ACI NSW Agency for Clinical Innovation

ICCMU Intensive Care Coordination & Monitoring Unit

IC Manual
best practice guidelines for intensive care

Central Venous Access Device Post Insertion Management

Guideline provenance

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Executive authorisation	Dr Nigel Lyons CE ACI
Primary author	Marghie Murgo
Guideline development network members	Vascular Access Specialists Tim Spencer CNC Evan Alexandrou CNS Therese Hallett NUM Irena Martinich CNC Julianne Denham Intensive Care Specialists Jeff Breeding CNC Bernie Baliotis CNE Michelle Copede Guihermino Maree Frogley CNE Rachel Whyte Billian Ray-Barruel Prof Claire Rickard
ICCMU Director	Dr Sean Kelly
Project Manager	Kaye Rolls, RN ACC BAppSc(Syd) ICCMU & ACI
Project Officer	Janet Masters, RN Crit Care Cert BHSc(Nur) MN – ICCMU & NaMO
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Disclaimer

- This clinical practice guideline (CPG) is aimed at providing clinicians working in NSW hospitals' intensive care units (ICU) with recommendations to frame the development of policies and procedures related to the CVAD management practices in adult ICUs.
- This CPG is a revision of 2007 CVAD management guideline and includes: 1) an update of the evidence base; 2) an evaluation of how this literature applies to the NSW intensive care context; 3) the extensive clinical knowledge of the guideline development network members (GDN); and 4) a consensus development process.
- The CPG is not intended to replace the critical evaluation processes that underpin the development of local policy and procedure nor does it replace a clinician's judgment in an individual case.
- Users of this CPG must critically evaluate this CPG as it relates to local circumstances and any changes in the literature that may have occurred since the dates of the literature review conducted. In addition, NSW Health clinicians must review NSW State Government policy documents to identify any directives that may relate to this clinical practice.
- These guidelines are intended for use in NSW acute care facilities.
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AGENCY FOR CLINICAL INNOVATION
Level 4, Sage Building
67 Albert Avenue, Chatswood NSW 2067

Agency for Clinical Innovation
PO Box 699 Chatswood NSW 2057
T +61 2 9464 4666 | F +61 2 9464 4728

E info@aci.nsw.gov.au | www.aci.health.nsw.gov.au

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FOREWORD

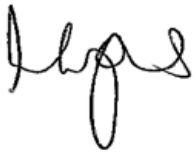
Insertion of a central venous access device (CVAD) is a common hospital procedure with an estimated 15,000 devices inserted in NSW Intensive Care Units every year.

Despite being a common procedure it is not one without significant risks which include risks in the insertion of the devices and those associated with having a CVAD in situ either short or long term. These risks can include infection, malposition, pneumothorax, thrombosis, vascular injury and air embolus.

The purpose of this guideline is to provide intensive care clinicians with best practice recommendations so that the evidence-based treatment and care can be delivered and patients can receive the therapy they need.

Developed under the auspices of the Intensive Care Best Practice Manual Project, this guideline highlights the ability of the Agency for Clinical Innovation (ACI) to facilitate strong working relationships with clinicians as well other executive branches of the Ministry.

On behalf of the ACI, I would like to thank Susan Pearce, Chief Nursing and Midwifery Officer for providing state executive sponsorship for the project and funds for the Project Officer. I would also like to extend my appreciation to the LHD executives for facilitating the participation of LHD staff in developing these guidelines, which I commend to you the clinicians of NSW.



Dr Nigel Lyons
Chief Executive, Agency for Clinical Innovation

ABOUT THE ACI

The Agency for Clinical Innovation (ACI) works with clinicians, consumers and managers to design and promote better healthcare for NSW. It does this by:

- Service redesign and evaluation – applying redesign methodology to assist healthcare providers and consumers to review and improve the quality, effectiveness and efficiency of services.
- Specialist advice on healthcare innovation – advising on the development, evaluation and adoption of healthcare innovations from optimal use through to disinvestment.
- Initiatives including Guidelines and Models of Care – developing a range of evidence-based healthcare improvement initiatives to benefit the NSW health system.
- Implementation support – working with ACI Networks, consumers and healthcare providers to assist delivery of healthcare innovations into practice across metropolitan and rural NSW.
- Knowledge sharing – partnering with healthcare providers to support collaboration, learning capability and knowledge sharing on healthcare innovation and improvement.
- Continuous capability building – working with healthcare providers to build capability in redesign, project management and change management through the Centre for Healthcare Redesign.

ACI Clinical Networks, Taskforces and Institutes provide a unique forum for people to collaborate across clinical specialties and regional and service boundaries to develop successful healthcare innovations.

A priority for the ACI is identifying unwarranted variation in clinical practice and working in partnership with healthcare providers to develop mechanisms to improve clinical practice and patient care.

Table 1: Guideline development network members

GUIDELINE MANAGEMENT TEAM		
Professor Claire Rickard	Academic Mentor	Griffith University
Marghie Murgo, Clinical Nurse Consultant Intensive Care Service	Chair	Royal Prince Alfred Hospital
Tim Spencer, Clinical Nurse Consultant Central Venous Access & Parenteral Nutrition Service	Co-chair Practice	Liverpool Hospital
Jeff Breeding, Clinical Nurse Consultant Intensive Care Services	Co-chair Evidence	St Vincent's Health Network
Evan Alexandrou CNS Lecturer	Member	Liverpool Hospital University of Western Sydney
Bernie Baliotis, Clinical Nurse Educator Critical Care Unit	Member	Canterbury Hospital
Michelle Copede Guilhermino	Member	John Hunter Hospital
Julianne Denham	Member	
Maree Frogley, Clinical Nurse Educator Intensive Care Unit	Member	Lismore Base Hospital
Therese Hallett, Nurse Unit Manager Vascular Access Team/ Ambulatory Care Unit	Member	Gosford Hospital
Irena Martincich, Clinical Nurse Consultant Nutritional Support	Member	St George Hospital
Angela Phillips, Acting Clinical Nurse Educator	Member	Wyong Hospital
Gillian Ray-Barruel, Senior Research Assistant	Member	Griffith Health Institute Centre for Health Practice Innovation
Penny Tudberry	Member	Bankstown Hospital
Rachel Whyte	Member	Canberra Hospital
Amanda Mathes	Member	
Dr Jon Gatward, Staff Specialist Intensive Care Service	Internal consensus panel member	Royal Prince Alfred Hospital
Jo Talon, Clinical Nurse Consultant Infection Control	Internal consensus panel member	Westmead Hospital

All members completed a 'declaration of Interest' form based on NHMRC guidelines. While several members have received payments for presentations they conducted, no product endorsements relevant to the guidelines have been identified and therefore no conflict of interests have been raised.

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SAFETY ALERT

1. EXECUTIVE SUMMARY

This Guideline has been developed for clinicians practising in NSW Intensive Care Units (ICU). This review was undertaken by a representative group (Guideline Development Network or GDN) of NSW Clinicians with expertise in ICU and/or CVAD management as part of a joint project between the NSW Intensive Care Coordination and Monitoring Unit (ICCMU) and the Nursing and Midwifery Office (NAMO). The GDN sought to answer the question:

"*What nursing interventions can reduce the risk of device failure (i.e. bacteraemia/bloodstream infection, local infection, blockage, accidental removal or dislodgement, thrombosis, phlebitis) and reduce costs while improving satisfaction for patients with a CVAD?*"

To answer these questions 45 randomised controlled trials or systematic reviews and 14 guideline documents were reviewed. Additionally, a number of clinicians were surveyed. As a result 50 recommendations for practice were generated and these recommendations have been classified into Assessment; Interventions; Infection prevention and Governance as set out in the table below.

SECTION	RECOMMENDATION	GOR
	Assessment	
1	The nurse must systematically assess the CVAD each shift covering the following elements: i. dressing ii. securement iii. integrity of CVAD iv. labelling of administration sets and infusion therapies **The findings must be documented in the clinical record.**	Consensus
	Interventions: Securement	
2.	Appropriate securement techniques include suturing of the CVAD with monofilament non-graded nylon or the use of sutureless securement devices [1-3].	Grade B
3.	The CVAD must be secured at the insertion site and also at the anchor point (if present).	Consensus
4.	The securement of the CVAD must be assessed at least once per shift and more frequently if required.	Consensus
5.	Sutureless securement devices should be changed when the dressing is changed or if loose or soiled.	Consensus
6.	Peripherally Inserted Central Catheters (PICC) are to be secured by sutureless fixation devices [3].	Grade B
7.	The weight of administration sets must be supported with additional fixation to reduce the risk of unplanned dislodgement of the CVAD.	Consensus

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SECTION	RECOMMENDATION	GOR
	Interventions: Antiseptic solution and cleaning of skin and catheter	
8.	• Single use 2% chlorhexidine gluconate in 70% isopropyl alcohol solution is the preferred antiseptic agent for insertion and dressing of CVADs [4-6]. • If this is not available, chlorhexidine 0.5% in 70% alcohol or iodine in alcohol should be used [7-12]. • Solutions must not be decanted into smaller containers and unused portions must be discarded. • Where a patient demonstrates chlorhexidine sensitivity, topical povidone iodine 10% in 70% alcohol may be used.	NSW Policy
9.	Avoid organic solvents (e.g., acetone, ether or adhesive remover wipes on the CVC or surrounding skin. [12, 13].	Grade B
10.	Prior to cleaning with chlorhexidine in alcohol, Sterile 0.9% saline is to be used to remove dried blood and/or other fluids from around the catheter and under the securement hub.	Consensus
	Interventions: Dressing of CVAD and insertion site	
11.	A sterile transparent semi-permeable dressing or sterile gauze and hypoallergenic tape must be used to cover the CVC insertion site. An alternative dressing must be used if allergy is suspected [12, 14] (PD2010_036).	Grade B
12.	Regardless of the dressing type used for the CVAD, the dressing should: a. be positioned so the catheter insertion site is in the centre of the dressing b. cover the catheter from the insertion site and the first securement c. create a complete seal from the securement through to the insertion site.	Consensus
13.	Transparent dressings must be changed every seven days or sooner if [12, 15-18]: a. the dressing is not intact (i.e. there is no longer a seal) b. there is evidence of inflammation c. there is excessive accumulation of blood and/or moisture under the dressing.	Grade A
14.	Sterile gauze and hypoallergenic tape dressing is preferable to a transparent dressing if the patient is diaphoretic or if the site is bleeding or oozing [12, 19]. • If a patient is oozing post insertion (e.g. thrombocytopaenic), use a sterile gauze square on top of the insertion site and cover with semi-permeable dressing. • Consider use of a calcium alginate fibre dressing to achieve haemostasis if oozing is problematic.	Consensus
15.	Sterile gauze and hypoallergenic tape dressing should be changed every 48 hours and whenever loose, soiled or moist.	Grade B
16.	A chlorhexidine impregnated sponge must be placed around the catheter at the insertion site after insertion. It should be replaced at each dressing change [20-25].	Grade A

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SECTION	RECOMMENDATION	GOR
	Interventions: Fluid and drug administration	
17.	Ensure drugs are compatible when administering multiple intravenous (IV) medications via the CVAD lumen. Refer to drug resources such as Micromedex or the institutional pharmacist.	Consensus
18.	Crystalloid solutions without drug additives (e.g. 0.9% saline) should only be changed when the administration set is changed, when the catheter is changed and or when the infusion is complete.	Consensus
19.	All blood products should be infused as per the National Blood Authority Australia Patient Blood Management Guidelines	National Guidelines
	Interventions: Accessing connectors	
20.	Catheter hubs (including needleless injection sites and blood sampling ports) must be vigorously cleaned with alcohol chlorhexidine swabs before and after use to ensure removal of microorganisms and particulate matter. The solution must be allowed to dry naturally prior to accessing the device i.e. scrub the hub.	Grade A
21.	When an unused lumen is accessed to administer a medication or commence an infusion, a small volume of blood should be gently aspirated and discarded and the lumen flushed with 10mL 0.9% saline prior to medication administration or fluid commencement [26].	Consensus
	Interventions: Intravenous administration sets	
22.	Intravenous administration sets attached to a CVAD must be attached to the patient so that no tension is applied to the catheter to reduce risk of dislodgement.	Consensus
23.	Administration sets (burettes, administration sets, multi-flow adapters, caps, connectors, extension devices) that are attached to antimicrobial or antibiotic-coated multi-lumen CVAD should be changed either after seven days or when clinically indicated (e.g. precipitate, particulate matter, blood in administration set, faulty set), or when the catheter is changed [27]. This excludes blood products and lipids.	Grade B
24.	Administration sets (burettes, infusion sets, multi-flow adapters, caps, connectors, extension devices) attached to standard CVADs should be changed either after 96 hours, or when clinically indicated (e.g. precipitate, particulate matter or blood in apparent in the administration set or the set is faulty), or when the catheter is changed. This excludes blood products and lipids [12, 28-30].	Grade B
25.	Administration sets for lipid-based emulsions should be changed within 24 hours of starting the infusion or as recommended by the manufacturer.	Grade A
	Interventions: Adjuncts to IV administration sets	
26.	Needleless connectors that can be disinfected or decontaminated are to be placed on each lumen of a CVAD [26, 31-36].	Grade A
27.	Multi-flow adaptors and three-way taps and connectors are to be changed when the administration set is changed [26].	Consensus
28.	Clamps should be engaged (when in situ) on the device's lumen when disconnecting the administration set from the lumen. This is to prevent complications such as air embolus, bleeding or inadvertent drug or fluid bolus administration.	Consensus
29.	Avoid administration set disconnections. If an administration set is disconnected it must be discarded and a new set used.	Consensus

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SECTION	RECOMMENDATION	GOR
	Interventions: Fluid and drug administration	
30.	How frequently a CVAD lumen should be flushed to maintain lumen patency remains unclear. It is suggested that a CVAD lumen that is used intermittently should be flushed no more frequently than every eight hours.	Consensus
31.	The recommended solution for flushing a CVAD lumen is 0.9% saline [37-41].	Grade B
32.	To reduce the risk of thrombosis and intraluminal occlusion in large bore catheter lumens (e.g. dialysis catheters), an anticoagulant lock may be used when the lumen is not in use [38, 39, 42].	Consensus
33.	Unused lumens are to be managed to prevent air emboli and backflow of blood, protein or lipid solutions depending on the connector used. Refer to **Table 4**.	Consensus
34.	It is recommended that syringes with a capacity of ≥ 10mL be used to access a CVAD for flushing. Smaller syringes exert higher pressure and may cause possible catheter rupture or dislodged an occlusion if excessive force is used.	Consensus
35.	When flushing a CVAD lumen use a pulsatile positive pressure flushing technique to create turbulence within the device lumen.	Grade B
36.	If attempting to flush a CVAD lumen due to a blockage, force should never be used because of the risk of catheter rupture.	Consensus
37.	Use of a solution other than 0.9% saline to unblock a CVAD lumen has been shown to be effective in restoring lumen patency. Use of agents such as urokinase and alteplase require a medical prescription and must be discussed with the Medical Officer or a Vascular Access specialist/team before use [43, 44].	Grade B
	Interventions: Removal	
38.	When removing a CVAD the patient should be placed in bed in a supine position [5]. Prior to repositioning the patient following removal of a CVAD, ensure the dressing is airtight and occlusive.	Consensus
39.	Removal of a CVAD should be timed to occur at end inspiration or during expiration for patients who are not on a ventilator.	Consensus
40.	Following CVAD removal pressure must be applied with sterile gauze until haemostasis is achieved. The insertion site must be sealed immediately using an airtight occlusive dressing. This dressing is to remain intact and insitu for 48 hours to reduce the risk of late air embolism.	Consensus
41.	Routine collection of the CVAD tip is not required when removing the device. If a CRSBI is suspected the medical team may request that the tip is sent for microbiological examination and a blood culture collected from a peripheral vein within 4 hours of CVAD removal [45].	Consensus
42.	Removal of the CVAD must be documented in the clinical record. The documentation must include: • visual inspection and description of the integrity of the CVAD • whether the CVAD tip was collected and sent to pathology • the condition of the CVAD insertion site.	NSW Policy
43.	Following removal of a CVAD the condition of the site must be monitored at 24 and 48 hours at a minimum. This must be documented in the clinical record.	Consensus

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SECTION	RECOMMENDATION	GOR
	Infection prevention	
44.	Clinicians must adhere to the Five Moments of Hand Hygiene.	Hand hygiene Policy
45.	Clinicians are to evaluate the risk of body fluid exposure and cross contamination risk when caring for a patient with a CVAD. PPE, including goggles/face shield, gloves and gown/apron as per the NSW 2007 Infection prevention and control policy, should be worn accordingly.	National Guidelines and NSW Policy
46.	Aseptic non-touch technique must be used when attending to CVAD dressings, administration set changes and any intervention that involves accessing the CVAD [12, 46, 47].	Grade A
47.	CVAD management is provided by nursing staff that are proficient in this activity and/or by nursing staff under the direct supervision of nursing staff that are proficient as per institutional policy [12, 26, 48].	Consensus
48.	To prevent errors or breaches of asepsis, administration set and dressing changes should be performed when the clinician is unlikely to be interrupted.	Consensus
49.	Infusions on each lumen of the CVAD are to be labelled as per the National Recommendations for User-applied Labelling of Injectable Medicines, Fluids and Lines	National Guidelines and NSW Policy
50.	Evaluation of patient outcomes in relation to device failure include: i. surveillance of CRBSI ii. unintended removal and other complications as reported in the institutional incident management system iii. audits of clinical practice	National Guidelines and NSW Policy

2. INTRODUCTION

Health question/s at focus of clinical practice

"What nursing interventions can reduce the risk of device failure (i.e. bacteraemia/bloodstream infection, local infection, blockage, accidental removal or dislodgement, thrombosis, phlebitis), reduce costs and improve satisfaction for patients with a CVAD?"

Target clinicians

This guideline is aimed at clinicians who care for adults across acute care hospitals in NSW. Specifically, it refers to nursing staff as this clinical practice falls within the nursing staff scope of practice. Medical Officers were consulted and included during consensus development.

Scope

For the purposes of this document a central venous access device (CVAD) refers to a temporary intravascular catheter for infusing drugs, fluids and delivering nutrition. In addition, CVADs are also used for taking blood samples, haemodynamic monitoring and for renal replacement therapies. It includes central venous catheters (CVC) and peripherally inserted central catheters (PICC). For the purposes of this guideline long-term devices (e.g. tunnelled and implantable ports) are excluded.

How the guideline was developed

The guideline development methods were based on Rolls and Elliott [49], which was revised to reflect updates from NHMRC [50] and the AGREE tool [51]. A guideline development network (GDN) was formed. This network developed the guideline template that outlined the clinical question and specific areas to be addressed within the guideline. Following this process a systematic review was undertaken. A technical report was developed from the systematic review and this document was used to inform discussions and recommendation development at a consensus meeting in November 2012. A practice review of clinicians subscribed to the Listserv Icuconnect was undertaken in February 2013 to assess compliance issues with the draft recommendations. Following the meeting the guideline document was written and circulated among group members. Consensus development and organisational consultation was undertaken over three stages:

i. Guideline group consensus: the guideline group received the guideline and technical report. Agreement on recommendations was undertaken using an online survey (Survey monkey) and a 1-9 Likert scale. Consensus was set as a median of ≥ 7. (See **Table 6** GDN and EVP consensus results)

ii. External validation consensus: another clinician group was recruited from NSW and their agreement with the recommendation statements was sought using the processes outlined above. (See **Table 6** GDN and EVP consensus results)

iii. Organisational consultation was undertaken by distribution via ACI networks

iv. Following each stage the guideline was revised to reflect the feedback received.

Guideline group

The GDN was comprised of senior nurses working in NSW intensive care units (ICU), nurses working in connection with vascular access teams and a nursing academic. This group undertook the bulk of work for the guideline and are listed in **Table 1**. Additional members including a doctor and infection control nurse were co-opted for internal consensus and the external consensus panel is listed in Table 5. It includes a mixture of vascular access nurses, intensive care nurses doctors and an infection control nurse.

Consumer consultation

We were unable to recruit a consumer to participate as part of the guideline group or to review the guideline.

Table 2: Grading of recommendations

GRADE OF RECOMMENDATION	DESCRIPTION
A	Body of evidence can be trusted to guide practice
B	Body of evidence can be trusted to guide practice in most situations
C	Body of evidence provides some support for recommendation/s but care should be taken in its application
D	Body of evidence is weak and recommendation must be applied with caution
Consensus	Consensus was set as a median of ≥ 7
Grades A–D are based on NHMRC grades [52]	

Evidence review

A systematic literature review was undertaken using the following clinical question: "*What nursing interventions can reduce the risk of catheter failure (i.e. bacteraemia/ bloodstream infection, local infection, blockage, accidental removal or dislodgement, thrombosis, phlebitis), reduce costs and improve satisfaction for patients with a CVAD?*"

The systematic review revealed that the evidence base for CVAD management following insertion in adults is incomplete. The previous guideline recommendations were reviewed with many remaining unchanged or minor wording adjustments applied. Several recommendations were added as a result of discussions about issues raised by the group or by stakeholders in other NSW Health organisations.

The most common problem with the papers included in this review was the inadequate sample sizes used in studies to test 'cause and effect' relationships. As a result some of the evidence had a high risk of bias. Due to the nature of the interventions, some papers with a moderate risk of bias have been included to inform the recommendation statements. Many of the recommendations related to asepsis and decontamination have been set out by state policies and are similar to many of the guidelines from around the world. The consensus recommendations were produced as a result of multiple discussions and recognised contentious practice issues. A number of practice points have also been added. The evidence review results can be found in **section 4** (p25)

Level of evidence taxonomy

NHMRC procedures and taxonomy were used (See , **Appendix 1**, **Appendix 2**). Where research evidence could not be identified participants' expert opinion was used with agreement methods applied.

Inclusion criteria

- Randomise Controlled Trials or systematic reviews
- All CVADs (including short and long term, peripherally inserted central catheters (PICCs), haemodialysis catheters, ECMO cannula, pulmonary artery catheters)
- Nursing interventions (post-insertion)
- Published 2000–2012
- English language

Exclusion criteria

- Neonates
- Choice of catheter type (e.g. antibiotic-coated)
- Insertion techniques

Search strategy

An electronic search of the Cochrane Library, Ovid MEDLINE, and EBSCO CINAHL from January 2000 until May 2012 was undertaken using multiple search terms related to CVADs. Additional limits included: human studies, peer-reviewed and abstract available. There were 791 references initially identified. After review of the title and abstract, 682 were excluded. 109 references were retrieved as the full text article and reviewed, after which 64 were excluded. Forty five articles met the inclusion criteria and were reviewed by two guideline group members using a standardised data extraction tool with quality assessment (see technical report for further details). Any additional materials identified by group members during the process were also reviewed. Sixteen guidelines were reviewed by three reviewers.

Glossary

BSI ..... Blood stream infection

CDC ..... Centers for Disease Control (United States)

CI ..... Confidence interval

CNC ..... Clinical nurse consultant

CNS ..... Clinical nurse specialist

CONSORT ..... Consolidated Standards of Reporting Trials

CPG ..... Clinical practice guideline

CVAD ..... Central venous access device

CLBSI ..... Central line related blood stream infection

ECMO ..... Extracorporeal membrane oxygenation

EPIC ..... Evidence-based practice for infection control

EVP ..... External validation panel

GCS ..... Glasgow Coma Scale

GDN ..... Guideline development network

GOR ..... Grading of recommendations

HDU ..... High dependency unit

HICPAC ..... Healthcare Infection Control Practice Advisory Committee
United States broad-based consultative committee

ICCMU ..... NSW Intensive Care Coordination and Monitoring Unit

ICU ..... Intensive care unit

Intensive care ..... This description includes all adult critical care units in NSW which admit both high dependency and intensive care patients.

NHMRC ..... National Health and Medical Research Council

OR ..... Odds ratio

PICC ..... Peripherally inserted central catheters

PICO ..... Population intervention comparison outcome

RCT ..... Randomised control trial

RR ..... Relative risk

SIRS ..... Systemic inflammatory response syndrome

SR ..... Systematic review

3. RECOMMENDATIONS FOR PRACTICE

Insertion of a central venous access device (CVAD) is a common hospital procedure and an estimated 15,000 devices are inserted in NSW ICUs every year [53]. It is unclear how many CVADs are inserted in patients presenting to acute care facilities. Most commonly CVADs are inserted into the internal jugular, subclavian or femoral vein. A peripherally inserted device may be inserted via the cephalic or basilic vein. Insertion of a CVAD is not risk free for patients. Factors such as the inexperience of proceduralists, multiple needle passes, high or low body mass index, previous catheterisations, and severe dehydration or hypovolaemia increase the risks of complications associated with the procedure. Additionally, uncorrected coagulopathy and insertion of large bore devices place the patient at further risk for complications. Other major risks associated with CVAD insertion include infection, malposition, pneumothorax, thrombosis, vascular injury and air embolus [54].

The most frequent complication of post insertion care is infection and a large project to standardise aseptic insertion found the NSW ICU incidence reported at 1.2/1000 patient line days [53]. Most infections are attributed to contamination from the insertion site or the catheter hub. Infection risk increases the longer a device is left in situ [55] and is perpetuated by biofilm formation, therefore many of the suggested management strategies in this document are in place to reduce infective risk.

Thrombosis is also a frequent occurrence with minimal clinical symptoms. There are many reasons for thrombosed CVADs including, but not limited to, endothelial injury, turbulence of the venous circulation, the catheter itself and the composition of the infusions delivered [54]. A fibrin sheath usually develops soon after CVAD insertion, which contributes to catheter occlusion and may lead to vessel stenosis. For this reason there are a number of recommendations relating to maintaining lumen patency and while there is increasing interest in restoring patency through infusion of fibrinolytic agents, this guideline includes no specific recommendations related to that practice. Removal of CVADs has been highlighted due to the number of occurrences of air embolus in patients in NSW. This is a severe complication with an associated high morbidity and mortality. Air embolism may also occur with accidental hub disconnection or through a residual catheter track. For this reason there are a number of recommendations specific to CVAD removal.

The recommendation statements have been divided into the following sections: Assessment; Interventions; Infection prevention; Governance. There are 50 recommendations with varying levels of evidence.

Assessment

SECTION	RECOMMENDATION	GOR
	Assessment	
1	The nurse must systematically assess the CVAD each shift covering the following elements: i. dressing ii. securement iii. integrity of CVAD iv. labelling of administration sets and infusion therapies **The findings must be documented in the clinical record.**	Consensus

Staff should undertake regular assessment and monitoring of these devices for signs of inflammation and infection. Catheter patency should also be evaluated to assess thrombotic risk. **Table 3** provides guidelines for performing a CVAD assessment with the goal and suggested strategies for when there are abnormal findings.

Table 3: How to assess a CVAD

	Goal/elements	Abnormal findings	Potential actions
CVAD site	Clean site free from abnormalities	Pain, induration, redness, swelling, tenderness, fever, chills, leakage or exudate are evident.	Abnormal findings must be reported to medical staff and documented in the patient's clinical record.
Integrity of CVAD device	Catheter integrity maintained	Leakage from catheter or around site is detected.	Assess catheter for damage and check connections for tightness and fit.
	Optimum catheter tip placement	• Ensure tip position has been confirmed. • Measurement of external portion of catheter is monitored for change or migration.	Change in external catheter measurement must be reported to medical officer and documented in patients clinical notes.
	All lumens of the catheter are patent and located within the vessel.	• The catheter has migrated from the initial documented position. • Blood is unable to be gently aspirated from unused lumen. • Infusions are unable to be administered through the lumen. There are occlusion alarms unrelated to the administration set or it cannot be flushed.	Discuss options to restore lumen patency with a medical officer.
Dressing	Clean and intact	Dressing is not intact or the dressing is soiled..	Redress site.
	Covers insertion point and catheter to securement junction.	Dressing does not cover sufficient area.	
Securement	Catheter • sutures are intact or sutureless fixation device is well secured to skin.	Non-intact sutures and/or sutureless fixation device is not well adhered to skin.	Replace with sutureless fixation device and redress.
	IV administration sets are secured to patient to prevent tension on catheter.	• Presence of strain or tension on catheter or administration sets • Catheter has migrated from documented position	Apply additional fixation to anchor IV administration sets to patient

Practice point 1: How to perform an assessment

- The frequency of the assessment will be determined by the patient's condition and individual institutional policy.
- Always attend to hand hygiene and wear clean gloves.
- Check flasks, medicines, connections to administration set and all Luer connections to the CVAD.
- Check for labelling as per National Recommendations for User-applied Labelling of Injectable Medicines, Fluids and Lines 2012 [56].
- Visually inspect and palpate the insertion site and surrounding area.
- Assess for swelling, heat, pain, tenderness or exudate.
- Observe CVAD site for redness, induration, integrity of sutures or sutureless securement device and dressing.
- Ensure all lumen of the CVAD are in working order. Assess patency including aspiration of blood and 0.9% saline flush of unused lumens. When an anticoagulant lock is in place the lumen should be appropriately labelled.
- Measure the external portion of the CVAD from insertion at skin to the last visible marking on catheter and check against insertion documentation. Document in the clinical record and notify the medical officer if there has been a change from original measurement.

Interventions

Securement

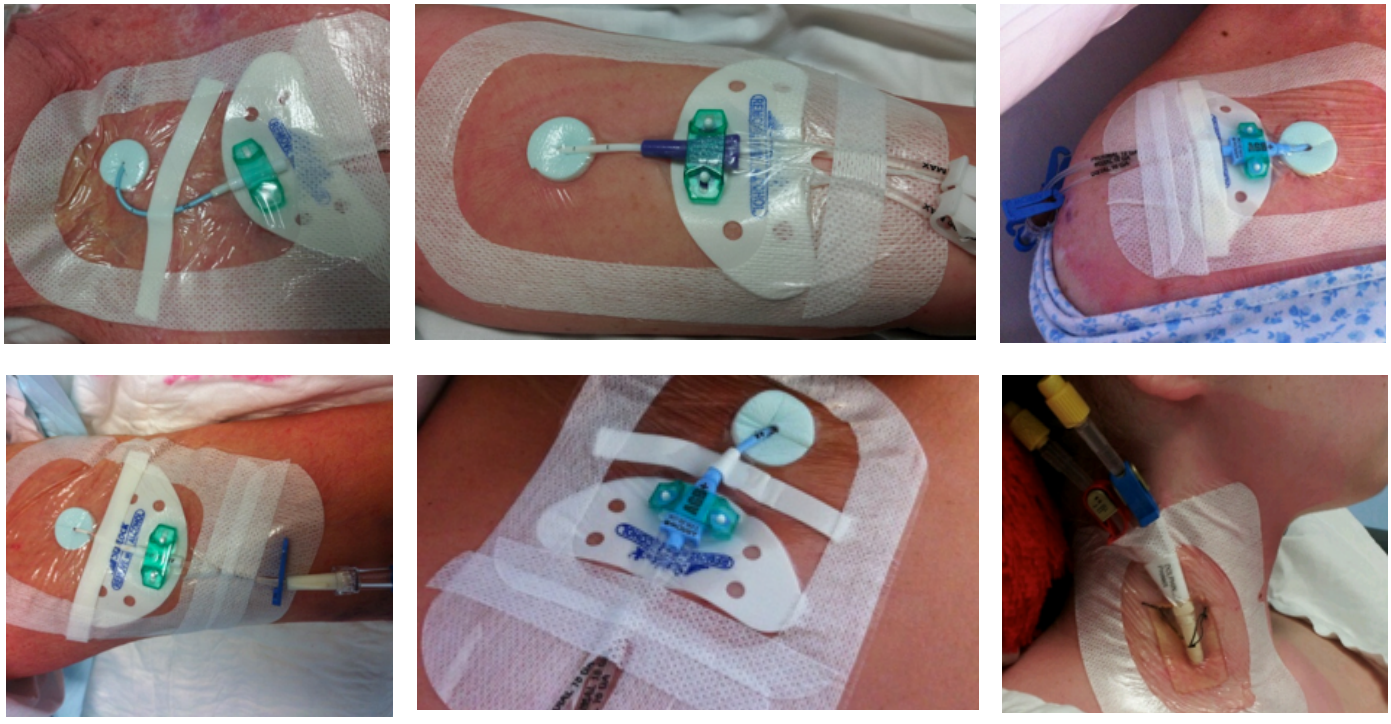
SECTION	RECOMMENDATION	GOR
	Interventions: Securement	
2.	Appropriate securement techniques include suturing of the CVAD with monofilament non-graded nylon or the use of sutureless securement devices [1-3].	Grade B
3.	The CVAD must be secured at the insertion site and also at the anchor point (if present).	Consensus
4.	The securement of the CVAD must be assessed at least once per shift and more frequently if required.	Consensus
5.	Sutureless securement devices should be changed when the dressing is changed or if loose or soiled.	Consensus
6.	Peripherally Inserted Central Catheters (PICC) are to be secured by sutureless fixation devices [3].	Grade B
7.	The weight of administration sets must be supported with additional fixation to reduce the risk of unplanned dislodgement of the CVAD.	Consensus

Securement of the CVAD is important to safely provide intravenous therapies to patients. Securement prevents migration of the catheter in or out of the entry site, which in turn reduces infective and thrombotic risk, and ensures that therapy is delivered into the venous circulation. It is important that the weight of multiple infusions is supported so that tension is not applied to the catheter and insertion site. In a review of the NSW CVAD ICU data the most common complication associated with CVADs was unplanned removal, which accounted for 23% of incidents. The GDN found this data surprising and unacceptable. Inadequate fixation by suture or fixation device was often identified as the major contributing factor. Practice is clearly variable among specialties as the issue was not limited to devices inserted in the ICU. Other than fixation concerns, factors influencing unplanned removal included patient transfer or movement, patient confusion or aggression and limited supervision due to staff shortage or multiple patient allocations. The GDN considered sutureless fixation devices preferable in practice due to the invasive nature and added infection risk of sutures, however, current practice and evidence suggests that either sutures or sutureless fixation devices are acceptable. In a small RCT, sutureless fixation devices were compared to suturing of cuffed tunnelled dialysis catheters with low complication rate of 8.3% versus 13.9% in the control group [2]. In another RCT of suturing versus sutureless fixation device there were fewer complications (42 vs. 61) with less infections and reduced risk to staff from needle stick injury [3] in the intervention group, but this was not statistically significant. Tape alone is insufficient for catheter securement. Graf [1] compared tape and sutures in the paediatric population. The tape intervention group had a significantly higher complication rate (5.8% vs. 32.4%) mostly due to catheter migration, thrombosis and leakage.

Securement techniques vary (see **Figure 1**) and NSW Health Central Venous Access Device Insertion and Post Insertion Care PD 2011_060 sets out the requirement that:

"The CVAD must be secured at the skin insertion point by catheter clamp or direct suturing and at the anchor point (if present) by suture or sutureless fixation device (to prevent catheter migration)."

Figure 1: Securement of CVADs



Antiseptic solution and cleaning of the skin and catheter

SECTION	RECOMMENDATION	GOR
Interventions: Antiseptic solution and cleaning of skin and catheter		
8.	• Single use 2% chlorhexidine gluconate in 70% isopropyl alcohol solution is the preferred antiseptic agent for insertion and dressing of CVADs [4-6], • If this is not available, chlorhexidine 0.5% in 70% alcohol or iodine in alcohol should be used [7-12]. • Solutions must not be decanted into smaller containers and unused portions must be discarded. • Where a patient demonstrates chlorhexidine sensitivity, topical povidone iodine 10% in 70% alcohol may be used.	NSW Policy
9.	Avoid organic solvents (e.g., acetone, ether or adhesive remover wipes on the CVC or surrounding skin. [12, 13].	Grade B
10.	Prior to cleaning with chlorhexidine in alcohol, Sterile 0.9% saline is to be used to remove dried blood and/or other fluids from around the catheter and under the securement hub.	Consensus

Based on available evidence alcohol-containing antiseptics, particularly those with chlorhexidine, are recommended for preparing for CVAD interventions as they are associated with a significantly lower risk of CRBSI compared with the use of aqueous solutions. The concentration of chlorhexidine in relation to infection is currently being examined in a RCT in Dublin, Ireland. The research findings should be available to inform this recommendation in 2014. The following solutions are recommended in PD 2011_060 in preferential order:

1. Topical chlorhexidine 2% in 70-80% alcohol (lower concentrations of chlorhexidine (0.5-1%) may also be used (e.g. for infants).
2. Topical povidone iodine 10% in 70% alcohol.

Other antiseptic alternatives for use on keratinised skin are inferior to the above products but include:

3. topical chlorhexidine 1-2% in water (aqueous preparation).
4. topical povidone iodine 10% in water.

All solutions must be allowed to dry before CVAD interventions to ensure optimal antimicrobial effect is achieved. Alcohol-based solutions will dry faster. Alcohol has an immediate antiseptic action, whereas chlorhexidine has a residual antimicrobial action for around seven days. Sterile saline or water solutions alone are not acceptable antiseptic solutions and should only be used to clean the skin of gross contaminants prior to applying antiseptic solution.

Safety alert 1: Antiseptic allergy

Before applying any antiseptic agent clinicians must check for the presence of allergies.

Aseptic non-touch technique

There are a number of ways that clinicians refer to and practise in relation to maintaining asepsis when accessing and touching attachments to the CVAD. Aseptic technique aims to prevent pathogenic organisms from being introduced to susceptible sites by hands, surfaces and equipment. Aseptic non-touch technique involves using an aseptic technique while also protecting the CVAD and insertion site by undertaking appropriate hand hygiene, touching the minimum number of parts required to perform an intervention (non-touch technique), using sterile equipment and/or cleaning existing parts so that asepsis is achieved prior to use [57]. Confusion often arises about when sterile gloves should be used during practice. This is clearly identified in the Australian Guidelines for the Prevention and Control of Infection in Healthcare 2010[58] and should be referred to for further information. For more information about Aseptic non-touch technique (ANTT®) refer to the Association for Safe Aseptic Practice at: http://www.antt.org.uk/ANTT_Site/Home.html.

Dressing of CVAD and insertion sites

SECTION	RECOMMENDATION	GOR
	Interventions: Dressing of CVAD and insertion site	
11.	A sterile transparent semi-permeable dressing or sterile gauze and hypoallergenic tape must be used to cover the CVC insertion site. An alternative dressing must be used if allergy is suspected [12, 14] (PD2010_036).	Grade B
12.	Regardless of the dressing type used for the CVAD, the dressing should: a. be positioned so the catheter insertion site is in the centre of the dressing b. cover the catheter from the insertion site and the first securement c. create a complete seal from the securement through to the insertion site.	Consensus
13.	Transparent dressings must be changed every seven days or sooner if [12, 15-18]: a. the dressing is not intact (i.e. there is no longer a seal) b. there is evidence of inflammation c. there is excessive accumulation of blood and/or moisture under the dressing.	Grade A
14.	Sterile gauze and hypoallergenic tape dressing is preferable to a transparent dressing if the patient is diaphoretic or if the site is bleeding or oozing [12, 19]. • If a patient is oozing post insertion (e.g. thrombocytopaenic), use a sterile gauze square on top of the insertion site and cover with semi-permeable dressing. • Consider use of a calcium alginate fibre dressing to achieve haemostasis if oozing is problematic.	Consensus
15.	Sterile gauze and hypoallergenic tape dressing should be changed every 48 hours and whenever loose, soiled or moist.	Grade B
16.	A chlorhexidine impregnated sponge must be placed around the catheter at the insertion site after insertion. It should be replaced at each dressing change [20-25].	Grade A

A Cochrane Review indicated that although current evidence for the choice of dressing is poor and estimates of effect are wide, gauze and tape have a lower risk of a central line associated blood stream infection (CLABSI) Cmpared to transparent semi-permeable membrane dressings.[19] In a secondary analysis of a large RCT, Timsit[59] et al examined the risk of CLABSI related to dressing disruption and found that dressings were often performed before the scheduled time, and there was an increased risk of BSI the more often the dressing was disrupted [60, 59]. The pragmatic approach of the GDN was to consider that the standard practice of using a semi-permeable transparent membrane dressing was supported in favour of gauze and tape dressings until there is stronger evidence available. Semi-permeable transparent membrane dressings are also possibly preferable because the dressing can be used in conjunction with chlorhexidine impregnated sponges.

The use of commercially available Chlorhexidine gluconate (CHG)-impregnated sponge dressings was considered in the 2007 version of the guideline. Since then, there is now substantial support for routine use at the time of insertion and at each dressing change. It was widely supported within the GDN that this practice be recommended in this subsequent version. A study by Timsit [25] found that the use of CHG sponge dressings significantly reduced the incidence of major catheter related infections (CRI) even when baseline rates were already low (<1/1000 catheter days). There was no benefit in changing unsoiled dressings any more frequently then every seven days [60]. Using data from the same study, Schewebel [24] subsequently found that the use of CHG sponges was a more cost effective practice when measured by the reduction in infections (and associated costs), as well as the costs associated with the dressing materials. Levy [22] found the use of CHG sponges decreased catheter colonisation and Ruschulte [23] showed a reduction in documented CRBSI, mainly at the internal jugular vein site. There was some evidence

to support the use of transparent semi-permeable dressings impregnated with chlorhexidine gel but little has been published comparing these with chlorhexidine impregnated sponges, so it is unknown whether these provide equivalent infection prevention effect [61]. Whichever dressing is in use, asepsis must be maintained.

Practice point 2: Dressings

- Refer to the Australian Guidelines for the Prevention and Control of Infection in Healthcare 2010 [58] related to aseptic non-touch technique.
- Clean skin around the insertion site to disinfect the total area covered by the dressing.
- Allow appropriate drying times for the disinfectant applied. For example, the manufacturer recommends the following times for various products:
  - Chlorhexidine/alcohol wipes: approximately 30 seconds
  - Chlorhexidine/alcohol swabsticks and maxi swabsticks: approximately 1 minute
  - Aqueous chlorhexidine swabsticks and Maxi Swabsticks: approximately 2-3 minutes
- Use of single-use adhesive spray/wipe to improve dressing adherence may be considered where needed.

See **Figure 1** for pictures of applied dressings.

Safety alert 2: Application of dressings

Before applying any dressings or tapes clinicians must check for the presence of allergies.

Fluid and drug administration

SECTION	RECOMMENDATION	GOR
	Interventions: Fluid and drug administration	
17.	Ensure drugs are compatible when administering multiple intravenous (IV) medications via the CVAD lumen. Refer to drug resources such as Micromedex or the institutional pharmacist.	Consensus
18.	Crystalloid solutions without drug additives (e.g. 0.9% saline) should only be changed when the administration set is changed, when the catheter is changed and or when the infusion is complete.	Consensus
19.	All blood products should be infused as per the National Blood Authority Australia Patient Blood Management Guidelines	National Guidelines

A large number of medications and fluids are usually administered to critically ill patients via a CVAD. Administration of intravenous medications is governed by policies and procedures to reduce the risk of medication errors. Incompatible medications administered via the same lumen of the CVAD without appropriate flushing of the lumen may lead to deleterious side effects for the patient such as blockage of the CVAD lumen or, more seriously, an embolus of crystallised medication administered when attempting to access the lumen.

Blood and blood products

The NHMRC, the Australian & New Zealand Society of Blood Transfusion (ANZSBT) and the National Blood Authority (NBA) have developed a series of six patient-focused, evidence-based modules that together outline Patient Blood Management Guidelines. The modules include evidence-based recommendations from a systematic review and practice points based on consensus decision making, where the systematic review found insufficient high-quality data to produce evidence-based recommendations. It was the consensus of this GDN that any recommendations from these guidelines relating to practices for post insertion management of CVADs should be adopted. Click the link to access the modules: http://www.nba.gov.au/guidelines/review.html

Accessing connectors

SECTION	RECOMMENDATION	GOR
	Interventions: Accessing connectors	
20.	Catheter hubs (including needleless injection sites and blood sampling ports) must be vigorously cleaned with alcohol chlorhexidine swabs before and after use to ensure removal of microorganisms and particulate matter. The solution must be allowed to dry naturally prior to accessing the device i.e. scrub the hub.	Grade A
21.	When an unused lumen is accessed to administer a medication or commence an infusion, a small volume of blood should be gently aspirated and discarded and the lumen flushed with 10mL 0.9% saline prior to medication administration or fluid commencement [26].	Consensus

Prior to accessing a hub connected to a CVAD, the hub should be cleaned with an appropriate disinfectant to reduce the risk of introducing microorganisms into a sterile site. A CLABSI is a rare but devastating risk for a patient with a CVAD and every effort should be focused on minimising the risk.

Practice point 3: Accessing CVAD

- Perform hand hygiene as per the five moments (moment two).
- Put on clean gloves prior to accessing the device.
- Perform a "hub scrub" using an alcoholic chlorhexidine wipe and friction in a twisting motion on the hub as if you were 'juicing fruit'.
- Infuse medication or draw blood and label as per policy.

See 'Scrub-the-hub' video at the ACI VIMEO channel

Discard gloves and perform hand hygiene (moment three).

Aspirating a small volume of blood and flushing unused lumen ensure that the CVAD is assessed for patency and that no residual product within the lumen of the CVAD is inadvertently administered to the patient. The group felt this was a good patient safety measure. Further, it enables staff to assess that the lumen is in the vessel if blood is able to be aspirated. In some devices (such as catheters inserted to provide renal replacement therapy) it is an essential component of assessment to promote appropriate therapy. However, aspirating and discarding blood through mechanical needleless valves may have the potential to increase risk of infection and luminal occlusion, particularly in smaller bore devices. The practice review indicated that 5mL was the most common volume aspirated by those responders that indicated aspirating formed part of routine practice (n=24/50 aspirate 5mL total responders n=120). The GDN felt this volume was unnecessarily large and the volume of aspirated blood should not exceed the internal lumen volume in order to reduce the risk of induced anaemia. For many CVADs this volume would not be greater than 2mL. In some cases, blood may not be able to be aspirated, which does not exclude use of the device. There are a number of reasons that this may occur.

Intravenous administration sets

SECTION	RECOMMENDATION	GOR
	Interventions: Intravenous administration sets	
22.	Intravenous administration sets attached to a CVAD must be attached to the patient so that no tension is applied to the catheter to reduce risk of dislodgement.	Consensus
23.	Administration sets (burettes, administration sets, multi-flow adapters, caps, connectors, extension devices) that are attached to antimicrobial or antibiotic-coated multi-lumen CVAD should be changed either after seven days or when clinically indicated (e.g. precipitate, particulate matter, blood in administration set, faulty set), or when the catheter is changed [27]. This excludes blood products and lipids.	Grade B
24.	Administration sets (burettes, infusion sets, multi-flow adapters, caps, connectors, extension devices) attached to standard CVADs should be changed either after 96 hours, or when clinically indicated (e.g. precipitate, particulate matter or blood in apparent in the administration set or the set is faulty), or when the catheter is changed. This excludes blood products and lipids [12, 28-30].	Grade B
25.	Administration sets for lipid-based emulsions should be changed within 24 hours of starting the infusion or as recommended by the manufacturer.	Grade A

A number of potential problems can occur if tension is applied to the intravenous administration sets attached to a CVAD. These include: 1) pain and discomfort for the patient; 2) partial or total catheter dislodgment resulting in failure to administer intended therapies and/or need for catheter replacement; 3) the risk of extravasation injury with extra luminal infusion; and 4) lifting of the dressing which creates an entry point for organisms. For these reasons the GDN members felt that it is important that the administration sets are also secured to the patient and not the bed or the patient's clothing.

Administration sets

The relevant research informing practice in relation to administration set changes was included in the 2007 version of the ICCMU CVAD guideline and these recommendations remain unchanged. However the practice review in NSW indicated that despite the introduction of the initial ICCMU guideline, administration set changes are commonly performed more frequently than recommended which may place the patient at increased risk and definitely results in increased costs [29].

The additional guideline used to support the current version of the recommendations is the updated 2011 CDC recommendations. The CDC supports the practice of administration set change between four and seven days except for blood and lipid-containing infusions [27]. The practice of four and seven day administration set changes, including all types of administration sets attached to different vascular devices, is currently the subject of a large randomised controlled trial in Australia. This study is now recruiting patients and is expected to further inform this recommendation in the future.

Practice point 4: Disconnecting IV administration sets

It is not acceptable to disconnect and reconnect the same administration set. The rationale for not disconnecting is to reduce opportunities for infection and/or error. The disconnection/reconnection process has many points where risk is apparent. It is, however, important to assess the ongoing need for infusion therapy and only disconnect for routine administration set changes or to cease therapy.

Adjuncts to IV administration sets

SECTION	RECOMMENDATION	GOR
Interventions: Adjuncts to IV administration sets		
26.	Needleless connectors that can be disinfected or decontaminated are to be placed on each lumen of a CVAD [26, 31-36].	Grade A
27.	Multi-flow adaptors and three-way taps and connectors are to be changed when the administration set is changed [26]	Consensus
28.	Clamps should be engaged (when in situ) on the device's lumen when disconnecting the administration set from the lumen. This is to prevent complications such as air embolus, bleeding or inadvertent drug or fluid bolus administration.	Consensus
29.	Avoid administration set disconnections. If an administration set is disconnected it must be discarded and a new set used.	Consensus

Connectors

In the context of the limits set on this review, high level evidence relating to connectors was minimal or had a high risk of bias. There was support within the GDN for use of needle-free Luer devices to reduce the risk of needle stick injury and for the use of devices that prove easy to disinfect. The rationale for use of Luer connectors is to reduce risk of accidental disconnection, which may lead to bleeding or infective complications. The use of devices with specific antimicrobial parts and displacement valves was unresolved.

Injection and sampling ports are accessed numerous times during the day for patients with CVADs in intensive care. In addition, blood, fluids and/or other biological matter may collect via the CVAD. Frequent access and collection of matter creates opportunities for microorganisms to be introduced to the patient. The CDC and multiple guidelines recommend cleaning of these ports before accessing the system [63][61].

The use of multi-lumen CVADs is common in ICUs, however, there are occasions when a CVAD lumen or a section of a multi-flow adaptor may not be in use. This can create opportunities for problems such as: 1) air embolism if disconnection occurs; 2) reflux of blood that can contribute to blockage of a lumen; and 3) admixture or reflux of intravenous fluids. Therefore, it is important that the clamps on unused CVAD lumens are engaged as appropriate. See **Table 4**.

Extension sets/add-on devices are considered part of the administration set as opposed to part of the CVAD and require changing when the administration set is changed.

Practice point 5: Needleless connectors

A 2012 review of needleless connectors [64] is available via CIAP in NSW. It is important to be aware of the functionality of the connector stocked in the facility. The basics include:

1. how it links into an intravascular system (usually Luer locking or split septum technology)
2. the complexity of the internal parts of the connector (how fluid moves through it)
3. when lumen clamping is required
4. how to 'scrub the hub'.

Although product labelling does not always indicate the type of fluid displacement, connector devices can be distinguished by the way fluid moves through them.

A negative displacement needleless injection system will allow blood to reflux into the catheter lumen when the tubing or syringe is disconnected. A positive-pressure flushing technique is required when a negative-displacement device is used (**Table 4**). A positive displacement needleless injection system will reserve a small amount of fluid to push toward the catheter tip at disconnection of the syringe or tubing, which prevents blood from remaining inside the lumen. A neutral displacement needle-free system will not allow fluid to move in either direction when tubing or a syringe is disconnected.

Negative and positive displacement devices are dependent upon flushing technique. A positive-pressure flushing technique is required with a negative-displacement device. The Infusion Nurses Society has defined positive pressure as a constant, even force within a catheter lumen preventing reflux of blood by clamping while injecting or by withdrawing from the catheter hub while injecting. However, positive-pressure flushing techniques prevent correct function of a positive-displacement system and should not be used with these devices.

Institutional policy often dictates the use of clamps on the catheter lumen to ensure closure when not in use. In facilities where positive-displacement devices are used clamping may also be used, but the tubing or syringe must be disconnected and sufficient time allowed for the positive fluid displacement prior to clamp activation.

Blood reflux into the catheter lumen results from syringe plunger rod compression and syringe or tubing disconnection. Although a positive-displacement system will displace the blood reflux caused by disconnection, there is no available research on its ability to overcome syringe compression reflux in addition to disconnection reflux.

The length of catheter lumen affected by blood reflux depends on the catheter lumen size. Catheters with a smaller lumen diameter will have more length filled with blood, whereas larger lumens will have a shorter length of reflux.

Table 4: Common needleless connectors

Type	How it works	Disconnection
Blunt cannula with split septum	Has simple split septum, which is opened by a blunt syringe to allow fluid down the pathway of the valve.	Flush device using a positive pressure pulsatile flush technique, clamping catheter lumen while maintaining positive pressure and disconnect syringe.
Mechanical valve (with negative/neutral displacement)	Has an internal mechanism that, when compressed by the insertion of a syringe, opens a fluid pathway through the device.	Flush device using a positive pressure pulsatile flush technique, clamping catheter lumen while maintaining positive pressure and disconnect syringe.
Mechanical valve (with positive displacement)	Has an internal mechanism with the addition of a fluid reservoir that creates a positive displacement of fluid through the device when the syringe is disconnected and removed.	Flush device using a positive pressure pulsatile flush technique. Disconnect syringe and wait 2-3 seconds before clamping the catheter lumen closed. This allows time for the positive pressure feature of the valve to activate.

Maintenance of lumen integrity

SECTION	RECOMMENDATION	GOR
	Interventions: Fluid and drug administration	
30.	How frequently a CVAD lumen should be flushed to maintain lumen patency remains unclear. It is suggested that a CVAD lumen that is used intermittently should be flushed no more frequently than every eight hours.	Consensus
31.	The recommended solution for flushing a CVAD lumen is 0.9% saline [37-41].	Grade B
32.	To reduce the risk of thrombosis and intraluminal occlusion in large bore catheter lumens (e.g. dialysis catheters), an anticoagulant lock may be used when the lumen is not in use [38, 39, 42].	Consensus
33.	Unused lumens are to be managed to prevent air emboli and backflow of blood, protein or lipid solutions depending on the connector used. Refer to **Table 4**.	Consensus
34.	It is recommended that syringes with a capacity of ≥ 10mL be used to access a CVAD for flushing. Smaller syringes exert higher pressure and may cause possible catheter rupture or dislodge an occlusion if excessive force is used.	Consensus
35.	When flushing a CVAD lumen use a pulsatile positive pressure flushing technique to create turbulence within the device lumen.	Grade B
36.	If attempting to flush a CVAD lumen due to a blockage, force should never be used because of the risk of catheter rupture.	Consensus
37.	Use of a solution other than 0.9% saline to unblock a CVAD lumen has been shown to be effective in restoring lumen patency. Use of agents such as urokinase and alteplase require a medical prescription and must be discussed with the Medical Officer or a Vascular Access specialist/team before use [43, 44].	Grade B

The evidence for maintaining catheter patency and reducing thrombotic risk indicates that 0.9% saline is equivalent to heparin solutions and safer in the context of risk associated with administration of heparin [37, 39] including bleeding complications. One study comparing 100 iU/kg continuous heparin infusion with 50mL of 0.9% saline/ day showed the intervention group had a lower rate of infections [65]. In a prospective randomised trial of heparin and saline flushed through a PICC using positive pressure Luer activated devices, there was no significant difference in occlusion rates, but there were occlusions reported in the saline group that had a significant cost implication for PICC replacement [38]. More recently, studies have compared citrate as a lock solution not only for maintaining catheter patency but also to reduce the risk of infection [40, 66]. Citrate is a safer option than heparin, but its availability in Australia is limited. At this time the pragmatic approach of instilling low concentrations of heparin (50 iU/mL or lower doses) or citrate-locking solutions may be considered for locking unused lumen in large bore catheters. Using a pulsatile flushing technique no more frequently than every eight hours and locking the unused lumens of the catheter, no more than twice weekly, was considered acceptable.

Removal

SECTION	RECOMMENDATION	GOR
	Interventions: Removal	
38.	When removing a CVAD the patient should be placed in bed in a supine position [5]. Prior to repositioning the patient following removal of a CVAD, ensure the dressing is airtight and occlusive.	Consensus
39.	Removal of a CVAD should be timed to occur at end inspiration or during expiration for patients who are not on a ventilator.	Consensus
40.	Following CVAD removal pressure must be applied with sterile gauze until haemostasis is achieved. The insertion site must be sealed immediately using an airtight occlusive dressing. This dressing is to remain intact and insitu for 48 hours to reduce the risk of late air embolism.	Consensus
41.	Routine collection of the CVAD tip is not required when removing the device. If a CRSBI is suspected the medical team may request that the tip is sent for microbiological examination and a blood culture collected from a peripheral vein within 4 hours of CVAD removal [45].	Consensus
42.	Removal of the CVAD must be documented in the clinical record. The documentation must include: • visual inspection and description of the integrity of the CVAD • whether the CVAD tip was collected and sent to pathology • the condition of the CVAD insertion site.	NSW Policy
43.	Following removal of a CVAD the condition of the site must be monitored at 24 and 48 hours at a minimum. This must be documented in the clinical record.	Consensus

Safety alert 3: Air embolism

Many of the recommendations relating to removal have been made in the context of risk minimisation for air embolus. Data from the Incident Information Management System in NSW indicates that a number of patients are subject to this complication every year and in some cases this has been related to the removal technique. The practice review yielded numerous techniques for ensuring patients (without positive pressure ventilation) do not inhale during the procedure.

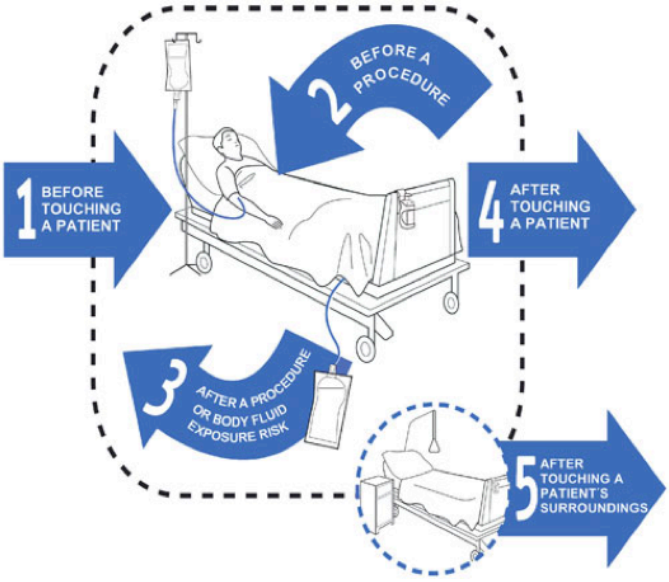
Practice point 6: Check CVAD when removed

When removing a CVAD, which may have been trimmed on insertion (i.e. PICC), the entire length removed must be visualised and checked against the original documentation to ensure that the entire catheter has been removed. This should be recorded in the patient's medical record.

Infection prevention

SECTION	RECOMMENDATION	GOR
	Infection prevention	
44.	Clinicians must adhere to the Five Moments of Hand Hygiene.	Hand hygiene Policy
45.	Clinicians are to evaluate the risk of body fluid exposure and cross contamination risk when caring for a patient with a CVAD. PPE, including goggles/face shield, gloves and gown/apron as per the NSW 2007 Infection prevention and control policy, should be worn accordingly.	National Guidelines and NSW Policy
46.	Aseptic non-touch technique must be used when attending to CVAD dressings, administration set changes and any intervention that involves accessing the CVAD [12, 46, 47].	Grade A

The insertion of a CVAD may result in an infection which is a serious complication. A Central Line Associated Blood Stream Infection (CLABSI) is a bloodstream infection associated with a CVAD where the CVAD is considered to be the source of bacteria or microorganisms. These microorganisms can lead to serious illness and the infections require significant treatment, often resulting in an extended hospital stay. Many bundled insertion projects around the world have been undertaken in recent years to mitigate the risk of infection at the time of insertion [53, 67, 65]. However, CLABSI is also a consequence of post insertion care and maintenance. CLABSI may be documented on the Central Line Insertion Record available in NSW.



Based on the 'My 5 moments for Hand Hygiene', URL: http://www.who.int/gpsc/5may/background/5moments/en/index.html © World Health Organization 2009. All rights reserved.

Hand hygiene

The NSW Health Hand Hygiene Policy (PD2010_058) states that all staff must perform hand hygiene as per the Five Moments for Hand Hygiene (http://www.hha.org.au/). Hand hygiene must occur before touching the patient; prior to a procedure; after a procedure or body fluid exposure risk; after touching a patient; after touching a patient's surroundings. Hand hygiene can be performed using appropriate soap solutions and water or alcohol-based hand rub (ABHR). Soap and water must be used when hands are visibly soiled.

Personal protective equipment

The Australian Guidelines for the Prevention and Control of Infection in Health Care and the NSW Infection Control Policy (PD2007_036) state that all procedures that generate or have the potential to generate secretions or excretions require that either a face shield or a mask with protective goggles be worn.

NSW Ministry of Health policies

Prevention of infection is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering infection control. Local policy must also be consulted.

1. Infection Control Policy - http://www0.health.nsw.gov.au/policies/pd/2007/PD2007_036.html
2. Infection Control Policy: Prevention & Management of Multi-Resistant Organisms (MRO) http://www0.health.nsw.gov.au/policies/pd/2007/PD2007_084.html
3. Hand Hygiene Policy http://www0.health.nsw.gov.au/policies/pd/2010/pdf/PD2010_058.pdf
4. Australian Guidelines for the Prevention and Control of Infection in Health Care http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/cd33_complete.pdf

Other relevant policies and standards

1. Australian Guidelines for the Prevention and Control of Infection in Health Care http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/cd33_complete.pdf
2. Cleaning, disinfecting and sterilising reusable medical and surgical instruments and equipment, and maintenance of associated environments in healthcare facilities. ASA 4187:2003.

Workplace health and safety

Prevention of work injury is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering work health and safety. Local policy must also be consulted.

NSW Work Health and Safety Act 2011 http://www.legislation.nsw.gov.au/maintop/view/inforce/act+10+2011+cd+0+N

The NSW Work Health and Safety Act 2011 states that organisations must eliminate risks to the health and safety of workers where at all possible. When it is not possible to eliminate risks, the risk must be minimised as far as reasonably practicable. Organisations must provide appropriate PPE for use by staff. Staff have a responsibility to use that PPE according to policy.

The worker has an obligation under the NSW Work Health and Safety Act 2011 to;

i) take all reasonable care for their own safety

ii) take care that their acts or omissions do not adversely affect the health and safety of other persons

iii) comply with any reasonable instruction they are given.

Governance

SECTION	RECOMMENDATION	GOR
47.	CVAD management is provided by nursing staff that are proficient in this activity and/or by nursing staff under the direct supervision of nursing staff that are proficient as per institutional policy [12, 26, 48].	Consensus
48.	To prevent errors or breaches of asepsis, administration set and dressing changes should be performed when the clinician is unlikely to be interrupted.	Consensus
49.	Infusions on each lumen of the CVAD are to be labelled as per the National Recommendations for User-applied Labelling of Injectable Medicines, Fluids and Lines	National Guidelines and NSW Policy
50.	Evaluation of patient outcomes in relation to device failure include: i. surveillance of CRBSI ii. unintended removal and other complications as reported in the institutional incident management system iii. audits of clinical practice	National Guidelines and NSW Policy

Recommendations of the Australian Commission on Safety and Quality in Healthcare

Two documents of the Australian Commission on Safety and Quality in Healthcare (ACSQHC) are referenced in this document and have been used to formulate recommendation statements.

The 2010 Australian Guidelines for the Prevention and Control of Infection in Healthcare include recommendations related to aseptic technique, use of disinfection solutions, needs assessment, administration set changes and disconnection.

The Labelling Recommendations [56] facilitate identification by clinicians of the correct medicine and/or fluid and route of administration of injectable medicines. The recommendations were produced as injectable medicines, fluids and devices used to administer infusions have been identified as a patient safety issue. The Labelling Recommendations support prevention of medicine administration errors by:

1. promoting safer use of injectable medicines
2. standardising user-applied labelling of injectable medicines
3. outlining the minimum requirements for user-applied labelling of injectable medicines including that:
   a. any medicine and fluid removed from the manufacturers' or hospital pharmacy's original packaging must be identifiable
   b. all containers with medicines leaving the hands of the person preparing the medicine must be labelled
   c. any medicine or fluid that cannot be identified (e.g. unlabelled syringe or other container) should be considered unsafe and discarded
   d. only one medicine at a time should be prepared and labelled before the preparation and labelling of a subsequent medicine.

Competence

CVAD management requires knowledge and technical skills in order to minimise risk to patients with these devices. It is clear from the NSW incident data and the practice review survey that care is variable. Standardisation of practices related to CVADs is required to improve patient safety. A number of guidelines also make recommendations in relation to education, training and competency [12, 26, 48]. For this reason, proficiency should be measured by standard competency assessment tools [26] as required.

4. EVIDENCE REVIEW – SUMMARY TABLES

Infection prevention

Author	Risk of bias	Study type	Study measures	Significance/implication
Question: What interventions will prevent or minimise infection in CVADs? *Chlorhexidine in ethanol appears to be the superior disinfectant.*				
Abdelkefi 2005[65]	Low	RCT	Compared continuous IV heparin vs. 0.9% saline	Heparin infusion 100u/kg day appeared to reduce infections in this group. Probably not suitable for ICU patients.
Astle 2005[8]	Low	RCT	Compared chlorhexidine to ExSept disinfectant of dialysis catheters	No difference in colonisation or exit site infections. Culture/bacteraemia results indicate ExSept and chlorhexidine comparable.
Chaiyakunapruk 2002[7]	Low	SR	Compared chlorhexidine to povidone iodine	Less catheter colonisation and CRBSI seen with chlorhexidine.
Dettenkofer 2010 [68]	Low	RCT	Compared octenidine to alcohol control	Less skin colonisation and catheter tip growth with octenidine. No significant difference in CRBSI.
Mimoz 2007[9]	Low	Parallel RCT	Compared chlorhexidine to povidone iodine	No significant difference in CRBSI. Lower colonisation rates were seen with chlorhexidine, but only at subclavian site. NOTE: CHG performed slightly better but was used in a lower concentration than is currently used in Australia.
Parienti 2004[10]	Low	Cross over CCT	Compared alcoholic povidone iodine with aqueous povidone iodine	Alcoholic povidone iodine reduced colonisation and infection rate compared with aqueous povidone iodine.
Valles 2008[11]	Low	RCT	Compared aqueous chlorhexidine to alcoholic chlorhexidine to aqueous povidone	CRBSI similar for all groups. Catheter colonisation lower in both chlorhexidine groups than povidone iodine.

Dressing

Author	Risk of bias	Study type	Study measures	Significance/implication
Question: What is the most appropriate covering for the CVAD insertion site?				
Benhamou 2002[18]	Mod	RCT	Compared dressing change 4 vs.15 days	No significant difference in incidence of CRBSI and colonisation between 4 to 15 days. The 15 day group had a mean dressing change time of 8 days. More skin toxicity seen in the 4-day group. Results may not be transferable to general adult ICU population, but suggest 8-day change as good as 4-day change.
Ishizuka 2011[15]	Mod-high	RCT	Compared routine dressing changes at 72 hours to non-routine changes. Use of povidone or chlorhexidine as disinfectant	No significant difference in CRBSI or colonisation. More fever in non-routine group.
LeCorre 2003[16]	High	RCT	Compared polyurethane transparent dressing changed every 7 days or gauze replaced every 2-3 days	Bacteraemia defined by distal catheter tip culture was not increased with less frequent in transparent dressing group compared to dry gauze but the study was insufficiently powered for statistical significance. 170 more patients needed per group to achieve significance. The study favoured transparent dressings due to patient comfort factors
Olson 2004[14]	High	RCT	Compared gauze vs. no dressing	CVC Realted sepsis using different definitions to other studies showed an insigbificant higher rate of sepsis in the dressing group
Olson 2008[61]	Mod-High	RCT	Compared patient comfort and satisfaction with CHG-impregnated Tegaderm® dressing compared to control of standard Tegaderm®	Improved satisfaction with CHG dressing and less discomfort.
Rasero 2000	High	RCT	Compared dressing changes at 2 and 5 days for tunnelled and non-tunnelled catheters	No change in local skin colonisation but greater skin toxicity (Grade 1 – 111) for 5-day non-tunnelled CVC group. Cost savings seen with decreased frequency. Reduced discomfort with less frequent changes.
Webster 2011[19]	Low	SR	Compared gauze and tape versus transparent polyurethane dressings for CVADs in relation to CRBSI, security and patient tolerance	There was a four-fold increase in CRBSI with transparent polyurethane dressings. Nil changes to current recommendations.

Chlorhexidine impregnated sponges

Author	Risk of bias	Study type	Study measures	Significance/implication
Question: What is the evidence supporting the use of chlorhexidine gluconate-impregnated (CHG) sponges around a CVAD insertion site as a way of preventing infection?				
Chambers 2005[21]	Mod	RCT	Compared CHG sponge vs. standard dressing	CHG sponge reduced incidence of exit site infections.
Ho 2006[20]	Low	Meta-analysis	Meta-analysis of efficacy of CHG dressing to prevent vascular and epidural colonisation and infection	CHG sponge reduced colonisation. Trend towards reduced BSI, which could be cost-effective. CHG sponge safe to use.
Levy 2005[22]	Mod	RCT	Evaluated effectiveness and safety of CHG sponge in paediatric population	Reduced catheter colonisation with CHG sponge. No difference in CRBSI. CHG sponge safe to use in paediatric population.
Ruschulte 2009[23]	Mod	RCT	Compared CHG sponge to standard dressing	Total CRBSI reduced with CHG sponge, especially at internal jugular site. No significant difference in CRBSI at subclavian site.
Schwebel 2012[24]	Low	RCT	Compared CHG sponge to standard dressing. Compared 3-day vs. 7-day dressing changes. Cost analysis of CHG sponge dressing	CHG sponge reduced major CRI to 0.6/1000 catheter days. Changing unsoiled dressings every 7 days not inferior. CHG reduced infection-associated costs ($83–$197/patient)
Timsit 2009[25]	Low	RCT	Compared CHG sponge to standard dressing. Compared 3-day vs 7-day dressing changes	CHG sponge reduced CRI to 0.5%, catheter colonisation to 5%, and CRBSI to 0.3%. Dressing changes at day 7 for unsoiled dressings appears safe.

Administration set changes

Author	Risk of bias	Study type	Study measures	Significance/implication
Question: What is the optimal interval for administration set (AS) changes?				
Gillies 2005 [24]	Low	SR	Determine optimal time interval for routine replacement of IV AS	No significant difference for catheter colonisation, CRBSI, all cause BSI when AS (excluding blood, blood products and lipids) left in situ for up to 96 hours. AS containing lipids to still be changed every 24 hours.
Raad 2001 [25]	Low	RCT	Compared safety and cost effectiveness of 3-day vs 4-7-day AS change	Seven-day AS change appears safe in oncology patients not receiving TPN, blood transfusions or interleukininterleukin-2 infusions.
Rickard 2004 [26]	Low	RCT	Compared 4-day routine AS change vs no AS change (max 7 days)	Non-statistically significant increase in colonisation in the 'no change' group. No increase in CRBSI. **NOTE:** All catheters had a chlorhexidine gluconate and silver sulfadiazine external coating

Connectors

Author	Risk of bias	Study type	Study measures	Significance/implication
Question: Which connectors have strong evidence of prevention of device failure?				
Bouza 2003[31]	Mod	RCT	Assessed closed-needleless hub device (CLAVE®) compared with conventional open systems (COS). CLAVE® hubs changed every 7 days, COS hubs changed every 3 days	Significant reduction in catheter hub colonisation and catheter tip colonisation with CLAVE® device. Trend toward lower rates of BSI in CLAVE® group. Staff satisfaction survey attended. 82% of nurses preferred CLAVE®, but reported more difficult to use in critical situations
Casey 2003[69]	High	RCT	Compared microbial contamination using 3-way tap and the PosiFlow® needleless connector vs. 3-way tap with standard Luer caps. Also, randomisation of 3 disinfectants (isopropyl alcohol, 0.5% chlorhexidine in isopropyl alcohol, and aqueous povidone iodine)	Significantly less microbial contamination in needleless connector group. Disinfection with chlorhexidine in alcohol significantly reduced microbial contamination. **NOTE:** PosiFlow® is a Becton Dickinson product and the study was sponsored by Becton Dickinson.
Casey 2007[32]	High	RCT	Compared Y-type extension with Clearlink® needleless connector to three-way tap with standard Luer caps	Significantly less microbial contamination in needleless connector group. **NOTE:** Clearlink® is a Baxter product and the study was supported by Baxter.
Leon 2003[33]	Mod-high	RCT	Compared hub model incorporating an antiseptic (alcohol) chamber (Segur Lock) vs. standard connector	CRBSI and hub colonisation lower in intervention group. **NOTE:** The product is available in Europe but not USA. Unsure about availability
Esteve 2007[34]	Mod	RCT	Examined efficacy of a needleless valve connection system (SmartSite®) vs. 3-way tap in the prevention of CRBSI	No significant difference between needleless valve vs. 3-way tap in CVC BSI rates (4.61 vs. 4.1/1000 catheter days) or CVC colonisation (4.4 vs. 3.7/1000 catheter days). However, arterial catheter BSI rates were higher in needleless valve group (5.0 vs. 2.83/1000 catheter days). **NOTE:** Study had a high baseline incidence of CRBSI.

Table continues on page 30

Table continued from page 29

Author	Risk of bias	Study type	Study measures	Significance/implication
Niël-Weise 2006[35]	Low	SR	Systematic review of needleless closed catheter access systems	There was a trend toward an advantage with the needleless closed devices in terms of less CRBSI, less catheter tip colonisation and less hub colonisation. This review did not find a trend in needleless closed devices to increased risk of CRBSI. Unable to combine data because of clinical heterogeneity. There is insufficient evidence to recommend needleless closed vascular devices.
Yebenes 2004[36]	Mod	RCT	Compared needleless connector (SmartSite®) vs. standard 3-way tap	

Lumen Patency

Author	Risk of bias	Study type	Study measures	Significance/implication
Question: What measures support maintenance of lumen patency?				
Bowers 2008[38]	Mod	RCT	Studied number of occlusions and failure of CVAD in heparin vs. 0.9% saline groups	Non-statistically significant reduction in the number of occlusions in heparin group. Heparin may help prevent occlusion of single lumen PICCs used intermittently. Possible lower costs related to replacement and unblocking.
de Neef 2002[39]	Low	RCT	Compared heparin (1 iU/ml) vs. 0.9% saline for maintaining patency of arterial and CVC lines	Heparin appeared to produce fewer blockages in arterial catheters. Nil significant difference in CVCs Paediatric Study ceased early.
Gabrail 2010[43]	Low	RCT	Compared tenecteplase vs. placebo for restoration of CVAD function	Restoration of catheter function with treatment arm 60% vs. 23%. There were a number of adverse events that increased in paediatric population.
Haire 2004[44]	Low	RCT	Compared urokinase vs. placebo to restore patency in occluded CVAD	Urokinase is efficacious in restoring CVAD function.
Hall 2006[42]	Low	RCT	Compared effect on platelet count of using heparinised flush solution vs. 0.9% saline for arterial catheters	Heparinised saline (1 IU/ml) continuous flush solution for arterial catheters did not reduce platelet count.
Hermite 2012[40]	Low	RCT	Compared 0.9% saline vs. sodium citrate for locking catheters	Citrate improved haemodialysis catheter patency. **NOTE:** Citrate is not available as a lock solution in Australia at this time.
Rabe 2002[41]	Low	RCT	Compared 0.9% saline, heparin (5000 iU/ml) and vitamin C (200 mg/ml) locking solutions to prevent catheter occlusion in intermittently used CVCs	Heparin 5000 IU/ml significantly prolonged CVC patency.
Schallom 2012[37]	Low	RCT	Compared heparin (3ml, 10 iU/ml) vs. 0.9% saline in maintaining CVC catheter lumen patency	No significant difference between groups.

Securement

Author	Risk of bias	Study type	Study measures	Significance/implication
Question: What securing features best prevent inadvertent removal?				
Graf 2006[1]	Mod	RCT	Compared PICC securement with tape vs. sutures	Significantly less complications in the suture group than tape group (0.8/1000 vs. 4.6/1000 catheter days).
Teichgraber 2011[2]	Mod	RCT	Compared sutures vs. sutureless fixation device (Statlock®) for haemodialysis catheters	More complications in the suture group. **NOTE:** NSW policy suggests either method.
Yamamoto 2002[3]	Mod	RCT	Evaluated performance of sutureless fixation device (Statlock®) for securing PICC lines	Fewer complications in StatLock® group than suture group (42 vs. 61) but not statistically significant. Complications included unplanned removal, migration, leak, cellulitis, occlusion, thrombosis. CRBSI rates lower in StatLock® group than suture group (1 vs. 8).

5. GUIDELINE DEVELOPMENT HISTORY

1. April 2012 – GDN executive formed; guideline scope and systematic review formulated
2. May 2012 – Team building; finalisation of guideline scope and CPG workplan; evidence-based practice education; team plan
3. May-September 2012 – Systematic review work undertaken culminating in development of technical report
4. November 19, 2012 – Consensus development meeting – recommendation development
5. December 2012 - February 2012 – Guideline writing
6. April 2013 – Internal consensus – (see Table 6)
    - Changes – Recommendations 15 and 32 reworded for clarity
7. May 2013 – External validation.
8. August 2013 – Organisation consultation via ACI networks.

Table 5: External validation panel members

ROLE IN GROUP	NAME/POSITION	ORGANISATION
Member	Rand Butcher, Clinical Nurse Consultant Intensive Care Service	The Tweed Hospital
Member	Hailey Carpen, Clinical Nurse Consultant	Nepean Hospital
Member	Vicki Denyer	
Member	Dr Robert Hackett, Consultant Anaesthetist	Royal Prince Alfred Hospital
Member	Ashley Job, Clinical Nurse Educator	Manly Hospital
Member	Anne McDade, Clinical Nurse	Concord Hospital
Member	Mark McLennan, Clinical Nurse Consultant Intensive Care Service	Lismore Hospital
Member	Kathleen O'Connor, Clinical Nurse Specialist, Vascular Access Team	Royal Prince Alfred Hospital
Member	Dr Ian Seppelt, Senior Specialist in Intensive Care Medicine	Nepean Hospital
Member	Mark Sutherland, Clinical Nurse Consultant Enteral and Parenteral Therapy	Prince of Wales Hospital
Member	Matthew Tinker, Clinical Nurse Consultant Intensive Care Service	Royal North Shore Hospital
Member	Mel Wilson	Manly Hospital
Member	Nic Yacopetti, Clinical Nurse Consultant Vascular Access, Acute Pain Management, Parenteral Nutrition	St Vincent's Hospital

Table 6: GDN and EVP consensus results

RECOMMENDATION	1	2	3	4	5	6	7	8	9	10
Internal consensus	9 (9-9)	7.75 (8-9)	8 (8-9)	8 (8-9)	9 (7-9)	9 (7-9)	7.75 (8-9)	8 (8-9)	8 (7.75-9)	9 (7-9)
External validation	9 (9-9)	8 (8-9)	9 (8-9)	9 (8-9)	8 (7-9)	7 (6-8)	8 (7-9)	9 (7-9)	8 (7-9)	8 (7-9)

RECOMMENDATION	11	12	13	14	15	16	17	18	19	20
Internal consensus	9 (7.75-9)	9 (8-9)	9 (8-9)	9 (6.75-9)	7 (6.75-9)	9 (7.75-9)	9 (8.75-9)	8 (7-9)	7.5 (7-9)	9 (7.25-9)
External validation	9 (7-9)	9 (8-9)	9 (8-9)	7 (7-9)	8 (7-9)	7 (5-9)	9 (8-9)	8 (8-9)	8 (7-9)	8 (7-9)

RECOMMENDATION	21	22	23	24	25	26	27	28	29	30
Internal consensus	9 (6.5-9)	9 (8.75-9)	8 (7.75-9)	9 (7.75-9)	9 (7-9)	9 (8-9)	9 (8-9)	8 (8-8.5)	9 (7.75.-9)	7 (7-8.5)
External validation	7 (5.75-9)	9 (7.75-9)	7 (6-9)	7 (6.5-8.5)	8 (7-9)	8 (7.5-9)	8 (7-9)	8 (7-9)	9 (7-9)	8 (6.5-9)

RECOMMENDATION	31	32	33	34	35	36	37	38	39	40
Internal consensus	9 (8-9)	5 (5-9)	8.5 (6.5-9)	8 (6.75-9)	9 (7.75-9)	8 (7.75-9)	8 (7.75-9)	8 (7-9)	7 (6.5.-9)	9 (8-9)
External validation	9 (7.5-9)	7 (7-9)	7 (7-9)	7 (6.75-8.25)	8.5 (7-9)	7 (5.75-7.5)	8 (7-9)	8.5 (7.75-9)	8 (7-9)	8.5 (7-9)

RECOMMENDATION	41	42	43	44	45	46	47	48	49	50
Internal consensus	9 (7.75-9)	8 (7-9)	8 (7-8)	9 (8-9)	9 (8-9)	9 (8-9)	9 (7.75-9)	9 (8-9)	9 (8.75-9)	9 (8-9)
External validation	8.5 (7-9)	8 (7-9)	8 (7-9)	8 (8-9)	8 (7.75-9)	8.5 (7.75-9)	9 (7-9)	8.5 (7-9)	9 (8-9)	8 (7-9)

Results reported as Median (IQR)

6. IMPLEMENTATION TOOLS

Training and assessment support tool

To ensure appropriate adherence to each element of this guideline in the facility, guidance for assessors should include the following information:

- Methods for clinical staff to gain and maintain currency
- The principles of aseptic non-touch technique and hand hygiene moments
- Type of CVADs stocked (e.g. antibiotic impregnated, standard, antiseptic coated, Power PICC, etc.) and circumstances for when each type may be inserted
- Acceptable securement practices
- Drying times for antiseptic solutions/products used
- When particular dressings are appropriate (including the use of chlorhexidine impregnated sponges around the insertion site)
- Type of connectors used and how they function (neutral, negative or positive displacement)
- Timeframes for administration set and dressing change
- Equipment required for blood collection when indicated
- Hospital-specific escalation procedures to manage complications
- Circumstances where patient positioning is specific to a procedure (e.g. CVAD removal)

Decision making/informed consent/accountability/attitude criteria

	OBSERVATIONAL ELEMENTS
1.	Identifies type, ensures tip lies in the vessel, associated anatomy and physiology and rationale for CVAD placement
2.	Ensures correct patient procedure and explains and seeks consent for CVAD interventions
3.	Operates within scope of practice and consults and escalates issues appropriately
4.	Considers patient comfort and minimises patient distress throughout procedures
5.	Demonstrates accountability for infection prevention of the patient and self
6.	Promotes patient privacy, dignity and confidentiality
7.	Demonstrates correct use of devices
8.	Ascertains appropriateness of infusion therapy and compatibility of infusions as appropriate
9.	Manages complications appropriately
10.	Documents procedures in the patient record including use of the Central Line Insertion Record where appropriate

Procedural preparation criteria and infection prevention and control

	OBSERVATIONAL ELEMENTS
1.	Selects necessary equipment for procedure
2.	Prepares equipment and describes use
3.	Prepares and positions patient appropriately for insertion site
4.	Ensures appropriate monitoring is in place (ECG, SpO_2, non-invasive BP monitoring/arterial line)
5.	Performs hand hygiene moments appropriate to tasks
6.	Prepares for procedure using aseptic technique
7.	Maintains aseptic non-touch technique throughout procedures
8.	Demonstrates the ability to don sterile gown and gloves when indicated
9.	Performs skin preparation with appropriate solution and allows drying time
10.	Demonstrates appropriate draping technique when indicated
11.	Returns patient to comfortable position where appropriate after procedure completion
12.	Disposes of contaminated waste materials appropriately

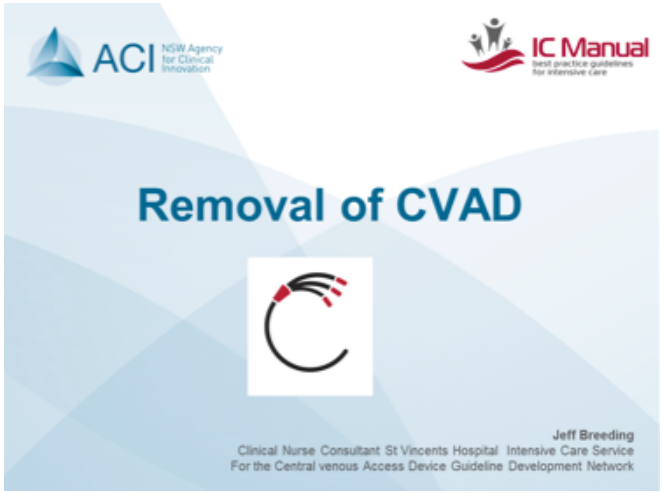
Procedures

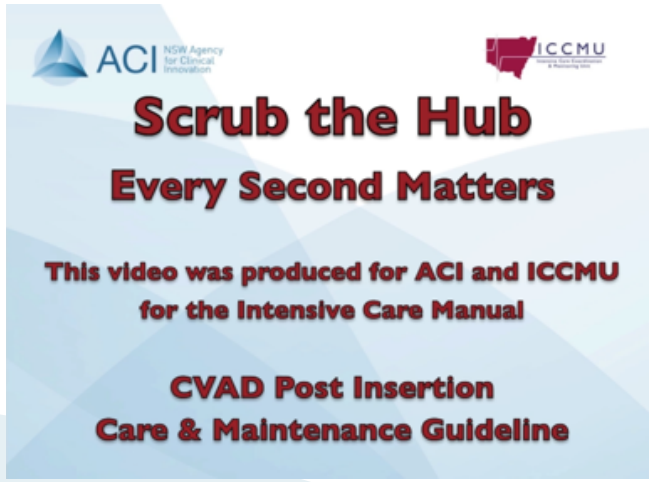
	OBSERVATIONAL ELEMENTS
1.	Assesses function and need for CVAD
2.	Ensures CVAD is secured in at least two places with the first close to the insertion site
3.	Replaces the dressings within appropriate timeframes (depending on type)
4.	Scrubs the hub when accessing lumen
5.	Aspirates and flushes lumen with 0.9% saline when required for function and other CVAD procedures (excluding locked lumen) using pulsatile positive flush technique
6.	Locks lumen of large bore catheters with appropriate locking solution after a medical order and replaces lock solution no more than twice a week
7.	Changes administration sets as indicated depending on infusion therapy and type of CVAD
8.	Removes unnecessary attachments
9.	Uses needleless Luer connectors correctly depending on their function
10.	Clamps unused lumen appropriately after all accessing
11.	Obtains blood from appropriate lumen when required for sampling (use largest if available)
12.	Mitigates for risk of air embolus during removal and observes for clinical signs
13.	Ensures an airtight sterile dressing is in place after device removal (48 hours minimum)

Education tools

Three vodcasts are available via the ACI Vimeo channel. These are

1. CVAD Management
2. Removal of CVAD
3. Scrub the Hub
   - www.aci.health.nsw.gov.au/networks/intensive-care
   - http://vimeo.com/user10508752/albums





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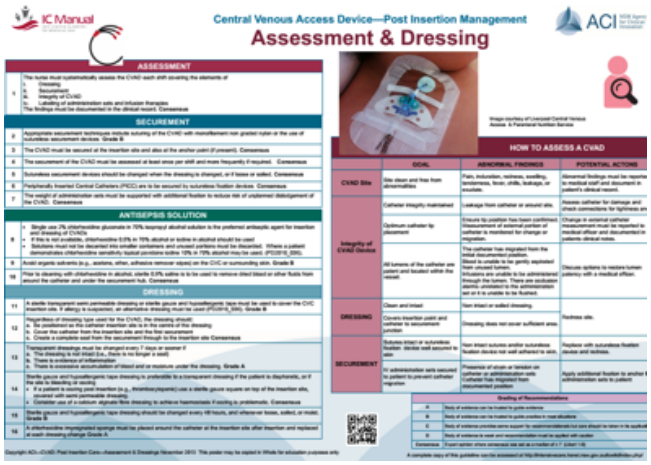

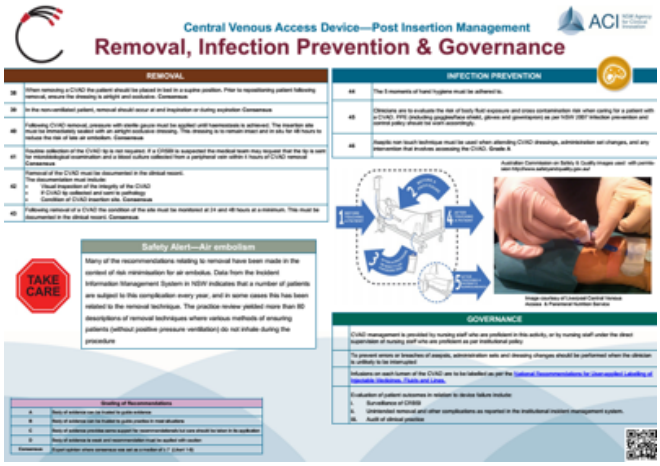

7. APPENDIX

Appendix 1: NHMRC levels of evidence

LEVEL	INTERVENTION
I	A systematic review of level II studies
II	A randomised controlled trial
III-1	A pseudo-randomised controlled trial
III-2	A comparative study with concurrent controls: • non-randomised, experimental trial • cohort study • case-control study • interrupted time series with a control group
III-3	A comparative study without concurrent controls: • historical control study • two or more single arm study • interrupted time series without a parallel control group
IV	Case series with either post-test or pre-test/post-test outcomes
GPG	Guidelines from international organisation
NHMRC grades [52]	

Appendix 2: NHMRC grading of recommendations

Component	A Excellent	B Good	C Satisfactory	D Poor
Evidence base [1]	One or more level I studies with low risk of bias or several level II studies with a low risk of bias	One or two level II studies with a low risk of bias or an SR/ several level III studies with a low risk of bias	One or two level III studies with a low risk of bias, or level I or II studies with a moderate risk of bias	Level IV studies, or level I to III studies/ SRs with a high risk of bias
Consistency [2]	All studies consistent	Most studies consistent and inconsistency may be explained	Some inconsistency reflecting genuine uncertainty around clinical question	Evidence is inconsistent
Clinical impact	Very large	Substantial	Moderate	Slight or restricted
Generalisability	Population/s studied in body of evidence are the same as the target population for the guideline	Population/s studied in the body of evidence are similar to the target population for the guideline	Population/s studied in body of evidence differ to target population for guideline but it is clinically sensible to apply this evidence to target population [3]	Population/s studied in body of evidence differ to target population and hard to judge whether it is sensible to generalise to target population
Applicability	Directly applicable to Australian healthcare context	Applicable to Australian healthcare context with few caveats	Probably applicable to Australian healthcare context with some caveats	Not applicable to Australian healthcare context
NHMRC grades (52)				

[1] Level of evidence determined from the NHMRC evidence hierarchy – **Table 3**, Part B.

[2] If there is only one study, rank this component as 'not applicable'.

[3] For example, results in adults that are clinically sensible to apply to children or psycho-social outcomes for one cancer that may be applicable to patients with another cancer.

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