ICCMU
Intensive Care Coordination & Monitoring Unit
Intensive Care Collaborative

Nursing Care of Central Venous Catheters in Adult Intensive Care

NSWHealth Statewide Guidelines for Intensive Care

NSW HEALTH

Full Title	Nursing Care of Central Venous Catheters in Adult Intensive Care	
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Disclaimer

This clinical practice guideline (CPG) is aimed at providing the clinicians of NSW intensive care units (ICU) with recommendations to frame the development of policies and procedures related to nursing management of a central venous catheter.

This CPG is a distillation of several processes: an integrative review of the literature (available up to December 2006); an evaluation of how this literature applies to the NSW intensive care context; the extensive clinical knowledge of the guideline development network members (GDN); and 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 a clinician's judgment in an individual case.

Users of this CPG must critically evaluate the CPG as it relates to local circumstances and any changes in the literature that may have occurred since the dates of the literature review. In addition NSWHealth clinicians must review NSW state government policy documents to identify any directives that may relate to this clinical practice.

These guidelines will be updated every 3 years.

These guidelines are intended for use in adults only.

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Glossary

BSI	Blood Stream Infection
CDC	Centre for Disease Control (United States)
CHX	Chlorhexidine
CI	Confidence interval
CNC	Clinical Nurse Consultant
CNE	Clinical Nurse Specialist
CONSORT	Consolidated Standards of Reporting Trials http://www.consort-statement.org/?o=1001
CPG	Clinical Practice Guideline
CVC	Central Venous Catheter
CVCR-BSI	Central Venous Catheter Related Blood Stream Infection
EPIC	Evidence Based Practice for Infection Control
ETT	Endotracheal tube
EVP	External Validation Panel
GCS	Glasgow Coma Scale
GDN	Guideline Development Network
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
ICC	Intensive Care Collaborative
ICC	Intensive Care Collaborative
ICC-CDC	Intensive Care Collaborative – Consensus Development Conference
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
PICO	Population Intervention Comparison Outcome
RCT	Randomised Control Trial
RR	Relative Risk
SIRS	Systemic Inflammatory Response Syndrome
SR	Systematic Review

Executive Summary

A central venous catheter (CVC) is a commonly used access device in critically ill patients. Although CVCs enable the administration of life supporting medications and therapies, the presence of these catheters place patients at risk of catheter-related blood stream infections or central line associated bacteraemia (CLAB) which can be fatal. Methods and techniques used during CVC insertion by medical staff and CVC management by nurses are critically important to preventing CLAB.

The purpose of this systematic review was to investigate and evaluate research findings regarding the nursing management of CVCs to prevent CLAB in critically ill adults in order to formulate clinical recommendations. These clinical recommendations can be used to develop unit specific clinical guidelines, protocols and procedures for managing critically ill patients with CVCs aimed at reducing the incidence of CLAB.

The systematic review sought to identify studies published between 2000 and 2005 that explored nursing practices and interventions to prevent CLAB in terms of:

1. Frequency of line changes;
2. The most effective solutions/antiseptics for cleaning lines and ports;
3. Dressing techniques in terms of type, frequency and method of dressing; and
4. Competencies required by nursing staff.

The review has highlighted that few studies have expanded upon the findings and quality of evidence presented in the Guidelines for the Prevention of Intravascular Catheter-Related Infections by the Centres for Disease Control and Prevention in 2002 (O'Grady et al. 2002). As these guidelines have been published for some years, many of the recommendations may be in place to support protocols in units around Australia. In addition, findings from an Australian study add to current knowledge and practices. Although not all studies in this review revealed high level evidence, many of the recommendations can be implemented in practice with a fair degree of confidence.

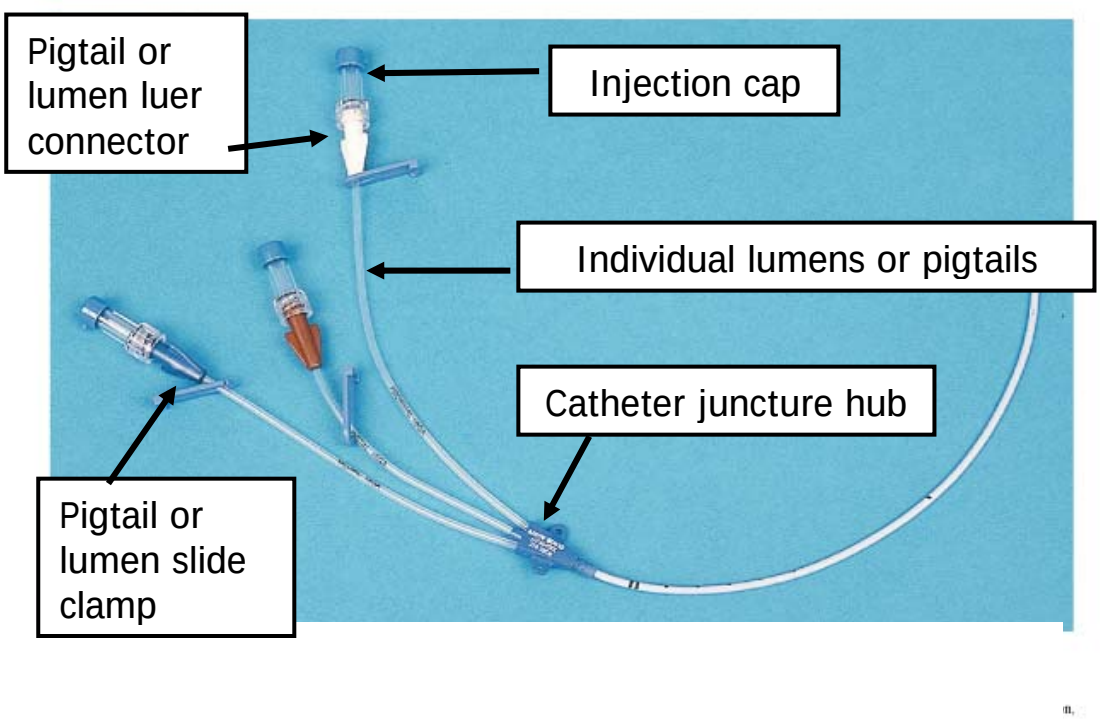
Table 1: Grade of Recommendation (GOR) NHMRC

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 Opinion	Where no evidence could be applied consensus opinion developed by: 1. Formulation of recommendation through discussion 2. Assignment of agreement by individual participants (Likert 1-9) 3. Consensus set at median of 7

Table 2: Centre for Disease Control - GOR

Category IA	Strongly recommended for implementation and strongly supported by well-designed experimental clinical or epidemiologic studies.
Category IB	Strongly recommended for implementation and supported by some experimental, clinical or epidemiologic studies and a strong theoretical rationale.
Category IC	Required by state or federal regulations, rules or standards
Category II	Suggested for implementation and suggestive clinical or epidemiologic studies or a theoretical rationale
No recommendations Unresolved issue	Issue where evidence is insufficient or no consensus regarding efficacy exists

Figure 1: The parts of a central venous catheter



The recommendation statements have been divided into the following sections:

1. Intravenous administration sets (e.g. line changes)
2. Daily care of IV administration sets
3. IV fluid bag changes
4. Antiseptic solution and cleaning of skin and catheter
5. Dressing of central venous catheter and catheter site
6. Nursing governance

Recommendations		
Number	Recommendation Statement	Grade of Recommendation.
1a	Administration sets (burettes, infusion lines, multiflow adapters, caps, bungs, extension lines) attached to **antimicrobial or antibiotic coated multi-lumen CVCs** should be changed at 7 days or when the catheter is changed. (This excludes lines used for blood products, parentral nutrition and lipids.)	NHMRC B
1b	Administration sets (burettes, infusion lines, multiflow adapters, caps, bungs, extension lines) attached to **standard CVCs** should be changed at an interval of up to 96 hours or when the catheter is changed. (This excludes lines used for blood products, parentral nutrition and lipids.)	NHRMC A
1c	Administration sets for blood products or lipid emulsions should be changed within 24 hours of starting the infusion or according to manufacturer instructions.	NHRMC A
1d	Any particulate matter on the luer connector of catheter lumens should be cleaned with alcoholic chlorhexidine prior to connection of new bungs or lines.	Consensus opinion
2a	Intravenous lines attached to a CVC should be secured to the patient so that there is no tension applied to the catheter or sutures.	Consensus opinion
2b	Catheter lumens and sampling ports (including needleless injection sites and blood sampling ports) must be wiped with an alcohol swab before and after use to decontaminate and remove any particulate matter.	NHRMC A
2c	Unused CVC lumens and multi-flow adaptors must be clamped to prevent air emboli and backflow of blood, protein or lipid solutions.	Consensus opinion

Number	Recommendation Statement	Grade of Recommendation.
3a	Crystalloid solutions without drug additives (eg normal saline, 5% dextrose) should be changed only with administration set or catheter change, and when infusion is completed.	Consensus opinion
3b	All blood products should be infused within 4 hours and the line then discarded, with the exception of Factor VIII or IX prepared for continuous infusion.	Consensus opinion
4a	2% Chlorhexidine based solution is the preferred antiseptic for insertion and dressing of CVCs. If this is not available, Chlorhexidine 0.5% in 70% alcohol should be used.	NHRMC A
4b	Sterile normal saline or chlorhexidine gluconate should be used to remove dried blood or other fluids from around the catheter, especially under the catheter hub, prior to cleaning with the chlorhexidine in alcohol.	Consensus opinion
4c	Once antiseptic is applied air-drying for 2 minutes is required or as per manufacturer's instructions.	NHRMC B
4d	Do not use antibiotic creams on insertion sites.	NHRMC A
4e	Do not use organic solvents (eg acetone or ether) on the skin or around the CVC.	NHRMC A
5a	A sterile transparent semi permeable dressing must be used. As per NSWHealth Infection control Policy (PD2007-36)	NHRMC B
5b	Transparent dressings should be changed at least every 7 days or sooner if: i. The dressing is not intact i.e. there is no longer a seal; ii. There is evidence of inflammation; iii. There is excessive accumulation of blood and or moisture under the dressing.	NHRMC A Consensus Opinion
5c	Gauze dressing is preferable to a transparent dressing if patient is diaphoretic, or if the site is bleeding or oozing.	NHRMC B

Number	Recommendation Statement	Grade of Recommendation.
5d	Sterile gauze and tape dressing should be changed daily, and whenever loose, soiled, or moist.	Consensus Opinion
5e	Whatever dressing type is used for the CVC, the dressing should: i. Be positioned so the catheter insertion site is in the centre of the dressing; ii. Cover the catheter from the insertion site to the hub; and iii. Create a complete seal from the catheter hub through to the insertion site.	Consensus Opinion
5f	Use of commercially available chlorhexidine impregnated sponge dressing may be considered.	NHRMC C
6a	Only competent nursing staff should change CVC dressings and lines.	NHRMC B
6b	CVC insertion sites should be systematically assessed each shift and findings documented in the patient notes. Any pain, induration, leakage, redness or exudate should be reported to medical staff.	Consensus Opinion
6c	To prevent errors or breaches of asepsis, line and dressing changes should be performed when the clinician is unlikely to be interrupted.	Consensus Opinion

Clinical Practice Guideline

1. *Introduction*

Central venous catheters (CVC) are frequently used in intensive care however they are not a benign technology. Healthcare-associated infections are a significant problem and 20-40 percent of healthcare-associated bloodstream infections may be linked to a CVC (NSWHealth 2005). This infection is referred to as central line associated bacteremia (CLAB). The VICNESS project (http://www.vicniss.org.au/Resources/VICNISSAnnualReport0705.pdf) projected that more than 3,500 incidences of CLABs occur in Australia annually, with the number of CLABs occurring at a rate of 23 per 1,000 catheter days. A directly attributable mortality for all CLABs is reported as 12 percent. In addition, the high incidence of CLABs increases hospital length of stay and contributes significantly to hospital costs (Soufir, Timsit et al. 1999). Clinical practices associated with CVC management are integral to nursing practice in the intensive care unit.

2. *Scope*

The management of CVC can be divided into pre- and post-insertion care. This guideline will focus on the nursing management of a CVC post insertion in an adult intensive care unit. The practices addressed include: 1) antiseptic and cleaning solution; 2) CVC dressing type, frequency and methods; 3) management of intravenous solutions; and 4) management of intravenous lines. No recommendation could be resolved regarding whether intravenous line changes could be done using either a no-touch clean technique or an aseptic technique. In addition the following issues although considered important are beyond the scope of this guideline:

1. Issues related to patient autonomy such as patient consent and explanation of procedure.
2. Documentation of patient assessment and outcomes of nursing procedures.

3. *Purpose*

This guideline has been developed to provide intensive care clinicians with recommendations to guide the development of local policy/procedures related to the nursing management of a CVC post insertion in an adult intensive care unit.

4. *Target Clinicians*

This guideline is concerned with the post-insertion care of a CVC in intensive care and therefore the target clinician is the intensive care nurse. Intensive care nurses should have a good knowledge and skill base including: the indications for and complications of CVCs; anatomy of the cardiovascular system; management of infusions; management of CVC; and prevention of nosocomial infections.

5. *How the guideline was developed*

This guideline was developed by the central line guideline development network (GDN) comprised of senior nursing clinicians and academics within the ICCMU Intensive Care Collaborative project. The literature review

began with the 2002 Centre of Disease Control Guidelines (O'Grady, Alexander et al. 2002). Literature published between 2000-2005 was identified using the PICO model (Leslie and Finn 2003) and reviewed using a standard appraisal tool [Appendix 1] by GDN members. These reviews were compiled and sent to GDN members prior to the Intensive Care Collaborative Consensus Development Conference (ICC-CDC) held in December 2006. At this meeting the GDN developed most recommendations using a standard consensus process; however, there was insufficient time to cover all practices. Subsequent to the meeting, the remaining recommendations were developed by the primary authors and an email consensus round conducted [See Integrative Literature Review]. During the process of writing the guideline more recent evidence based infection control guidelines (Pratt et al 2007) were published, and these recommendations have been included as they are congruent with recommendations developed.

6. *How to use guideline*

This guideline should be used to guide the development of local policy and procedures related to nursing management of a CVC after insertion in an adult intensive care unit. However as guidelines will be updated every three years, users must check the literature for new research that may influence the recommendations. The guideline should be evaluated by a local group of suitably experienced practitioners to ensure the applicability of recommendations to the local context.

7. *Format of guideline*

This guideline includes an executive summary and guideline body that includes recommendations for practice with background narrative and integrated literature review.

8. *Level of Evidence taxonomy and how consensus opinion was developed*

The Australian NHRMC (NHMRC 2005) levels of evidence and grades of recommendations were used. Where suitable research evidence was not available the GDN members, from their clinical experience and the NSW survey of practice, formulated a recommendation. This recommendation was then voted upon using a 1-9 Likert scale and consensus was set as a median of 7.

9. *Infection Control*

Prevention of infection is an important aspect of clinical practices associated with CVC and guideline users are directed to NSWHealth Policy Directive (PD2007_036) and local policy to comprehensively identify the infection control elements of this clinical practice. These elements include but are not limited to: use of personal protective equipment, hand hygiene before and after manipulation of CVC and administration lines, aseptic and non-touch technique and correct disposal of equipment and medical waste and isolation of infectious patients.

10. *Occupational Health and Safety*

Guideline users are directed to local policy and procedures related to occupational health and safety to ensure operator safety whilst completing this procedure.

11. Academic Facilitators

Convenor, Academic Facilitators	Professor Doug Elliott Director of Research, Faculty of Nursing, Midwifery and Health University of Technology Sydney
Oral Care GDN	Associate Professor Patricia Davidson Professor of Cardiovascular and Chronic Care School of Nursing and Midwifery Curtin University of Technology
Eye Care GDN	Ms Andrea Marshall Sesqui Senior Lecturer in Critical Care Faculty of Nursing and Midwifery The University of Sydney
Suction of an artificial airway GDN	Dr Bridie Kent Director of Clinical Nursing Research School of Nursing - Faculty of Medical and Health Sciences University of Auckland Professor Wendy Chaboyer Director, Research Centre for Practice Innovation Griffith University Queensland
Stabilisation of an endotracheal tube GDN	Associate Professor Anne Gardner Professor, School of Nursing, Midwifery and Nutrition, James Cook University Professor Sandy Middleton School of Nursing Australian Catholic University, National - North Sydney Campus
Arterial catheter GDN (nursing management)	Dr Tina Jones Manager, Australian Centre for Evidence Based Clinical Practice, Flinders Medical Centre Senior Lecturer, Faculty of Health Sciences, Flinders University
CVC GDN (nursing management)	Dr Judy Currey Senior Lecturer, School of Nursing Deakin University Melbourne

The Academic facilitators were identified through professional networks and were not paid to participate in the ICC project however ICCMU paid the costs of travel and accommodation for the ICC-CDC. Apart from Professor Elliott the other academic facilitators did not join the ICC project until June 2006. Five meetings were held, four by teleconference and one the day prior to the ICC-CDC. Tasks completed during these meetings included:

1. Assignment to a particular GDN
2. Discussion regarding the most appropriate levels of evidence and recommendation taxonomy
3. Format of the consensus conference (ICC-CDC)
4. Process of developing recommendations and reaching consensus
5. Process for writing guidelines and peer reviewed publications.

Recommendations for Practice

The recommendations statements have been divided into the following sections:

1. Intravenous administration sets (e.g. line changes)
2. Daily care of IV administration sets
3. IV fluid bag changes
4. Antiseptic solution and cleaning of skin and catheter
5. Dressing of central venous catheter and catheter site
6. Nursing governance

Section 1: Intravenous administration sets		
Number	Recommendation Statement	Grade of Recommendation and Key reference.
1a	Administration sets (burettes, infusion lines, multiflow adapters, caps, bungs, extension lines) attached to **antimicrobial or antibiotic coated multi-lumen CVCs** should be changed at 7 days or when the catheter is changed. This excludes blood products, parenteral nutrition and propofol.	NHRMC B (Rickard, Lipman et al. 2004)
1b	Administration sets (burettes, infusion lines, multiflow adapters, caps, bungs, extension lines) attached to **standard CVCs** should be changed at an interval of up to 96 hours or when the catheter is changed. This excludes blood, blood products and lipids.	NHRMC A (Gillies, O'Riordan et al. 2003) (O'Grady, Alexander et al. 2002)
1c	Administration sets for blood products or lipids emulsion should be changed within 24 hours of starting infusion.	NHRMC A
1d	Any particulate matter on the luer connector of catheter lumens should be cleaned with alcoholic chlorhexidine prior to connection of new bungs or administration lines.	Consensus opinion

The 2002 Centre for Disease Control Guidelines for the prevention of intravascular catheter related infections (O'Grady, Alexander et al. 2002) and EPCI2 guidelines (Pratt, Pellowe et al. 2007) advise changing administration sets for standard infusions and for non-lipid parentral infusions at 'not more frequent than every 72 hours'; the document does not state how long the interval between changes should be for example 96 hours, 7 days). Few studies have been published since 2000; however, these studies included a randomised control trial (RCT) and a systematic review by Australian authors making the application to the Australian health care context highly appropriate.

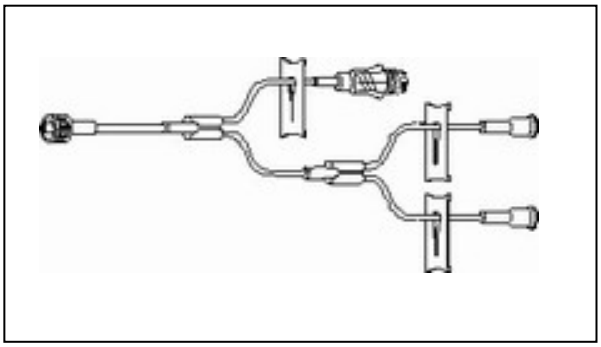
Rickard and colleagues (2004) conducted a RCT to determine the effect of routine IV administration set changes on CVC's (chlorhexidine gluconate and silver sulfadiazine-coated multi–lumen) colonisation and catheter-related bacteremia. CVC's were inserted in ICU and if in situ on day 4, were randomised to have IV

administration sets changed on day four (n-203) or when the catheter was replaced at seven days (n-201) There were 10 colonised CVC's in the group receiving a set change and 19 in the group not receiving a set change (no statistically significance difference on Kaplan-Meier survival analysis). There were 3 cases of catheter-related bacteraemia per group. The authors concluded that administration sets (including burettes, infusion lines, caps, bungs, and extension lines) attached to chlorhexidine gluconate and silver sulphadiazine coated multi lumen CVC's should be changed at Day 7 or when the catheter is changed. Although the study included parentral nutrition and lipid therapy, it was our consensus opinion to exclude blood products, parentral nutrition and propofol. However as already stated, this study was conducted with chlorhexidine gluconate and silver sulphadiazine coated multi lumen CVC's, so findings cannot be applied to non-coated CVC's.

A Cochrane review on the optimal timing for intravenous administration set replacement (Gillies, O'Riordan et al. 2005) identified 18 papers. Of the 13 included studies 6 were conducted in an intensive care unit, 2 in an oncology unit, and 5 were conducted in a variety of settings. Therefore, it might be possible, that these findings are not completely representative of patients who are more likely to develop CLAB and related effects. There was no significant difference in the risk of all-cause BSI when studies that reported data from adults only, were compared to studies that reported data for children or infants only. There was no difference in infusate colonization or catheter colonization between peripheral catheters and CVC's, but the risk ratio for infusate catheter related BSI could not be calculated, as there were no included studies that reported catheter-related BSI data for patients with peripheral catheters only. The authors concluded that administration sets (including burettes, infusion lines, caps, bungs, and extension lines) attached to CVC's should be changed at intervals of up to 96 hours. Although some studies included parentral nutrition and lipid therapy, the evidence was weak and it was our consensus opinion to exclude blood products, parentral nutrition and lipid based fluids (for example propofol), until further trials were performed. There was no mention in the systematic review whether antimicrobial, coated, or uncoated CVC's were used.

The EVP panel agreed with all recommendations however minor changes to the wording of some recommendations was made to reduce confusion.

Figure 2: An example of a multi flow adaptor



Section 2: Daily care of IV Administration Sets		
Number	Recommendation Statement	Grade of Recommendation and Key reference.
2a	Intravenous lines attached to a CVC should be secured to the patient so that there is no tension applied to the catheter or sutures.	Consensus opinion
2b	Catheter lumens and sampling ports (including needleless injection sites and blood sampling ports) must be wiped with an alcohol swab **before and after use** to decontaminate and remove any particulate matter[1].	NHMRC A
2c	Unused CVC lumens and multiflow adaptors must be clamped to prevent air emboli and backflow of blood, protein or lipid solutions.	Consensus opinion

There are a number of potential problems that can occur if tension is applied to the intravenous lines attached to a CVC. These include: 1) pain and discomfort for the patient; 2) partial or total dislodgment of catheter resulting in failure to administer intended therapies and/or need for catheter replacement; and 3) lifting of the dressing which creates an entry point for organisms. For these reasons the GDN members felt that it is important that the intravenous lines are secured to the patient.

Injection and sampling ports are accessed on numerous occasions throughout any single day. Additionally blood, fluids or other biological matter may collect. This medium creates numerous opportunities for microorganisms to be introduced to the patient. The CDC recommends cleaning of these ports before accessing the system (O'Grady, Alexander et al. 2002). During discussions the GDN members concluded it was important that the system be cleaned both immediately before and after accessing the system.

The use of multi lumen CVCs are common in intensive care however there are occasions where a CVC lumen or a section of a multi-flow adaptor may not be in use. This can create opportunities for problems to develop 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. For these reasons it is important that the slide clamps on the unused CVC lumens and multi-flow adaptors are used.

The EVP panel agreed with all recommendations.

[1] Particulate matter refers to any organic substance or drug.

Section 3: IV fluid bag changes		
Number	Recommendation Statement	Grade of Recommendation and Key reference.
3a	Crystalloid solutions without drug additives (e.g. normal saline, 5% dextrose) should be changed only with administration set or catheter change, and when infusion is completed.	Consensus opinion
3b	All blood products should be infused within 4 hours and the line then discarded, with the exception of Factor VIII or IX prepared for continuous infusion.	Consensus opinion (O'Grady, Alexander et al. 2002)

No literature was identified to assist in providing information on when it is appropriate to change IV flasks. Following discussion by members of the network, consensus was reached those crystalloid solutions without drug additives (for example normal saline or 5% dextrose) should only be changed with administration set or catheter change, and when infusion is completed. However flasks containing blood or blood products should be infused within four hours and the tubing discarded unless transfusions are followed by further products. There may be exceptions for some blood products and clinicians should refer directly to instructions provided.

The EVP panel agreed with all recommendations.

Section 4: Antiseptic solution and cleaning of the skin and catheter		
Number	Recommendation Statement	Grade of Recommendation and Key reference.
4a	Chlorhexidine 2% based solution is the preferred antiseptic for insertion and dressing of CVCs. If this is not available, Chlorhexidine 0.5% in 70% alcohol should be used.	NHMRC A (Pratt, Pellowe et al. 2007)
4b	Sterile normal saline or chlorhexidine gluconate should be used to remove dried blood or other fluids from around the catheter, especially under the catheter hub, prior to cleaning with the chlorhexidine in alcohol.	Consensus opinion
4c	Once antiseptic is applied, air-drying for 2 minutes is required or as per manufacturer's instructions.	NHMRC B (O'Grady, Alexander et al. 2002)
4d	Do not use antibiotic creams on insertion sites.	NHMRC A (Pratt, Pellowe et al. 2007)
4e	Do not use organic solvents (e.g. acetone or ether) on the skin or around the CVC.	NHMRC A (O'Grady, Alexander et al. 2002)

Cutaneous antisepsis before catheter insertion and during dressing changes may be undertaken using 2% chlorhexidine solution, tincture of iodine or 70% alcohol (O'Grady, Alexander et al. 2002). A recent meta-analysis identified eight papers and found that patients whose CVC sites were disinfected with chlorhexidine gluconate instead of povidone iodine had a summary risk ratio for catheter-related bloodstream infection of 0.49 (95% CI, 0.28 to 0.88)(Chaiyakunapruk, Veenstra et al. 2002). In Australia access to some of these solutions may be difficult so an alternative solution such as chlorhexidine 0.5% in 70% alcohol is recommended. However the choice of solution must also be guided by the manufacturer's recommendations for solutions known to be compatible with catheter materials. Consideration also needs to be given to the condition of the patient's skin at the insertion site and any known or likely allergies. Once the antiseptic is applied, air-drying is required which may take two minutes or longer (O'Grady, Alexander et al. 2002). If there is dried blood or other fluids around the catheter or insertion site sterile normal saline or chlorexidine gluconate can be used prior to antisepsis with chlorhexidine 2%. Future investigations may be warranted to compare the efficacy of widely used antiseptic solutions in Australia to those reported overseas.

The efficacy of application of antibiotic ointments to the insertion site has not been demonstrated (Pratt et al, 2007) and there are concerns regarding promotion of fungal infection or antibiotic resistance, therefore

this is not recommended for CVCs used for common intensive care purposes (O'Grady, Alexander et al. 2002). Organic solvents have the potential to impact on the integrity of the CVC and should not be used (O'Grady, Alexander et al. 2002).

The EVP panel agreed with all recommendations.

Section 5: Dressing of the Catheter and Insertion Ste		
Number	Recommendation Statement	Grade of Recommendation and Key reference.
5a	A sterile transparent semi permeable dressing must be used. As per NSWHealth Infection control Policy (PD2007-36)	NHMRC B (O'Grady, Alexander et al. 2002)
5b	Transparent dressings should be changed at least every 7 days or sooner if: i. The dressing is not intact i.e. there is no longer a seal; ii. There is evidence of inflammation; iii. There is excessive accumulation of blood and or moisture under the dressing.	NHMRC A Consensus Opinion
5c	Gauze dressing is preferable to a transparent dressing if patient is diaphoretic, or if the site is bleeding or oozing.	NHMRC B (Pratt, Pellowe et al. 2007)
5d	Sterile gauze and tape dressing should be changed daily, and whenever loose, soiled, or moist.	Consensus Opinion (Pratt, Pellowe et al. 2007)
5e	Whatever dressing type is used for the CVC, the dressing should: i. Be positioned so the catheter insertion site is in the centre of the dressing; ii. Cover the catheter from the insertion site to the hub; and iii. Create a complete seal from the catheter hub through to the insertion site.	Consensus Opinion
5f	Use of commercially available chlorhexidine impregnated sponge dressing may be considered.	NHMRC C

The CDC guidelines recommend a sterile transparent semi permeable dressing unless the dressing is unlikely to remain in place such as when the patient is diaphoretic or the insertion site is bleeding or oozing. A systematic review (Gillies, O'Riordan et al. 2003) identified eight suitable studies (publication years 1966-2000) with six studies suitable for meta-analysis, and found there was no differences in infectious outcomes when either a gauze or transparent dressing was used. However all studies had small sample sizes. Limited literature was identified since 2000 however EPIC2 also recommends the dressings as listed above (Pratt, Pellowe et al. 2007). The type of dressing advised for CVC's are sterile transparent semi permeable dressing as these facilitate assessment of the site and allow water vapour to dissipate; however, gauze and tape

dressing may be preferred when the patient is diaphoretic, or if the site is bleeding or oozing. Dressing change frequency is recommended at every 7 days for transparent dressings, and daily for sterile gauze and tape dressings. In both dressings types the dressing should be changed more frequently if they become loose, soiled and moist. While there are a number of different methods of applying a dressing it is important that the dressing creates a cover over the entire length of the exposed catheter including the catheter junction hub and a seal created to minimise the tracking of organisms along the length of the catheter. Choice of dressing technique should be influenced by the complexity of the dressing technique and the difficulty of maintaining asepsis. A review of risk factors for CLAB reported that contaminated catheter junction hubs were closely associated with CLAB [OR 17.9-44.1], however the primary document could not be sourced (Safdar, Kluger et al. 2002). Commercially available impregnated sponge dressings may also be considered (O'Grady, Alexander et al. 2002).

The EVP panel agreed with all recommendations. In addition the order of recommendations has been revised to reflect comments.

Section 6: Nursing Governance		
Number	Recommendation Statement	Grade of Recommendation and Key reference.
6a	Only competent nursing staff should change CVC dressings and lines.	NHMRC A (Pratt, Pellowe et al. 2007)
6b	CVC insertion sites should be systematically assessed each shift and findings documented in the patient notes. Any pain, indurations, leakage, redness or exudate should be reported to medical staff.	Consensus Opinion
6c	To prevent errors or breaches of asepsis, line and dressing changes should be performed when the clinician is unlikely to be interrupted.	Consensus Opinion

Nursing management of a CVC is complex and includes: 1) catheter site care such as dressings; 2) line changes; 3) daily assessment; and 4) prevention of error. Both the CDC and EPIC guidelines consider that CVC care must be undertaken by competent practitioners to not only ensure the patient receives the appropriate treatment but also to prevent CLAB and other potential iatrogenic complications (O'Grady, Alexander et al. 2002; Pratt, Pellowe et al. 2007). Novice practitioners will be able to acquire these competencies under a structured education program that includes clinical supervision.

The EVP panel agreed with all recommendations.

Process of Guideline Development

1. *Introduction*

The CVC GDN was established at the 'Getting Evidence into Practice' workshop held on June 14 2005 (http://intensivecare.hsnet.nsw.gov.au/five/htm/education.php). At this meeting senior nurses, from NSW ICUs as nominated by the nursing unit managers, self-selected into a GDN. In the period between June 2005 and December 2006 GDN meetings were convened via teleconference with ICCMU CNC coordinating the process. At the initial meeting the scope and state of current practice was established and issues related to nursing care of a CVC were brainstormed. At subsequent meetings a clinical question and literature review protocol were developed and literature review tasks allocated [see Integrative literature review]. A data extraction tool was developed by the project manager and academic lead [see Appendix 1] and GDN member training completed during a scheduled meeting. The project manager collated the article reviews and these compilations were sent to GDN members some weeks prior to the Intensive Care Collaborative Development Conference (ICC-CDC).

Midway through 2006, a group of critical care academics from Australia and New Zealand were identified as academic facilitators for each GDN. A number of meetings were held to establish the final processes of guideline development in particular the taxonomy for levels of evidence and recommendations and consensus development [see Box A].

2. *Description of Consensus development process*

On Friday December 1 2006 the ICC-CDC was held where all of the GDNs met to develop the recommendations for practice under the facilitation of an Australasian critical care academic. Each GDN followed the processes outlined in Box A. The CVC GDN established that there had been only a limited number of publications published since the CDC guidelines of 2002 (O'Grady, Alexander et al. 2002).

Box A: Process of consensus development at ICC-CDC

1. Establish current practice
2. Revisit clinical question
3. Review papers
    a. Include relevant papers
    b. Assign level of evidence for each paper
4. Recommendation
    a. Develop statement
    b. Assign grade of recommendation
        i. From literature
        ii. Expert opinion
5. Assign agreement using Likert Scale
6. Review voting - consensus is a median of 7-9
7. Revisit process once only if consensus not reached

3. Guideline construction

The authors using the recommendations developed at ICC-CDC as well as a second consensus round to cover missing recommendations constructed this guideline. The primary authors were Kaye Rolls and Judy Currey however all GDN members contributed to the narrative supporting the recommendations statements. The final draft was sent to the GDN for review prior to external validation.

4. External Validation Panel

Validation of the guideline was conducted by external validation panel (EVP) using a limited Delphi round conducted in May-June 2007.

4a. Formation of Panels

Panel members (n=48) for all guidelines were identified using professional networks and associations and were allocated to a specific guideline using two processes. First, there were nine panel members who were approached directly because of their acknowledged expertise with a particular practice (including research or employment role). Secondly the majority of panel members were randomly allocated to a specific guideline by placing all names into a hat and assigning names sequentially to each guideline until names and panel positions were exhausted. In order to describe the panels, panel members were asked to provide limited demographic data additionally they completed a 'conflict of interest' form.

Table 3: External Validation Panel for CVC guideline

EVP role	Name	Position and Facility
Nursing academic	Dr Sharon McKinley	Professor of Critical Care Nursing Research Development Coordinator University of Technology Sydney
Nursing academic	Dr Claire Rickard	Professor of Nursing Griffith University, Nathan Campus Brisbane, QLD
Clinical nurse	Karl Askew	ANUM ICU, St Vincents Health Melbourne, VIC
Clinical nurse	Tim Spencer	CNC Liverpool Hospital Liverpool, NSW
Clinical nurse	Hailey Carpen	CNC Liasion Nepean ICU, Kingswood, NSW
Clinical nurse	Marghie Murgho	Project Officer, Clinical Excellence Commission, NSWHealth, NSW
Intensive care medical specialist	Dr Patricia Figgis	Staff Specialist ICU Prince of Wales, Randwick , NSW
Intensive care medical specialist	Dr Michael Parr	Director ICU Liverpool Hospital Liverpool, NSW

4b. Method of validation

Panel members received the draft guideline and the literature review (which included the data extraction tools completed by the GDN members) along with a recommendation agreement form. They were then asked to assign their level of agreement (Likert 1-9) with the recommendation statement. A median score of 7 was set for consensus to be reached.

Table 4: Results of external validation process

Recommendation	25th	Median	75th	minimum	maximum
1a	7	8	8	7	9
1b	7.5	8	8	7	9
1c	7.5	8	9	5	9
1d	6.5	8	8.5	6	9
2a	7.5	8	9	7	9
2b	7.5	9	9	7	9
2c	7.5	8	9	7	9
3a	7	8	8.5	1	9
3b	6.5	8	8	5	9
4a	7	8	8.5	2	9
4b	7	8	8.5	6	9
4c	8	8	8.5	7	9
4d	8	9	9	7	9
4e	8.5	9	9	8	9
5a	7.5	8	9	7	9
5b	8	9	9	7	9
5c	7	8	8.5	1	9
5d	7.5	8	9	7	9
5d	8.5	9	9	7	9
5f	5.5	7	7.5	5	8
6a	6.5	7	9	5	9
6b	7	9	9	7	9
6c	7	8	8.5	3	9

Integrative Literature Review

1. *Introduction*

Using the PICO model (Leslie and Finn, 2003), the literature review sought to identify studies published between 2000 and 2005 that included the following three criteria: (1) adults in a critical care unit with a CVC; (2) study interventions that addressed the management of CVCs after insertion such as: a) antiseptic and cleaning solutions; b) dressing type; c) management of intravenous solutions; and d) management of intravenous lines including change frequency and access issues; and (3) outcomes as measured by the incidence of catheter-related blood stream infections or CLAB and local site infection. Key words used to conduct the search included central line associated bacteraemia, catheter-related blood stream infections, site infection, lumen patency, central line, central venous access, critically ill, flush solution, line change frequency, technique, frequency, antiseptic, chlorhexidine and type of dressing. Databases searched included CINAHL, Medline, Pubmed, Google and Google Scholar. Unpublished data were not accessed, use of search filters was limited and not all reference lists were checked to additional studies related to the central venous catheter focus. Most data supporting these recommendations were based on guidelines for CVC management published by the Centres for Disease Control and Prevention (O'Grady et al. 2002). During the guideline writing phase the EPIC2-Evidence based Practice Infection control guidelines were published and these recommendations been amalgamated (Pratt et al 2007).

Based on a checklist provided by ICCMU, single reviewers critically appraised the literature. The CVC GDN group collectively rated each paper using the National Health and Medical Research Council (NHMRC) intervention grading criteria. Statements based on study findings were formulated in relation to each aspect of managing CVCs, and were graded against the NHMRC criteria. Where formulated statements were unsupported by study findings, statements were constructed and consensus opinion regarding the expressed statement was sought through an explicit process.

2. *Literature Search Protocol*

<table>
<tr><td colspan="5">Structured Research Question:</td></tr>
<tr><td colspan="5">What clinical practices are most effective in maintaining line patency and preventing central line associated bacteraemia (CLAB) for the critically ill adult with central venous catheter?</td></tr>
<tr><td colspan="5">For the critically ill adult with a central venous catheter:
1. What is the frequency of line changes required to prevent central line associated bacteraemia (CLAB)?
2. What is the most effective cleaning solution/antiseptic to use when dressing the line?
3. What dressing technique (type, frequency and method of dressing) is most effective in maintaining line integrity and minimises central line associated bacteraemia (CLAB)?
4. What flush bag solution is most effective (saline vs heparin) in maintaining lumen patency?
5. What flushing techniques (solution, frequency and methodology) are the most effective in maintaining the patency of the unused lumens of a central line?
6. What are the competencies required by nursing staff that promote effective central line management?</td></tr>
<tr><td>P</td><td>Population (of interest)</td><td colspan="3">Critically ill adult</td></tr>
<tr><td>I</td><td>Intervention</td><td colspan="3">Central line</td></tr>
<tr><td>C</td><td>Control (group)</td><td></td><td>N/A</td><td>✓</td></tr>
<tr><td>O</td><td>Outcome (measured)</td><td colspan="3">Central line associated bacteraemia (CLAB)
Local infection (site infection)
Lumen patency</td></tr>
<tr><td colspan="2">Search Strategy</td><td colspan="3"></td></tr>
<tr><td colspan="2">Databases:</td><td colspan="3">All</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
</table>

Key words: All Central line associated bacteraemia (CLAB) Local infection (site infection) Lumen patency Central line Central venous access Critically ill		Lines and fluids	flush solution line change frequency
		Dressings	technique frequency antiseptic chlorhexidine betadine type
		Competencies	
Publication years:	2000-2005		
Other search filters:			
English language only	Yes		
Adult	Yes		
Human	Yes		
Abstracts	yes		

3. *Literature Review Process*

Articles were assigned two reviewers and reviews were completed using the critical appraisal tool. The project manager collated the reviews and these can be found at the ICCMU website. Apart from editing, reviews were kept in the form returned by GDN members.

4. *Literature Synthesis Process*

The systematic review, consisting of the articles reviews, was sent to the GDN members for review. An online forum was established to facilitate discussion however this was not used. The literature was discussed further at the ICC-DC and levels of evidence applied (for both individual studies and recommendations) using the NHMRC taxonomy.

Table 5: NHMRC Designations of Levels of Evidence

Level	Intervention	Number of Papers identified
I	A systematic review of level II studies	4
II	A randomised controlled trial	1
III-1	A pseudorandomised controlled trial (i.e. alternate allocation or some other method)	
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	2

Table 6: NHMRC Grading of Recommendations

Component	A	B	C	D
	Excellent	Good	Satisfactory	Poor
Volume of evidence	several level I or II studies with low risk of bias	one or two level II studies with low risk of bias or a SR/multiple level III studies with low risk of bias	level III studies with low risk of bias, or level I or II studies with moderate risk of bias	level IV studies, or level I to III studies with high risk of bias
Consistency	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 different to target population for guideline but it is clinically sensible to apply this evidence to target population	population/s studied in body of evidence different 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

Table 7: Summary Tables of Research Papers included

Short reference	Design/Method	Sample Description	Outcomes/findings	Methodological Quality
Chaiyakunapruk N. Veenstra DL. Lipsky BA. Saint S. 2002 Chlorhexidine compared with povidone-iodine solution for vascular catheter-site care: a meta-analysis. Annals of Internal Medicine. 136(II):792-801 Level of Evidence: I	ID literature Manual search of index medicus (1960-1965); reference list of retrieved articles; and conference proceedings. Electronic search of medline (1966-2001); CINAHL (1982-2001); Doctoral dissertation abstracts (1861-2001); International Pharmaceutical Abstracts (1970-2001); EMBASE; Lexis-Nexus, Web of Sciences and Cochrane Library databases Manuafacturers of chlorhexidine	RCT comparing any CHX to povidone-iodine solution for vascular catheter site care; Report the incidence of catheter colonisation or CRBSI with sufficient data to calculate risk ratio N=302 culled to 8	• Colonisation favours CHX : RR 0.49 (95% CI 0.31-0.71) • Absolute Risk reduction 7.1% • Test for heterogeneity $p < 0.0001$ • CRBSI favours CHX : RR 0.49 (95% CI 0.28-0.88) • Absolute Risk reduction 1.1% • Test for heterogeneity $p=0.2$ • The subset of articles (n=5) using CHXin alcohol produced the significant reduction in CRBSI	• Different CHX preparations and concentrations • Non-standard definitions of CRBSI • Heterogeneity of catheter duration caused by 1 study
Rickard CM, Lipman J, Courtney M, Siverson R, Daley P (2004): Routine changing of Intravenous Administsration sets does not reduce colonization or infection in Central Venous Catheters. Infection Control and Hospital Epidemiology, 2004 Aug, 25(8): 650 -5 Level of Evidence: II	Randomised control trial. Australian ICU. Medical staff and Intensivist reviewing microbiological results was blinded. CVC inserted in ICU & in situ D4.IV sets change D4 (n=203) or not changed (n=201) for duration of catheter (up to D 7). Fluid containers changed every 24 hrs. Blood products discarded after use. CVC's removed at D7, or before, if not needed, or suspected infection. Sets containing PN, lipids included in study CVC's removed by RN. Distal portion of CVC cultured using semiquantitative techinique. Intensivist r/v micro results & blood & other sites & cases of SIRS using strict def.	Unit of measure was CVC. 251 patients with 404 chlorhexidine gluconate & silver sulfadiazine coated multiple lumen CVC's (3-4 lumens per CVC). 203 CVC's randomised to group receiving line changes on D4; 201 to group not receiving line change. CVC's sutured & non tunnelled. Inserted in ICU & in situ on D4	• 375 CVC's. • 10 in group receiving set change on D4 colonized vs 19 in group not receiving change. • The 29 colonized CVC's belonged to 23 pts. • 3 Cases of CLAB in group receiving set change & 3 in group not receiving change. • Patients with burns or increased ICU days on catheter insertion were more susceptible to colonization. • Skin site most dominant route of colonization.	• Lost 29 CVC's due to autopsy or lost or contaminated specimens (equally distributed between groups – n=14 vs n=15). • Left only 375 catheters when 392 were needed. • Different culture method favouring internal luminal culture might have shown different results in colonization

Review name	Review Question/Outcomes	Search strategy	Findings	Limitations
Gillies D. O'Riordan E. Carr D. O'Brien I. Frost J. Gunning R. (2003) Central venous catheter dressings: a systematic review. *Journal of Advanced Nursing. 2003 Dec; 44(6): 623-32.* Level of Evidence: I	To identify whether there are any differences between gauze and tape and/or transparent polyurethane film dressings in the incidence of CVC-related infection, catheter-related sepsis, catheter security, tolerance to dressing material, dressing condition and ease of application in hospitalised patients.	Databases: CINAHL, Medline, Dare, Cochrane, reference list Data extraction by two reviewers, differences resolved by third party or consensus Authors contacted for missing information	23 – cull to 6 • two compared gauze and tape with Opsite IV3000, • two compared Opsite with Opsite IV3000, • one compared Tegaderm with Opsite IV3000, • one compared Tegaderm with Opsite. Conclusions: There was no evidence of any difference in the incidence of infectious complications between any of the dressing types compared in this review. Each of these comparisons was based on no more than two studies and all of these studies reported data from a small patient sample. Therefore it is unlikely that any of these comparisons would have had sufficient power to detect any differences between groups.	
Gillies, D, O'Riordan L, Wallen M, Morrsison A, Rankin K, Nagy S (2005): Optimal timing for intravenous administration set replacement. Cochrane library, volume (1) 2006 *Population* All patients Level of Evidence: I	What is the optimal interval for the routine replacement of IV administration sets when infusate or parenteral nutrition (lipid and non-lipid) solutions are administered to people in hospital via central or peripheral venous catheters *Interventions*: Longest interval between administration set changes that did not increase risk of infection (24 vs 48 hrs, 48 vs 72 hrs, 72 vs 96 hrs *Outcomes*: Infusate colonization, Infusate-related BSI, Catheter colonization, Catheter-related BSI, All-cause BSI, Mortality Subgroup analysis: Central vs Peripheral catheter, children vs adults, PN vs infusates	*Keyword/s* catheter colonization, catheter related BSI, Infusate colonization, Infusate related BSI, administration set change, *Data bases* • CINAHL • Yes 1982 → Feb 2004 • Embase • Yes 1980 → Feb 2004 • Cochrane • Yes (CENTRAL) Issue 1 • CDSR • DARE Searched it, but did not identify reviews which addressed topic • Hand search • Contacted researchers in field • Medline 1966→2004, • Reference list of identified trials, bibliographies of published reviews *Method*: • Piloted data extraction tool • 2 reviewers per paper (5 reviewers) Resolved disagreement through consensus or consultation with 3rd member	23 articles retrieved – cull to 10 • Infusate colonization: no diff up to 96hrs. • Infusate related BSI: only found in 1 study up to 48 hrs. • Catheter colonization: no diff up to 96 hrs, • Catheter related BSI: no diff up to 96 hrs only from 6 studies. • All cause BSI: no diff up to 72 hrs. • Mortality: Higher mortality in 24 hr group than 48 hrs. • Subgroup analysis: • Catheter site: no diff between central or peripheral catheter with infusate-, or catheter colonisation. Could not calculate risk ratio for infusate, or catheter related BSI. • Type of Infusion: no diff between patients receiving PN or infusates in catheter colonization, catheter- related BSI, all cause BSI. Could not calculate risk ratio for infusate-related BSI as 0 in all studies. • Age group: No diff in all-cause BSI between infants, children or adults. • Infusate related BSI not calculated	

SAFDAR, NASIA M.D.; KLUGER, DANIEL M. M.D.; MAKI, DENNIS G. M.D. A Review of Risk Factors for Catheter-Related Bloodstream Infection Caused by Percutaneously Inserted, Noncuffed Central Venous Catheters: Implications for Preventive Strategies . *Medicine 81 (6)* Level of evidence: I	*Clinical Question / Review method* Not explicitly documented English-language prospective studies in adults were identified by a MEDLINE search The following criteria were required for a study to be included in this analysis: • the exact type of device was described; • all devices were prospectively evaluated for risk of device-related bloodstream infection • the relative risk of device-related bloodstream infection was evaluated by a multivariable regression model	*Keywords:* risk factors, intravascular devices, central venous catheter *and* infection	• Increased risk: • Nurse-to-patient ratio 1:2 (OR61.5) • Nurse-to-patient ratio 1:1.5 (OR15.6) • Nurse-to-patient ratio 1:1.2 (OR 4) • Internal jugular (OR 1-3.3) • Femoral vein (OR3.3-4.83) • Placement in an old site by guide wire exchange (OR 1-3.3) • Heavy colonization of the insertion site (OR6.3-56.5) • Contamination of a catheter hub (OR17.9-44.1) • Duration of CVC placement > 7 days (OR 1-8.7)	Lack of information regarding • clinical question • review method • methodology of studies Likelihood of missed research due to limited search strategy.

O'Grady (2002) Guidelines for the prevention of intravascular catheter-related infections. Infection control and hospital epidemiology 23 (12) Summary of recommendations as related to nursing management of CVC

Focus of Guideline - Prevention of catheter related blood stream infection (CRBSI)
Healthcare Infection Control Practice Advisory Committee (US Based broad based consultative committee).
Process of guideline creation very limited information available

Review method - Recommendations use CDC/HICPAC systems
Category IA: strongly recommended for implementation and strongly supported by well-designed experimental clinical or epidemiologic studies.
Category IB: strongly recommended for implementation and sported by some experimental, clinical or epidemiologic studies and a strong theoretical rationale.
Category IC: Required by state or federal regulations, rules or standards
Category II: suggested for implementation and suggestive clinical or epidemiologic studies or a theoretical rationale.
No recommendations: Unresolved issue: issue where evidence is insufficient or not consensus regarding efficacy exists

I - Healthcare worker education & training

- Educate regarding indicators for use (Level of Recommendation - IA).
- Assess knowledge of adherence to guidelines (Level of Recommendation - IA).
- Ensure appropriate nursing mix (Level of Recommendation - IA).

II - Surveillance

- Monitor & assess daily for infection (Level of Recommendation - IB).
- Record operator date & time of catheter insertion & dressing on a standardised form. (Level of Recommendation – II).
- Do not routinely culture catheter tips (Level of Recommendation –IA).

III - Hand hygiene

- Observe proper hand hygiene procedures (Level of Recommendation - IA).
- Gloves do not obviate the need for hand hygiene (Level of Recommendation –IA).
- Clean or sterile gloves when changing dressings. (Level of Recommendation - IC).

IV Aseptic Technique during catheter insertion and care

- Maintain aseptic technique for care of intravascular catheters (Level of Recommendation - IA).
- Wear clean or sterile gloves when changing the dressing on intravascular catheters (Level of Recommendation - IC).

VI – Catheter site care

- Cutaneous antisepsis – 2% chlorhexidine preferred however tincture of iodine, an iodophor or 70% alcohol is acceptable [37-40] (Level of Recommendation - IA).
- Do not apply organic solvents during dressing changes [41](Level of Recommendation - IA).

VII – Catheter-site dressing regimens

- Use either sterile gauze or sterile, transparent semi permeable dressing to cover the catheter site (Level of Recommendation - IA).
- If the patient is diaphoretic or bleeding a gauze dressing is preferable. (Level of Recommendation – II).
- Replace dressing when damp, loosened or visibly soiled (Level of Recommendation – IB).
- Change dressing according to patient need however should be done at least weekly (Level of Recommendation – II).
- Use topical antibiotic creams or ointment at insertion sites for dialysis catheters (Level of Recommendation - IA).
- Do not submerge catheter or lines under water. If showering cover catheter and lines with an impermeable cover (Level of Recommendation – II).

IX – Replacement of administration sets, needless systems and parentral fluids

- Replace all tubing and components no more frequently than 72 hrs unless catheter-related infection is suspected (Level of Recommendation - IA).
- Replace tubing used for blood, blood products or lipid emulsions (including 3-1 admixtures of amino acids, glucose and lipids) within 24 hrs of initiation (Level of Recommendation – IB).
- Replace tubing used for admixtures of amino acids and glucose no more frequently than 72hrs (Level of Recommendation - II).
- Change needle-less components at least as frequently as the administration set (Level of Recommendation - II).
- Change the caps after 72hrs or according to manufacturer's recommendation (Level of Recommendation – II).
- Ensure that all components of the administrative system are compatible to minimize leaks and breaks in the system (Level of Recommendation - II).
- Minimize contamination risk by wiping the access port with an appropriate antiseptic and accessing the port with sterile devices (Level of Recommendation – IB).
- Infusions containing only lipid emulsions should be completed within 12 hrs or if there are volume considerations within 24hrs (Level of Recommendation – IB).
- Complete infusion of blood or blood products within 4hrs of hanging (Level of Recommendation - II).
- Clean Injection ports with 70% alcohol or an iodophor before accessing the system (Level of Recommendation – IA).
- Cap all stopcocks when not in use (Level of Recommendation - IB).
- Do not use filters routinely for infection control purposes (Level of Recommendation - IA).

Table 8: Summary of Literature not included

Full name of paper	Reasons for non inclusion
Garland, JS., Alex CP., Mueller CD, Otten D., Shivuri C., Harris MD et al., 2001., A Randomised trial comparing povidine-iodine to a chlorhexidine gluconate impregnated dressing for prevention of central venous catheter infections in Neonates., Chlorhexidine reduced catheter tip colonisaion more than 10% povidone-iodine in critically ill neonates, Evidence Based Nursing;5;73	Wrong population
Kline AM., 2005., Pediatric catheter related bloodstream infections. Latest strategies to decrease risk	Wrong population
Maki, D.G., Crinch, C.J. 2003 Seminars is Respiratory and Critical Care Medicine, 24(1) pp23-36 Reviewer 2	Same recommendations as CDC
McGee (2003)Current Concepts: Preventing Complications of Central Venous Catheterization, N Engl J Med 2003; 348:II23-33. Reviewer 1	Same recommendations as CDC

Appendix 1 – Data Extraction Tools

Primary Study	The empty cells are for describing or discussing the concept above. If RCT use validity Checklist at bottom of page - Cells will expand / use small font			Use article in systematic review narrative Yes /No
Full reference → Ethics approval sort/gained Yes/No				
Study Aims/Objectives	Setting	Sample Inclusion/exclusion criteria	Interventions	Outcome Measure/s
Short reference	Design/Method	Sample Description	Outcomes/findings	Methodological Quality
Is the literature review adequate? Yes/No	Does the method suit the question/s? Yes/No	Sample size calculated and then achieved? Yes/No	Statistical significance? Yes/No	What are the authors conclusions ?
Are data collection instruments adequately described? Yes/No	RCT or quasi-experimental? Yes/No (RCT score)	Is the sample homogenous? Yes/No	Clinical significance? Yes/No	Clinical Bottom Line
Were data collection instruments validated? Yes/No	Were the statistics used appropriate? Yes/No	Were all patients enrolled accounted for? Yes/No	Is there enough information to judge results? Yes/No	

Randomised Control Trial Validity Checklist #	Yes	No	?		Yes	No	?
Was the assignment to treatment groups really random?				Were the control and treatment groups comparable at entry?			
Were the participants blinded to treatment allocation?				Were groups treated identically other than for the named interventions?			
Was allocation to treatment groups concealed from allocator?				Were the outcomes of people who withdrew described and include in the analysis (ie was the analysis by intention to treat?)			
Were those assessing outcomes blind to the treatment allocation?				Were outcomes measured in a reliable way?			
				Was an appropriate statistically analysis used?			

Reviews – systematic and narrative

→ Use one per article which is a review of the literature.
→ Please be brief. Cell size is locked so add text; use a smaller font size to fit your conclusions in.
→ Where yes/no is asked for, text can be added to flesh out answer.
→ Where a number exists, please refer to the expanded question.
→ For the databases searched please add a tick ☑ and describe the hand search strategy.

1. Is there an explicit review plan documented?
2. Was an explicit search strategy documented?
3. Was an explicit article review method used?
4. Were points 1-3 covered adequately?
5. Does the summary of each reviewed study reflect the essential components of the study design, research process and analysis techniques?
6. Is the organisation of the reviewed studies chronological and logical?
7. Does the organisation of the reviewed studies lead the reader to the same conclusions as the authors?

<table>
<tr><td>Full Reference ⇨</td><td colspan="5"></td></tr>
<tr><td colspan="2">1 - Review Plan - Yes/No</td><td colspan="2">3 - Review Method - Yes/No</td><td>Findings</td><td>Synthesis</td></tr>
<tr><td colspan="2">Clinical Question -</td><td colspan="2" rowspan="2">What was the article review method?</td><td>Are all the relevant concepts and variables included? Yes/No</td><td>6 - Organisation chronological/logical? Yes/No</td></tr>
<tr><td colspan="2" rowspan="2">→ Population -</td><td rowspan="2">5 - Summary Yes/No</td><td rowspan="2">7- Organisation ⇨ Conclusions? Yes/No</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">→ Intervention/s</td><td colspan="2">Are all articles found accounted for? Yes/No</td><td colspan="2" rowspan="4">What are the key findings of the Review?</td></tr>
<tr><td colspan="2">→ Outcome/s</td><td colspan="2">Type of review?</td></tr>
<tr><td colspan="2">2 - Search Strategy</td><td colspan="2">4 Quality of the review –</td></tr>
<tr><td colspan="2">Keyword/s (list)</td><td colspan="2">Limits (list)</td></tr>
<tr><td>Search Time Line</td><td colspan="3"></td><td colspan="2" rowspan="5">Are the conclusions of the authors warranted? Yes/No & discuss</td></tr>
<tr><td colspan="2">Data Bases – adequate? Y/N</td><td colspan="2">Please tick list below ☑</td></tr>
<tr><td>CINAHL</td><td>Pubmed</td><td>Embase</td><td>Cochrane</td></tr>
<tr><td>Psych info</td><td>DARE</td><td>Hand search</td><td>Other</td></tr>
</table>

References

Chaiyakunapruk, N., D. L. Veenstra, et al. (2002). "Chlorhexidine Compared with Povidone-Iodine Solution for Vascular Catheter–Site Care: A Meta-Analysis." Annals of Internal Medicine **136**: 792-801.

Gillies, D., E. O'Riordan, et al. (2003). "Central venous catheter dressings: a systematic review." Journal of Advanced Nursing **44**(6): 623-632.

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O'Grady, N. P., M. Alexander, et al. (2002). "Guidelines for the prevention of intravascular catheter-related infections." Infection Control and Hospital Epidemiology **23**(12): 759-769.

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