College of Nursing. 2016[4] Infusion Nurses Society. 2021[26]
For chlorhexidine sensitivity or allergy, povidone-iodine in alcohol can be considered as an alternative.	NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13]
When adherence to full aseptic technique cannot be ensured, where a catheter is inserted during a medical emergency, it should be replaced as soon as practicable, within 48 hours.	CDC. 2011[29]

Local anaesthetic

The use of local anaesthetic to facilitate the insertion of a CVAD should be used to alleviate anticipated patient discomfort.[2] Select an agent that is the least toxic and has the lowest risk of allergic reaction to the patient.[8] Most commonly in adult patients this is lignocaine 1% for injection.

Health organisations are encouraged to establish a protocol for the use of local anaesthesia as part of the CVAD insertion process.[8] Administration of local anaesthesia should occur using an aseptic technique, and the type, dose and site of local anaesthesia used should be documented in the patient's healthcare record. [2]

Table 11: Recommendation summary table – local anaesthetic use

Recommendation	Source
Local anaesthetic should be administered as needed, using an aseptic technique.	Infusion Nurses Society. 2021[26]

Patient position

While the patient is being prepped and draped for the insertion procedure, the supine position may be the most comfortable and afford the best cardiovascular and pulmonary stability.

However, once the patient and insertion site have been prepared, successful CVAD insertion is likely to occur if the patient is positioned so that the proposed insertion site is placed at the same level or below the level of the heart. This position facilitates venous engorgement which in turn helps the clinician to access the vein and reduces the entrainment of air into the circulation, thereby minimising the risk of air embolism during the insertion procedure.[26, 30]

Typically, the Trendelenburg position is used for this purpose, however the cardiovascular and/or respiratory systems of patients who are obese or critically ill may not tolerate this position. For these patients, anaesthetic support to establish a controlled airway may be needed to safely position the patient for CVAD insertion.[20]

Table 12: Patient position required depending on the device inserted

Device	Patient position for insertion procedure
Midline catheter	Supine in a reclining position, with arm extended at a 90-degree angle away from body. Elevate head of the bed for patient comfort if the flat position cannot be tolerated.[26]
Peripherally inserted central catheter (PICC)	Supine in a flat reclining position, with arm extended at a 90-degree angle away from body. Elevate head of the bed for patient comfort if the flat position cannot be tolerated.[26]
Non tunnelled CVC or haemodialysis catheter	Supine for vessel assessment. After prepping and draping the insertion site, place the patient in a 10- to 15-degree Trendelenburg position for catheter insertion when using the vessels above the level of the heart.[26, 31]

Table 13: Recommendation summary table – patient positioning for CVAD insertion

Recommendation	Source
To minimise the risk of air embolism, the patient should be positioned so the intended insertion site is at or below the level of the heart.	Infusion Nurses Society. 2021[26]
Patients at risk of respiratory compromise may require anaesthesia for the purpose of achieving a controlled airway to safely place a central catheter.	Heffner, Androes. 2020[20]

Insertion checklist

Checklists can improve patient outcomes as they outline the inherent risks associated with CVAD insertion, and of the importance of adhering to evidence-based procedural protocols. Checklists are also effective clinical performance measurement tools.[2, 5, 26, 32] The Australian and New Zealand Intensive Care Society (ANZICS) and the Australian Commission on Safety and Quality in Health Care (ACSQHC) have developed a central venous catheter insertion checklist for clinician use. This checklist specifically aims to lower the rate of CLABSI in patients with a CVAD in place, by reminding clinicians that aseptic technique should be maintained throughout the procedure.[33]

Furthermore, the use of independent suitably trained personnel to observe clinician technique against the criteria outlined on the insertion checklist has been shown to reduce insertion related complications. This has improved patient outcomes.[26]

Table 14: Recommendation summary table – insertion checklist

Recommendation	Source
A trained observer and insertion checklist should be used to ensure aseptic technique is employed throughout the insertion procedure.	Infusion Nurses Society. 2021[26]

Insertion techniques

A variety of insertion techniques may be used depending on the type of CVAD and the insertion site chosen.

- The Seldinger technique is a multistep process that describes the insertion of a guidewire and dilation of the vessel to facilitate catheter advancement into a central location.
- The modified Seldinger technique is also a multistep process that has been modified to include the use of a micro puncture needle, a dilator and introducer combination to insert a catheter for vascular access.[26]

The safest available insertion technique should be used to reduce the risk of insertion related complications, e.g. air embolism, guidewire loss, arterial puncture, nerve injury and bleeding.[26] For example, the modified Seldinger technique will reduce the risk of haemorrhage as it uses a micro puncture needle.

Using real-time ultrasound technology to guide insertion offers benefits in safety and quality compared to using anatomical landmarks alone.[5, 24] Clinicians should be appropriately trained to use and understand ultrasound technology. The use of ultrasound guidance increases first attempt insertion success rates, and a decrease in insertion related complications has been observed.[5, 26, 29]

Referral to interventional radiology or a vascular surgeon should occur if any predisposing conditions are identified by ultrasound that would make insertion of a CVAD difficult.[34]

Predisposing conditions could include venous thrombus, contraindicated extremities such as those following lymph node dissection or previous multiple CVAD insertion attempts.

Table 15: Recommendation summary table – insertion checklist

Recommendation	Source
Real-time ultrasound technology should be used to guide CVAD insertion.	NHMRC. 2019[5] Infusion Nurses Society. 2021[26] CDC. 2011[29]

Initial tip confirmation

The location of the tip of the CVAD influences the risk of catheter-related complications.[10] The safest tip location that is associated with the lowest rates of complications, is the superior vena cava for upper extremity insertion, ideally at the cavoatrial junction, and the inferior vena cava for lower extremity insertions. [6, 13, 26]

The tip of midline catheters should be at the level of the axilla. These catheters do not require tip position verification since midline catheters remain in peripheral veins and do not enter the chest area.[13] However, as extravasation from a midline catheter can be difficult to detect, if there is difficulty in aspirating blood or flushing of the catheter, consider removal or changing the catheter.[34]

Confirmation of CVAD tip location can be achieved using different methods, e.g. a post procedure chest radiograph, intracavitary use of electrocardiography, real-time fluoroscopy and image intensification.[35] If tip confirmation is delayed, pressure monitoring or blood gas analysis can be used to rule out arterial placement, until formal confirmation can be sought.[26] If real-time tip confirmation can be verified during the insertion procedure, post procedure chest radiographs are not required.[26] When tip location has been verified this must be documented in the patient's health record.[26]

Malposition of the CVAD tip should be rectified as soon as possible as suboptimal positioning may increase the risk of catheter-related thrombosis, vessel damage, arrhythmias or valve damage.[26] If the CVAD has been advanced too far and the tip lies beyond the intended location, the clinician may remove the dressing and reposition the catheter using aseptic non-touch technique (ANTT).[35]
If the CVAD tip falls short of the intended location and external parts of the CVAD have been contaminated with skin flora, catheter exchange or removal should be considered as advancement of the CVAD further into the insertion site poses a significant infection risk.[4, 26]

Electrocardiographic intraprocedural confirmation

Evidence supports the electrocardiogram (ECG) method as accurate, precise and cost effective for CVAD terminal tip positioning during catheter insertion. Precise positioning reduces the incidence of thrombotic malfunctions, vessel damage leading to venous thrombosis, arrythmias, valve damage or other areas of malposition that impact the circulation or cardiac function.[36] ECG tip confirmation is performed during insertion, using the real-time baseline rhythm connected to a lead on the patient, while the wire within the catheter functions as a separate lead.[35]

Table 16: Recommendation summary table – initial tip confirmation

Recommendation	Source
CVAD catheter tip must be confirmed as being in an appropriate location prior to use, or when malposition is suspected.	Infusion Nurses Society. 2021[26]
Initial catheter tip position must be confirmed by any of the following methods: • ECG confirmation • Chest X-ray • Fluoroscopy imaging • Image intensifier • Pressure transducer or blood gas analysis to rule out arterial placement until formal confirmation of tip position can be sought.	Infusion Nurses Society. 2021[26] Hill, Moureau. 2019[35]
Advancement of any external portion of a CVAD catheter that has been in contact with skin into the insertion site should be avoided.	Royal College of Nursing. 2016[4] Infusion Nurses Society. 2021[26]

Initial stabilisation and securement

Initial stabilisation and securement of a CVAD is very important as dislodgement and premature removal may contribute to increased rates of complications such as infection, treatment delays and an associated increase in cost of care.[4, 26] Patient factors such as patient age, skin condition, history of skin breakdowns or insertion site draining exudate, should dictate the securement device chosen.[6]

Sutureless securement devices, including engineered stabilisation devices (ESDs), have been shown to be effective at stabilising and securing CVADs.[26]

There are two main types of ESDs:

- adhesive based devices
- subcutaneous devices.

ESDs maintain a secure hold of the CVAD and prevent it from moving in and out of the insertion site. The use of sutureless devices are preferred over sutures due to the reduction in the risk of infection.[6, 26, 35, 37]

Adhesive devices may cause a medical adhesive-related skin injury (MARSI), necessitating the use of a prophylactic skin barrier solution prior to device application.[26]

Table 17: Recommendation summary table – CVAD catheter stabilisation devices

Recommendation	Source
All CVADs must be secured to the patient's skin post insertion.	Working group consensus
Sutureless securement devices may reduce risk of infection and catheter dislodgment and should be considered safer than sutures.	Gorski, Hadaway, Hagle, et al. 2021[6] Infusion Nurses Society. 2021[26] Ullman, Marsh, Mihala, et al. 2015[37] NICE. 2012[38]
Use a sterile alcohol-free, skin-barrier product, compatible with skin antiseptic agent, to protect at-risk skin when using an adhesive-based securement method.	Gorski, Hadaway, Hagle, et al. 2021[6] Infusion Nurses Society. 2021[26]

Initial dressing

A sterile transparent semipermeable membrane (TSM) film dressing should be used to cover CVAD insertion sites.[4, 13, 39] These dressings are different to typical wound dressings, in that they are transparent polyurethane dressings that are impermeable to microorganisms but semipermeable to oxygen, carbon dioxide and water vapour, to reduce colonisation of bacteria.[37]

For patients aged ≥18 years, a sterile, transparent, semipermeable dressing that is impregnated with chlorhexidine should be used, unless contraindicated by patient's allergy status.[6, 37, 39, 40]

If blood or exudate is leaking from the CVAD insertion site, or if excessive diaphoresis occurs, a sterile gauze dressing may be preferred to absorb the fluid, until this situation resolves.[5, 13, 41] If initial site bleeding occurs following a PICC insertion and prior to the application of a dressing, consider the use of a haemostatic agent if other methods, e.g. pressure, have failed. This will reduce the need for unplanned dressing changes.[26]

Table 18: Recommendation summary table – initial dressing selection

Recommendation	Source
Chlorhexidine-impregnated dressings should be used to cover the CVAD insertion site of adult patients (18 years or older).	Loveday, Wilson, Pratt, et al. 2014[13] Ullman, Marsh, Mihala, et al. 2015[37] NICE. 2015[39] CDC. 2017[40]
While a patient is diaphoretic or has excessive bleeding or oozing from the CVAD insertion site, a sterile gauze secured with a sterile transparent, semipermeable dressing should be used.	NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13] NICE. 201[238]
If initial site bleeding occurs following CVAD insertion, prior to the application of a dressing, consider the use of a haemostatic agent if other methods, e.g. pressure, have failed.	Gorski, Hadaway, Hagle, et al. 2021[6] Infusion Nurses Society. 2021[26]

Initial addition of needleless injection ports and access devices

Needleless injection and access devices reduce the risk of needle stick injuries to clinicians by eliminating the need for clinicians to use needles to access a CVAD to administer medication.[26] There are a variety of devices available, e.g. needleless IV catheter systems, swabable capless valves, swabable capless access device, needleless access ports, needle-free injection port, needleless and needle-free connectors.[1]

While needle stick injuries have declined, the use of these devices have grown for a secondary reason. Their internal valve mechanism and luer-lock designs create a closed and continuous system between the patient's vasculature and the external environment.[41] These features significantly reduce the incidence of air embolism and infection by minimising possible disconnection and decreasing direct access of air into the patient's circulation. For this reason, it is strongly recommended that these devices, when used, should be of a luer-lock or integrated design to minimise the risk of disconnection, air embolism and infection.[2, 4, 26]

Each needleless injection device has a different internal mechanism or valve that alters the flow of fluid through it. Valve designs may be considered negative, neutral, positive or anti-reflux in design. Each valve creates a potential for thrombotic events and associated infection to occur.[42] The device design that results in the least number of thrombotic occlusions and microbial contamination remains unclear.[26]

To further reduce the incidence of microbial contamination, consideration should be given to using passive disinfection caps. These caps contain a sponge impregnated with alcohol that can be attached to injection and access devices and have been shown to reduce intraluminal microbial contamination by providing continuous decontamination.[13, 26] Once removed, the caps are discarded and a new cap applied.[26, 43]

Table 19: Recommendation summary table – addition of needleless injection ports and access devices

Recommendation	Source
Injection and access devices should be of a luer-lock or integrated design to minimise the risk of disconnection.	Royal College of Nursing. 2016[4] Infusion Nurses Society. 2021[26]
May consider using passive disinfection caps to further reduce the incidence of microbial contamination.	Loveday, Wilson, Pratt, et al. 2014[13] Infusion Nurses Society. 2021[26]

Insertion documentation

The *NSW Health Policy directive: Clinical procedure safety (PD2017_032)* mandates that the insertion of a CVAD without sedation (Level 2 procedure), or with sedation (Level 3 procedure), requires the following information be recorded in the patient's healthcare record

- Name of the proceduralist
- The procedure completed
- Counts and tray list checks completed (if relevant)
- Advice for clinical handover
- Blood loss (if any)
- Equipment problems and issues (if any)
- Specimens and images labelled correctly (if relevant)
- Post procedure tests where clinically relevant, e.g. chest X-ray post insertion. [9]

To facilitate the documentation of the insertion of a CVAD, standardised templates with the capacity for recording additional information are useful in sharing information amongst clinicians and facilities and in ensuring patient safety. Entering CVAD specific data in an electronic form may be particularly beneficial when collecting data for quality improvement purposes.[26]

In addition, the following information should be considered for inclusion in the patient's health record.

- Evidence of informed written consent for CVAD insertion, when this is not included in consent for a surgical procedure
- The date and time of the insertion and the clinician inserting the device
- The reason for the insertion of the device and anticipated length of time
- The reason for the selection of device and site chosen
- The type of device, length, gauge and size, number of lumens and lot or batch number and expiry date
- Local anaesthetic (if used)
- For midline catheters and PICCs:
  a. External catheter length and length of catheter inserted
  b. Arm circumference: before insertion of a PICC or midline catheter. Take this measurement 10cm above the antecubital fossa
- Method of verifying catheter tip location and anatomic location of the catheter tip
- Length of exposed catheter and if this is measured from skin or catheter hub
- The patient's tolerance of the insertion procedure.[4, 13, 26, 44]

Table 20: Recommendation summary table – CVAD insertion documentation

Recommendation	Source
A standardised template should be used to record the insertion of a CVAD in the patient's healthcare record.	Infusion Nurses Society. 2021[26]

Complications and escalation during insertion

Escalation

Complications may occur during the insertion of a CVAD.[26] An escalation procedure should be in place to minimise risk to patients should difficulties arise.[5] Health organisations should develop local policies and guidelines to address strategies to manage insertion related complications.[45, 46]

Air embolism

An air embolism is a medical emergency. It is an uncommon but potentially catastrophic event that occurs due to the entry of air into the vasculature. This can occur at time of insertion and removal, but also during access of the lumens. Signs and symptoms are dependent upon the amount of gas that has been entrained, and include acute dyspnoea, tachypnoea, light headedness, alteration in mental state, wheeze, hypotension, tachycardia, altered speech and chest pain.[26]

If an air embolism is suspected, place the patient in the left-lateral position with the head down (Trendelenburg position) and apply 100% oxygen.[26] The health organisation's clinical emergency response system must be initiated via the hospital emergency number. A handover should be attended upon arrival of the rapid response team, identifying the device removed, it's location, and patient status prior to deterioration.[26, 47]

Cardiac arrhythmia

Arrhythmias during insertion of a CVAD are caused by irritation of the endocardium by the guidewire or catheter tip. Patients must receive continuous cardiac monitoring during CVAD insertion. In the event of an arrhythmia, the proceduralist should retract the guidewire or catheter tip.

Inadvertent arterial catheterisation or puncture

In the event of a CVAD being inadvertently inserted into an arterial space, immediate escalation for intensive care medical officer intervention is required, to determine the appropriate action. The catheter should not be removed by nursing staff at the bedside. Hospital process will determine the appropriate escalation pathway for removal under surgical or image intensifying procedures, e.g. vascular surgery, cardiothoracic surgery.[1]

Pneumothorax

If a pneumothorax is suspected, urgent escalation to an intensive care medical officer is required. A small pneumothorax may be managed conservatively, whereas a larger pneumothorax may require the insertion of a chest tube and underwater seal drain. In the instance of a mechanically ventilated patient, insertion of a chest drain should be considered regardless of size to prevent a tension pneumothorax.[1, 46]

Inability to pass guidewire

In the event of a guidewire unable to be inserted, it is suggested that the clinician remove the needle and guidewire together to avoid mediastinal injury or shearing off the guidewire inside the patient.[1]

Lost guidewire

In the event of a guidewire being lost inside a patient, interventional radiology should be consulted for attempted removal assisted by image intensifying techniques.[1]

Table 21: Recommendation summary table – complications and escalation

Recommendation	Source
An escalation procedure should be in place to minimise risk to patients, should difficulties arise.	NHMRC. 2019[5]
Health organisations should have policies and guidelines in place to manage insertion-related complications.	Working group consensus
Patients should receive at a minimum continuous cardiac and SpO_2 monitoring during and immediately after insertion of a CVAD.	Working group consensus

Post insertion

Clinical competency for managing a CVAD

Routine care of a CVAD is an advanced practice skill. As such clinicians tasked with managing a CVAD should undergo training and formal competency assessment.[29] Health organisations should have a credentialing process embedded into clinical practice. Opportunities should be provided for clinicians to be supervised by experienced and competent clinicians, until proficiency in the management of a CVAD can be attained. Regular reviews should take place to ensure that clinical credentials are maintained.[1, 2]

Table 22: Recommendation summary table – clinical competency for CVAD management

Recommendation	Source
Credentialing processes for all aspects of CVAD management should be embedded into clinical practice.	CEC. 2015[2] CEC. 2019[1] CDC. 2011[29]

Device assessment

Assessment of a CVAD should occur at least every shift.[13] Assessment should include:

- the entire infusion system
- the functionality of the device, e.g. constant flow or high pressure and occlusion alarms
- the CVAD dressing is clean, intact and dated
- insertion site and surrounding area
- CVAD tip location and/or external catheter length
- upper arm circumference for PICC and midline catheters as clinically indicated to assess the presence of oedema and possible deep vein thrombosis
- clarity of fluids
- correct labelling as per *National standard for user-applied labelling of injectable medicines, fluids and lines*
- expiration date of infusate
- luer-lock connections are secure
- the catheter remains secured in place.[6, 48, 49]

All assessment findings, actions taken and clinical outcomes should be documented in the patient's healthcare record.[4] There should be a daily review of CVAD necessity, with prompt removal if deemed unnecessary.[50]

CVAD patency should be assessed prior to connecting an infusion to a previously unused lumen and when a blockage is indicated during administration of infusate. The clinician should recognise that each manipulation to test patency of the infusion system increases risk of contamination.[6]

Assessment of the CVAD insertion site and surrounding area should include a visual inspection and palpation through the intact dressing for redness, tenderness, swelling and drainage, as well as asking the patient if they are experiencing discomfort including pain, paraesthesia, numbness or tingling.[6, 29] If an adhesive-based ESD is being used, the skin underneath the dressing may be at risk of MARSI and may exhibit similar symptoms.[48] In this case the use of a skin barrier solution to reduce the risk of MARSI should be considered.

CVAD tip dislodgment may occur at any time due to a variety of causes, e.g. changes in intrathoracic pressure including positive pressure ventilation, original tip location high in the superior vena cava, presence of a deep vein thrombosis (DVT), congestive heart failure and neck or arm movement.[6] Dislodgment carries an increased risk of catheter-related complications such as infection and air embolism.[4] Measurement of the external CVAD length, and comparison of this measurement against the external CVAD length documented at insertion, should be performed regularly to detect catheter dislodgment.[6, 48]

A patient with a PICC or midline catheter should have an upper arm measurement taken regularly, if oedema or DVT is suspected.[6] Measurement of the respective arm circumference should be taken. The measurement should occur 10cm above the antecubital fossa and be compared to baseline measurement. A 3cm increase in arm circumference and the presence of oedema have been shown to be associated with catheter-related venous thrombosis.[6, 48]

The need for a CVAD should be reviewed on a daily basis or during care interaction for patients in outpatient settings.[4, 6, 29] When no longer required, vascular access devices should be removed due to their high risk as a source for infection and other complications. The aim is to prevent the interruption of treatment, assess the patency of the device and to detect signs of infection or other complications at the earliest possible stage.[4, 6, 13, 48]

Table 23: Recommendation summary table – daily CVAD assessment

Recommendation	Source
Assessment of CVADs should occur at least every shift.	Loveday, Wilson, Pratt, et al. 2014[13]
All assessment findings, actions taken and clinical outcomes should be documented in the patient's healthcare record.	Royal College of Nursing. 2016[4]
Assessment should include the following; the entire infusion system including securement and dressing, the device functionality, the insertion site and surrounding area underneath the dressing and CVAD tip location.	Gorski, Hadaway, Hagle, et al. 2021[6]
Upper arm circumference (PICC and midline catheters only) should be assessed on insertion, and then continue to be assessed regularly for monitoring of potential catheter-associated DVT.	Gorski, Hadaway, Hagle, et al. 2021[6]
The ongoing requirement for a CVAD should be assessed every shift (or at each care interaction for those in outpatient care settings) and promptly removed when no longer required.	Royal College of Nursing. 2016[4] Gorski, Hadaway, Hagle, et al. 2021[6] CDC. 2011[29]

CVAD dressing changes

Following CVAD insertion, a dressing is necessary to protect the insertion site from microorganisms.[48] Microorganisms that grow on CVAD hubs and on skin surrounding the CVAD insertion site are the cause of most CLABSI.[5] A clean, dry and intact dressing can reduce the incidence of microorganisms from entering the bloodstream through the CVAD insertion site.[48]

Changing the dressing at regular and established intervals ensures the dressing remains in an optimal functioning condition. Transparent semipermeable membrane (TSM) dressings including those impregnated with chlorhexidine, should be changed every 5-7 days.[13, 29] Gauze dressings (used for patients who perspire profusely or whose insertion site is leaking or bleeding), should be changed every 24-48 hours.[5, 6, 29] Once the insertion site becomes dry, the gauze dressing should be replaced with a TSM dressing as soon as practicably possible.[4, 13]

If the integrity of a CVAD dressing becomes compromised, e.g. moisture, drainage or blood can be seen under the dressing, or if the dressing becomes loose, or signs of infection are evident, e.g. redness, exudate or pain is present, the dressing should be immediately replaced.[4, 5, 13] If blood or exudate is of a large volume, or occurring frequently, the site should be assessed and escalated as required.

ANTT should be followed when providing site care and dressing changes.[6] This includes hand hygiene and appropriate personal protective equipment (PPE). Non-sterile gloves may be worn to remove a dressing by carefully rolling up the edges of the dressing in a controlled manner to reduce the risk of catheter dislodgment. Hand hygiene should be performed again before sterile gloves are used to apply a new dressing.[48]

CVAD dressing changes should be recorded in the patient's healthcare record according to organisational policy and procedure guidelines.[4] The dressing should be labelled with the date performed or date to be changed.[6]

Table 24: Recommendation summary table – CVAD dressing changes

Recommendation	Source
Aseptic technique including hand hygiene and appropriate PPE should be followed whenever CVAD dressing changes occur.	Gorski, Hadaway, Hagle, et al. 2021[6]
Non-sterile gloves may be worn to remove a dressing. Further hand hygiene should be performed before sterile gloves are used to apply a new dressing.	Weston. 2019[48]
TSM dressings including those impregnated with chlorhexidine should be changed every 5-7 days.	Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13] CDC. 2011[29]
Gauze dressings secured by tape should be changed every 1-2 days.	NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6] CDC. 2011[29]
Gauze dressings should be replaced with a TSM dressing as soon as practicably possible.	Royal College of Nursing. 2016[4] Loveday, Wilson, Pratt, et al. 2014[13]
If the integrity of a CVAD dressing becomes compromised it should be replaced immediately.	Royal College of Nursing. 2016[4] NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13]
Documentation related to CVAD dressing changes should be recorded in the patient's healthcare record.	Royal College of Nursing. 2016[4] Gorski, Hadaway, Hagle, et al. 2021[6]
Label the dressing with the date performed or date to be changed.	Gorski, Hadaway, Hagle, et al. 2021[6]

Antiseptic solutions and CVAD site cleansing

Cleansing of the insertion site, surrounding skin and catheter should be undertaken at each dressing change.[4, 6] Aseptic technique should be used whenever a CVAD is accessed for the purpose of providing site care. Cleansing with 2% chlorhexidine gluconate in 70% isopropyl alcohol is effective in reducing rates of CLABSI.[1, 5, 6, 13] If hypersensitivity or allergic responses to chlorhexidine gluconate are known or observed, povidone-iodine in alcohol can be used as an alternative.[5, 13]

Prior to the application of antisepsis, if dry blood or organic matter is present on the skin at the insertion site or on the catheter, cleansing using gauze soaked in sterile water should be performed from the insertion site outwards ensuring the catheter remains securely in place.[50] An assessment of the surrounding skin should be performed at this time, paying attention to the risk of MARSI associated with the use of adhesive based ESDs. Use a skin barrier solution to reduce the risk of MARSI. For patients who require enhanced adhesive adherence, e.g. diaphoresis, exudate, drainage, bleeding, gum mastic liquid adhesive can be considered.[6] The use of a skin barrier film should be considered prior to the application of liquid adhesive Correct technique in dressing removal is required to prevent the bonding of adhesives to skin, leading to catheter-associated skin injury.[6]

A single-use applicator to apply the antiseptic should be considered and the application itself should utilise a back-and-forth motion for at least 30 seconds and then allow the antiseptic to dry.[4, 6] Furthermore, the use of chlorhexidine in daily cleansing of the patient, e.g. using chlorhexidine impregnated wash cloths, has been shown to be effective in reducing rates of CLABSI when infection rates have remained high despite preventative strategies.[13]

Table 25: Recommendation summary table – CVAD site cleansing

Recommendation	Source
Cleansing of the insertion site, surrounding skin and catheter should be undertaken at each dressing change.	Royal College of Nursing. 2016[4] Gorski, Hadaway, Hagle, et al. 2021[6]
Hand hygiene, appropriate PPE and aseptic technique, including sterile gloves, should be used whenever CVAD site care is performed.	Loveday, Wilson, Pratt, et al. 2014[13] DeVries. 2019[50]
Cleansing using an antiseptic solution should be performed from the insertion site outwards, ensuring the catheter remains securely in place.	DeVries. 2019[50]
Prior to applying an antiseptic solution, any visibly soiled skin should be cleansed using gauze soaked in sterile water.	DeVries. 2019[50]
A skin barrier solution to reduce the risk of MARSI, associated with adhesive based ESDs, should be used.	Gorski, Hadaway, Hagle, et al. 2021[6]
2% chlorhexidine gluconate in 70% isopropyl alcohol should be used as the preferred antiseptic solution and allowed to dry.	NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13] CEC. 2019[1]
A single-use applicator may be used to apply an antiseptic solution for at least 30 seconds.	Royal College of Nursing. 2016[4] DeVries. 2019[50]
For chlorhexidine sensitivity or allergy, povidine-iodine in alcohol should be considered as an alternative antiseptic solution.	NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13] DeVries. 2019[50]
Cleansing patients daily with a chlorhexidine product should be considered as an additional strategy when increased rates of CLABSI are seen in the health organisation.	Loveday, Wilson, Pratt, et al. 2014[13] CDC. 2011[29]

Management of sutureless securement devices

Securement devices are essential in improving patient safety by preventing catheter movement in and out of the insertion site, lowering the incidence of bacteria entering the patient and reducing the risk of accidental dislodgement.[48]

ESDs adhere a securement platform to the skin, onto which plastic lumen holders can be locked into place.[48]

There are two main types of ESDs, both of which are considered safer than sutures:

- an adhesive-based device
- a subcutaneous device.

Adhesive based devices should be changed with each dressing change or earlier if it becomes visibly soiled or loose.[6, 48] Removal of the device allows thorough assessment of the underlying skin. In the case of chlorhexidine sensitivity or allergy, skin antisepsis should be done using 2% chlorhexidine gluconate in 70% isopropyl alcohol, or povidone-iodine in alcohol.[1, 6, 13, 29]

Subcutaneous devices most commonly remain in place for the duration of the device and only need to be removed or replaced if stabilisation can no longer be achieved.[6] The device can be lifted to achieve skin antisepsis at each dressing change.[48]

Table 26: Recommendation summary table – management of CVAD stabilisation devices

Recommendation	Source
Assessment of sutureless securement devices should occur at each dressing change.	Gorski, Hadaway, Hagle, et al. 2021[6]
Use a sterile, alcohol-free, skin barrier product, compatible with skin antiseptic agent, to protect at-risk skin when using an adhesive-based securement method.	Gorski, Hadaway, Hagle, et al. 2021[6] Infusion Nurses Society. 2021[26]
Adhesive-based securement devices should be changed with each dressing change, or earlier if soiled or loose, using aseptic technique.	Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13] Weston. 2019[48]
Subcutaneous stabilisation devices should be carefully lifted to achieve skin antisepsis at each dressing change, using aseptic technique.	Loveday, Wilson, Pratt, et al. 2014[13] Weston. 2019[48]
The subcutaneous stabilisation device does not need to be changed at regular intervals when the dressing is changed; it can remain in place if there are no associated complications.	Gorski, Hadaway, Hagle, et al. 2021[6]
In the case of chlorhexidine sensitivity or allergy, skin antisepsis should be done using 2% chlorhexidine gluconate in 70% isopropyl alcohol or povidine-iodine in alcohol.	NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13] CEC. 2019[1]

Accessing CVADs

To reduce the risk of infection, manipulations of a CVAD should be kept to a minimum.[1, 48] Any manipulation of the catheter during injections or access exposes it to microorganisms from the clinician, patient or immediate environment.

Strategies to reduce the risk of infection include:

- adhering to the appropriate level of ANTT technique on every manipulation
- decontaminating injection and access devices immediately prior to use.[4, 6, 48]

Decontaminating injection and access hubs, e.g. central venous pressure transducer, with a single-use application of 70% isopropyl alcohol via a flat swab pad is effective in minimising the risk of microbial infection.[13, 29, 48] This also applies to those devices with antimicrobial properties.[6]

If hypersensitivity or allergic responses to chlorhexidine gluconate are known or observed, povidone-iodine in alcohol can be used as an alternative.[13, 29]

Cleaning should occur using a vigorous 'scrubbing' technique that creates friction and the solution should be allowed to dry.[1, 6, 13, 48, 50] Differences exist regarding optimal scrub time to ensure biocide activity occurs. Suggested scrub times range from five to 60 seconds,with a minimum of 15 seconds recommended. [6, 13] If an injection or access device is removed, it should be discarded and a new sterile injection or access device should be attached.[4, 6]

As an alternative to relying on clinicians performing adequate decontamination, passive disinfection of injection and access devices can be achieved using alcohol-impregnated catheter hub protection caps.[48] These caps contain a sponge impregnated with alcohol that can be attached to injection and access devices and have been shown to reduce intraluminal microbial contamination, by providing continuous decontamination.[6, 13] Once removed, the caps are discarded and a new sterile alcohol impregnated catheter hub protection cap applied.[6]

During decontamination, the integrity of the injection and access hubs should be assessed. If integrity is compromised, the injection or access device should be replaced immediately, and consideration given to changing the administration set.[4]

Table 27: Recommendation summary table – management of needleless injection and access devices

Recommendation	Source
To reduce the risk of infection, manipulations of a CVAD should be kept to a minimum.	CEC. 2019[1] Weston. 2019[48]
Needleless injection ports and access devices should be decontaminated with a single-use application of 70% isopropyl alcohol and allowed to dry.	NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13] CDC. 2011[29] Weston. 2019[48]
If hypersensitivity or allergic responses to chlorhexidine gluconate are known or observed, povidine-iodine in alcohol should be used as an alternative.	NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13]
Use a vigorous 'scrubbing' technique that creates friction for a minimum of 15 seconds for decontamination.	Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13] CEC. 2019[1]
Consider alcohol-impregnated catheter hub protection caps, to achieve passive decontamination.	Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13]
The integrity of the injection and access devices should be assessed during each decontamination episode.	Royal College of Nursing. 2016[4]

Addition of intravenous administration sets and devices

Intravenous (IV) administration sets are attached to a CVAD injection or access device and are used to administer IV fluids and medications directly into the patient's central venous circulation. Other examples of add-on devices include extension sets, inline filters, manual flow control devices, haemodynamic monitoring sets, three-way taps, blind hub caps, needleless connectors and stopcocks.[4, 6]

The addition of IV administration sets and add-on devices should only occur when clinically indicated, e.g. to add length to an existing administration set, facilitate filtration of IV solutions or to monitor invasive haemodynamics.[6] Stopcocks should be avoided due to their increased risk of infection. They should be replaced with a needleless connector at the first opportunity.[6]

Whenever add-on devices are manipulated or disconnected, the potential for contamination increases.

Add-on devices must:

- be compatible with the administration system
- be of a luer-lock or integrated design to reduce manipulation of the fluid system
- have secure junctions between the CVAD and add-on devices to reduce the risk of accidental disconnection.[4, 6, 29]

There are no circumstances where caps should be left open or exposed.[4]

IV fluids, including parenteral nutrition and blood products, require filtration using an inline or add-on filter incorporated into the administration system.[4]

The appropriate filter depends on what it will be used for, e.g.:

- clear IV fluids require a 15-micron filter (or less), these are most commonly inline filters and are usually part of the IV administration set
- parenteral nutrition containing lipids require a 1.2-micron filter to reduce passage of bacteria, other harmful particulates and air into the intravascular space
- non-lipid containing parenteral nutrition solutions require a less retentive 0.2-micron filter
- blood products are typically administered through a standard blood administration set that contains an integrated 170-260-micron filter, capable of removing blood clots and harmful particulates.[4, 6]

Table 28: Recommendation summary table – addition of intravenous administration sets and devices

Recommendation	Source
IV administration sets or add-on devices should only be used with the CVAD if clinically indicated.	Gorski, Hadaway, Hagle, et al. 2021[6]
Add-on devices should be compatible with the administration system and be of a luer-lock or integrated design, to reduce risk of disconnection.	Royal College of Nursing. 2016[4] Gorski, Hadaway, Hagle, et al. 2021[6] CDC. 2011[29]
Filtration devices should be appropriate to the solution being administered.	Royal College of Nursing. 2016[4]
Filtration devices should not be routinely used as an infection prevention measure.	Loveday, Wilson, Pratt, et al. 2014[13]

Changing IV administration sets and add-on devices

IV administration sets are routinely changed to reduce the risk of bacterial growth occurring. The frequency of change is based on the type of solution administered and whether the infusion is continuous or intermittent.

To further minimise the opportunity for bacterial growth, IV administration sets and add-on devices should be changed immediately if they become contaminated, compromised or disconnected, or if the CVAD is replaced.[5, 6, 13] Standard-ANTT technique and standard precautions should be observed whenever the infusion system is accessed.[6] This includes episodes of care to change IV administration sets or add-on devices.[4, 13]

Administration sets and their attachments should be changed as per the following time periods.

- An IV administration set that is continuously administering an IV fluid, that does not contain lipids, blood or blood products, should be changed between 96 hours and seven days.[45] Evidence suggests that changing these IV administration sets any more frequently than 96 hours does not result in lower incidences of infection.[4, 6, 13]
- An IV administration set that is being used intermittently to administer an IV fluid or medication including lipid or parenteral solutions (except for propofol infusions) should be changed every 24 hours or when the infusion is complete.[4, 5, 13]
- An IV administration set that is used to administer propofol lipids should be changed every 6-12 hours, as per the manufacturers' directions for use.[4-6, 13, 29]
- An IV administration set and filter that is used to administer blood or blood products should be changed every 12 hours, or when the transfusion is complete.[4, 13, 51]
- Any number of red blood cell units may be administered through the same set within a 12-hour period, if the flow rate is enough to prevent coagulation. However, specific manufacturer's recommendations defining the maximum number of units per blood administration set must not be exceeded.[51]
- If infusion of another medication, fluid or other blood product is to follow a blood transfusion, a new IV administration set should be used for this purpose to reduce the risk of incompatibility between fluids and medications and reduce the risk of haemolysing any residual red blood cells.[51]
- Haemodynamic monitoring sets including the internal flush device and flush solution are considered a single closed component and should be changed every 96 hours.[4]

Add-on devices, e.g. extension sets including filters, stopcocks, caps, needleless access devices and hubs and secondary administration sets, should be changed whenever the administration set it is attached to is changed. They should also be changed if the add-on device is disconnected for any reason.[1] Add-on devices should be changed no more frequently than every 96 hours; more frequent changes than every 96 hours has demonstrated an increase in the risk of CLABSI.[4, 6, 29]

Table 29: Recommended frequency of administration set or device change

Administration set or add-on device	Change time interval	Source
Continuous infusions	≥96 hours up to a maximum 7 days	NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13]
Haemodynamic monitoring	≥96 hours	Royal College of Nursing. 2016[4]
Add-on devices	≥96 hours	Royal College of Nursing. 2016[4]
Intermittent infusions e.g. total parenteral nutrition	24 hours or when complete	Royal College of Nursing. 2016[4] NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13]
Propofol infusion	6-12 hours	NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13] CDC. 2011[29]
Blood or blood products	12 hours	Royal College of Nursing. 2016[4] Loveday, Wilson, Pratt, et al. 2014[13] Australian and New Zealand Society of Blood Transfusion (ANZSBT). 2019[51]

Note: all administration sets and add-on devices should be discarded and a new set or device used if they become contaminated, compromised or disconnected, or if the CVAD is changed.[5, 6, 13]

Lipid emulsions should be administered using di-ethylhexyl-phthalate (DEHP) free sets, as studies have demonstrated that DEHP enters lipid solutions and poses a potential risk to patients.[6]

The *National standard for user-applied labelling of injectable medicines, fluids and lines* mandates that all administrative sets and medications infused through them should be clearly labelled.[49] Administration lines and catheters must be labelled with the relevant route of administration and with the date and time the line was commenced clearly documented on the label.[49]

Table 30: Recommendation summary table – changing IV administration devices and add-ons

Administration set or add-on device	Source
IV administration sets and add-on devices should be changed immediately if they become contaminated, compromised or disconnected, or if the CVAD is replaced.	NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13]
Standard-ANTT should be used when accessing and changing a needleless connector.	Gorski, Hadaway, Hagle, et al. 2021[6]
An IV administration set that is continuously administering an IV fluid, and does not contain lipids, blood or blood products, should be changed every 96 hours.	NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13]
An IV administration set that is being used intermittently to administer an IV fluid, or medication including lipid and parenteral solutions (excluding propofol), should be changed every 24 hours or when the infusion is complete, whichever is sooner.	Royal College of Nursing. 2016[4] NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13]
An IV administration set that is used to administer propofol lipids should be changed every 6-12 hours.	Royal College of Nursing. 2016[4] NHMRC. 2019[5] Gorski, Hadaway, Hagle, et al. 2021[6] Loveday, Wilson, Pratt, et al. 2014[13] CDC. 2011[29]
An IV administration set and filter that is used to administer blood or blood products should be changed every 12 hours, or when the transfusion is complete.	Royal College of Nursing. 2016[4] NHMRC. 2019[5] Loveday, Wilson, Pratt, et al. 2014[13]
Haemodynamic monitoring sets including the internal flush device and flush solution should be changed every 96 hours.	Royal College of Nursing. 2016[4]
Add-on devices such as extension sets including filters, stopcocks, caps, needleless devices and secondary administration sets, should be changed whenever the administration set it is attached to is changed, or if the add-on device is disconnected.	CEC. 2019[1]
Lipid emulsions should be administered using DEHP-free sets as studies have demonstrated that DEHP enters lipid solutions and poses a potential risk to patients.	Gorski, Hadaway, Hagle, et al. 2021[6]
Date and time labels should be used to indicate when IV administration sets should be changed.	Royal College of Nursing. 2016[4]
All administrative sets and medications infused through them should be clearly labelled.	ACSQHC. 2015[49]

Flushing and locking

Flushing

Flushing is recommended to promote and maintain patency and prevent the mixing of incompatible medical solutions. Sterile 0.9% sodium chloride for injection must be used by clinicians, unless the manufacturer recommends flushing with an alternate solution.[1, 48]

Clinicians must flush catheters immediately:

- after placement of a line
- before and after each fluid infusion or injection
- prior to and after drawing blood.

CVADs not being accessed must be flushed and locked every seven days. Ports or intra venous ports not being accessed must be flushed and locked every 4-6 weeks.[48] A 10mL syringe should be used to assess CVAD function.[6] Flushing should never be forced against resistance.[6]

Flushing involves the aspiration of blood from the CVAD lumen prior to flushing the lumen to reduce the risk of medication and solution remaining in the dead space in the CVAD.[6] Drugs such as muscle relaxants or strong sedative agents can remain in the dead space if not flushed sufficiently. There is then a risk of the drug being flushed into the bloodstream at a time and place where the effect of the drugs is unanticipated, e.g. respiratory depression or sedation, and the staff being unprepared to manage the adverse events.

Locking

Instillation of a fluid lock into a CVAD catheter lumen creates a column of fluid to help maintain patency.[48] There is insufficient evidence to support the recommendation of one lock solution over another (0.9% saline or heparin solution of 10units/mL).[6] NSW Health *Policy directive: Intravascular access devices (IVAD) - infection prevention and Control PD2019_040* recommends the use of sterile 0.9% sodium chloride for injection to lock a catheter or lumen that is no longer required, unless the manufacturer recommends catheter lumens be locked with an alternate solution.[1, 48]

Lumen locks containing medication must be prescribed by a medical officer or nurse practitioner. Refer to NSW Health *Policy directive: Medication handling in NSW public hospitals PD2013_043*.[52] This may be via direct or standing order, as per organisational policy. Catheters with a medicine in situ to lock the catheter, must be labelled as per the *National Standard for User-applied Labelling of Injectable Medicines, Fluids and Lines*.[49]

Table 31: Recommendation summary table – flushing and locking of CVADs

Recommendation	Source
CVADs and lumens not in use should be flushed and locked weekly, and ports should be flushed and locked every 4-6 weeks.	CEC. 2019[1]
The volume of fluid used for flushing should be twice the volume of the lumen and any extension or add-on devices.	Gorski, Hadaway, Hagle, et al. 2021[6]
Sterile 0.9% sodium chloride for injection should be routinely used to flush and lock a catheter, unless the manufacturer recommends catheter lumens be locked with an alternate solution, e.g. heparin.	Weston. 2019[48]
Locked CVAD lumens and catheters should be labelled with the name of the fluid, additives and the date of instillation.	ACSQHC. 2015[49]

Complications

Infection

Infection is a serious complication of CVAD insertion and management. CVADs provide direct access to the patient's bloodstream and therefore pose a serious risk for infection of microorganisms to be introduced either at the time of insertion or while the device is in situ.[1] All clinicians are responsible for adhering to infection prevention measures when dealing with CVADs.

Patients should be assessed regularly for signs and symptoms of a CVAD-related infection. Symptoms of infection include erythema, oedema, pain or tenderness; increased body temperature; exudate or discharge from the catheter site; fluid in the subcutaneous pocket of a totally implanted intravascular device or subcutaneous tunnel for any tunnelled catheter; or induration at the exit site or over the pocket.[6]

Changes in the patient's clinical state must be escalated to the treating medical team or other care provider as required.[6] A CVAD should be removed if infection is confirmed or suspected, when catheter salvage is not appropriate.[6]

Occlusion

CVADs should be regularly observed for patency during routine catheter assessment.[6] Signs of occlusion include inability or difficulty aspirating blood, sluggish flow, inability to flush, frequent occlusion or high-pressure alarms on electronic infusion pumps, and leaking of fluid (either at insertion site or into surrounding tissues).[6]

Catheter occlusion can be prevented by using proper flushing and locking procedures, correct sequence of clamping and syringe disconnection relative to the type of needleless connector, checking fluids and medications for compatibility prior to administration, and identifying those drugs or fluids that may have a high risk of precipitation.[6]

Dislodgment or disconnection

A CVAD should have a continuous connection between the device and the giving set and attachments, as intermittent disconnection increases the risk of infection.[1] The administration set should be attached to the patient so that no tension is applied to the CVAD.[1]

All components of the administration system must be compatible and incorporate a luer-lock system to ensure a secure connection.[1, 6] A catheter that has migrated externally from its original placement should not be re-advanced.[1] A catheter that has migrated internally should be retracted to the original insertion length, and the medical team notified for risk assessment of potential infection.[1]

Accidental disconnection of an administration set creates the risk of air embolus for the patient. Immediately clamp the affected lumen and observe for signs of air embolism, if accidental disconnection occurs. The local clinical emergency response system should be activated in the event of acute deterioration. If the catheter is completely dislodged, cover the insertion site and apply direct manual pressure whilst calling for assistance; the patient will require monitoring for possible air embolus and re-establishment of central venous access for critical medications.

Catheter fragmentation

Assessment of device integrity should be included in the evaluation of CVADs by clinicians. Potential causes for catheter fragmentation include a manufacturing defect, use of excessive pressure on the CVAD when flushing, clearing an occlusion or during removal, piercing the catheter of an implanted port with the access needle, mechanical stress as occurs with pinch-off syndrome or accidental slicing or cutting of the catheter with scissors or a scalpel.[53]

Catheter embolism should be suspected if assessment findings reveal visible catheter damage, hub fracture, site leakage, catheter dysfunction, localised pain or swelling in patients displaying symptoms such as palpitations, arrhythmias, dyspnoea, cough or new thoracic pain not associated with the patient's presentation.[6] In some cases, there may be no symptoms.[6] Local emergency procedures should be activated to seek further assistance in managing the patient.

Incident reporting

Adverse incidents relating to the removal of a CVAD must be documented in the patient's progress notes and entered into the incident management system (IMS+). This should occur on the same day the incident occurs, or as soon as practicably possible.[54]

Table 32: Recommendation summary table – complications and escalation

Recommendation	Source
Changes to the condition of a CVAD (including but not limited to patency, position, ability to flush, infuse or aspirate) must be escalated to the treating team as soon as possible.	Gorski, Hadaway, Hagle, et al. 2021[6] CEC. 2019[1]
An escalation procedure should be in place to minimise risk to patients should difficulties arise.	NHMRC. 2019[5]
A patient who is clinically deteriorating must be escalated to the treating medical team and the local emergency response system (Clinical Emergency Response System or Rapid Response).	NHMRC. 2019[5]
Catheter integrity should be included as part of routine CVAD assessments.	Gorski, Hadaway, Hagle, et al. 2021[6]
Documentation of an adverse incident should be made into the incident management system on the same day, or as soon as possible.	CEC. 2020[54]

* **Pinch-off syndrome** – A relatively rare but significant and often unrecognised complication; occurs when the CVAD enters the costoclavicular space medial to the subclavian vein and is positioned outside the lumen of the subclavian vein in the narrow area bounded by the clavicle, first rib, and costoclavicular ligament. Catheter compression causes intermittent or permanent catheter occlusion and, because of the 'scissoring' effect of catheter compression between the bones, can result in catheter tearing, transection, and catheter embolism. [4]

Removal

Indications for removal

Timing of removal

The ongoing necessity of a CVAD should be assessed daily by the patient's medical team as part of a daily patient assessment.[26] If a CVAD is no longer required, it should be removed as soon as practicably possible once decided upon by the medical team, with an accompanying written order in the patient's healthcare record.[2] CVADs that remain in situ for extended periods of time without being accessed, pose a significant risk to the patient regarding complications such as infection risk and air embolism from accidental dislodgement or disconnection.

Communication of CVAD removal by treating medical team

When the treating medical team deems that a CVAD is no longer necessary, the decision for removal should be documented in the patient's healthcare record and communicated to the nursing staff.[55] A CVAD should only be removed in the presence of a written order from the patient's medical team in the progress notes.[2, 55]

Table 33: Recommendation summary table – indications for CVAD removal

Recommendation	Source
Patients should be assessed daily by their medical team for whether they have an ongoing requirements for a CVAD. Patients outside of a hospital setting should be assessed at each visit.	Infusion Nurses Society. 2021[26]
CVADs should be removed as soon as practicably possible after a decision by the treating medical team, and replaced with a peripheral device if required.	CEC. 2015[2] Infusion Nurses Society. 2021[26]
The decision to remove a CVAD should be documented in the patient's progress notes.	Infusion Nurses Society. 2021[26] Cancer Institute of NSW. 2019[55]

Removal process

Staff competency

Any staff member tasked with removing a CVAD must be accredited in the procedure by their organisation.[2, 26] The Clinical Excellence Commission recommends that health organisations embed credentialing processes into clinical practice for all aspects of CVAD management and include appropriate supervision and maintenance of proficiency.[2]

Coagulation status

Patient coagulation status should be considered when deciding on and preparing for removal of a CVAD.[6]

Patient positioning

For CVAD removal, the patient should be positioned in a Trendelenburg position if tolerated, otherwise in a supine position in bed.[2] If a patient is unable to tolerate a supine position, it should be discussed with the medical team to formulate a plan for the safe removal of the line. For a PICC, position patient so that the exit site is at or below the level of the heart during removal.[6] The patient's arm may need to be extended to 90 degrees to aid in removal.[55]

Respiratory cycle

In a non-ventilated patient, the removal of a CVAD should be attended with the patient performing a Valsalva manoeuvre, or breath hold.[6, 55] If the patient is not able to perform a Valsalva or breath hold, complete catheter removal at end of inspiration.[55]

Dressing selection

A sterile, occlusive dressing should be used for covering the CVAD insertion site post removal. It should remain intact for at least 24 hours.[6, 26, 55]

Tip specimens for culture

There is currently no body of evidence to support the routine practice of sending CVAD catheter tips for culture.

Removal procedure

Steps for removal of a non-tunneled CVAD have been published by the NSW Cancer Institute and are available at the eviQ website.[55]

SAFETY ALERT:

CVADs (including PICCs) should **never** be removed from a patient in a seated or upright position, as this places the insertion site above the level of the heart, increasing risk of air embolus.[26]

Table 34: Recommendation summary table – removal process

Recommendation	Source
Staff members attending to the removal of CVADs should be accredited in this skill as per their local organisational requirements.	CEC. 2015[2] Infusion Nurses Society. 2021[26]
Patients should be positioned in a supine position for CVAD removal and remain so for 30 minutes post removal.	CEC. 2015[2] Infusion Nurses Society. 2021[26]
The removal of the CVAD should be performed with a Valsalva manoeuvre and/or timed with end-inspiration to ensure a positive pressure relative to atmospheric pressure is maintained.	Cancer Institute of NSW. 2019[55]
A sterile, occlusive dressing should be placed over the CVAD insertion site and remain in situ for at least 24 hours.	Cancer Institute of NSW. 2019[55]
CVAD catheter tips should not be routinely sent to pathology for culture.	Working group consensus

Post CVAD removal monitoring

Patient observation

Patients should remain supine for approximately 30 minutes post removal of a CVAD.[26] A full set of observations should be attended post removal, and again prior to sitting the patient up from the supine position.[55] The insertion site should be inspected for signs of bleeding, swelling, pain or discharge, and the state of the occlusive dressing assessed. If the dressing integrity looks to be compromised, it should be replaced as necessary.[26]

Patient transfer

Transfer of a patient between locations should not occur within 30 minutes of removal of a centrally inserted CVAD.[2] After the appropriate observation period, a patient who is transferred post removal of a CVAD must have the removal of the CVAD included in the clinical handover, and the site inspected by the two staff members giving and receiving the handover.

Table 35: Recommendation summary table – post CVAD removal monitoring

Recommendation	Source
Patient observations should be attended immediately after the removal of a CVAD, and again prior to moving the patient from the supine position.	CEC. 2015[2] Infusion Nurses Society. 2021[26] Cancer Institute of NSW. 2019[55]
Transfer of a patient between clinical areas should not occur within 30 minutes of the removal of a CVAD.	CEC. 2015[2]
Clinical handover of a patient who has had a CVAD removed should include the details of the line removal, the patient status and the site inspected by both staff members.	Working group consensus

Complications and adverse events during CVAD removal

Air embolism

Air embolism is a medical emergency. It is an uncommon but potentially catastrophic event that occurs due to the entry of air into the vasculature. It is preventable through supine positioning and rapid occlusion of the insertion site. Signs and symptoms are dependent upon the amount of gas that has been entrained, and include; acute dyspnoea, tachypnoea, light headedness, alteration in mental state, wheeze, hypotension, tachycardia, altered speech and chest pain.[26]

If an air embolism is suspected, place the patient in the left-lateral position with the head down (Trendelenburg position) and apply 100% oxygen.[26] The facility's clinical emergency response system must be initiated via the hospital's emergency number. An ISBAR handover should be attended upon arrival of the rapid response team, identifying the device removed, it's location and patient status prior to deterioration.[26]

Haemorrhage

Prior to the removal of a CVAD, the patient's coagulation state should be assessed to identify any potential issues with achieving haemostasis.

Digital pressure should be applied after the removal of a CVAD until haemostasis is achieved.[26] The clinician should use a sterile dry gauze pad and place direct manual pressure over the insertion site.[26] If bleeding is prolonged or of a large volume, emergency assistance should be sought.

Catheter fragmentation

CVADs may become damaged at any point along the catheter. Therefore, it is important to include device integrity as part of any assessment. Potential causes for catheter fragmentation include a manufacturing defect, use of excessive pressure on the CVAD when flushing, clearing an occlusion or during removal, piercing the catheter of an implanted port with the access needle, mechanical stress as occurs with pinch-off syndrome, or accidental slicing of the catheter with scissors or scalpel.[54]

The CVAD catheter tip and length should be assessed after removal, comparing the removed length to the inserted length for damage and possible fragmentation.[26] If damage is seen or suspected, a chest radiograph or further evaluation may be warranted.[26] Catheter embolism should be suspected in patients displaying symptoms of air embolism, such as palpitations, arrhythmias, dyspnoea, cough, or new thoracic pain not associated with the patient's presentation.[26] Local emergency procedures should be activated to seek further assistance in managing the patient.

Incident reporting

Adverse incidents relating to the removal of a CVAD must be documented in the patient's progress notes and entered into the incident management system (IMS+). This should occur on the same day the incident occurs, or as soon as practically possible.[54]

Table 36: Recommendation summary table – complications and escalation

Recommendation	Source
Catheter tip and length should be examined upon device removal and compared to insertion documentation.	CEC. 2015[2]
Documentation of an adverse incident should be made into the incident management system (IMS+) on the same day, or as soon as possible.	CEC. 2020[54]

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Glossary

ABHR	Alcohol based hand rub
ACSQHC	Australian Commission on Safety and Quality in Health Care
ANTT	Aseptic non-touch technique
CDC	Centers for Disease Prevention and Control
CEC	Clinical Excellence Commission
CLABSI	Central line associated blood stream infection
CVAD	Central venous access devices
CVC	Central venous catheter
DEHP	Di-ethylhexyl-phthalate
DVT	Deep vein thrombosis
ECG	Electrocardiogram
ESD	Engineered stabilisation devices
ICU	Intensive care unit
ICNSW	Intensive Care New South Wales
IMS+	Incident management system
IV	Intravenous
MARSI	Medical adhesive-related skin injury
NHMRC	National Health and Medical Research Council
NICE	National Institute for Health and Care Excellence
PICC	Peripherally inserted central catheter
PPE	Personal protective equipment
RaCeVA	Rapid assessment of the central veins
TSM	Transparent semipermeable membrane

Acknowledgements

This clinical practice guideline has been developed by a specialist working group. Intensive Care NSW (ICNSW) wishes to thank all clinicians involved for their time, expertise and knowledge sharing.

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