Guidance for New Zealand Hospitals

Preventing central venous catheter–related bloodstream infections

December 2009

Published in December 2009 by:

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This manual is also available on the Infection Prevention and Control Programme website:
www.infectioncontrol.org.nz

ISBN: 978-0-473-16365-5 (web)

Disclaimer

Although every effort has been made to ensure that this guidance document is as accurate as possible, the authors will not be held responsible for any action arising out of its use. District Health Boards and other organisations or individuals involved in implementing a catheter-related bloodstream infection control programme should also refer directly to other documents and evidence referred to in these guidelines; and decide for themselves the most appropriate approach for their particular circumstances.

Table of contents

Acknowledgements

This guidance document is based on a number of existing programmes and published guidelines. In particular, the extensive work of the Institute of Healthcare Improvement in creating the initial '100k lives' and subsequently the '5 million lives' campaigns.

Accordingly, the Catheter-related Blood Stream Infection (CRBSI) Project Team acknowledges the authors of the following documents that have informed the development of this guidance document for New Zealand hospitals.

Institute for Healthcare Improvement. (2008). 5 Million Lives Campaign. Getting Started Kit: Prevent Central Line Infections How–to Guide, Cambridge, MA. (Available at http://www.ihi.org/)

Safer Healthcare Now. (2007). Getting Started Kit: Prevent Central Line Infections How-to Guide, Quebec.
(Available at http://www.saferhealthcarenow.ca/Default.aspx?folderId=82&contentId=184)

Victorian Government Department of Human Services. (2005). Safer Systems - Saving Lives. Preventing CVC Related-Blood Stream Infections. Toolkit. Melbourne. (Available at http://www.health.vic.gov.au/sssl/)

Western Australian Department of Health. (2007). Central Venous Associated Infections (CVC), Perth. (Available at www.safetyandquality.health.wa.gov.au/squire/cvc.cfm)

O'Grady NP, Alexander M, Dellinger EP, et al. (2002). Guidelines for the Prevention of Intravascular Catheter-Related Infections. Centers for Disease Control and Prevention. *MMWR*, 51 (no. RR-10): 1-26.
(Available at http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5110a1.htm)

Pratt RJ, Pellowe CM, Wilson JA, et al. (2007). epic2 National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England. Journal of Hospital Infection, 65S; S1-S64. (Available at http://www.epic.tvu.ac.uk/)

Foreword

The Catheter-related Bloodstream Infection (CRBSI) Project is part of the National Quality Improvement and Infection Prevention and Control Programmes (explained below).

The National Quality Improvement Programme

The National Quality Improvement Programme (NQIP) is one of the programmes initiated by the Quality Improvement Committee (QIC)[i], implemented by District Health Boards (DHBs) and overseen by the Ministry of Health.

NQIP recognises that the most important quality improvement activities are frequently those activities that are planned and undertaken by the staff who deliver services directly to consumers. Health care has, however, become increasingly complex and a strategic, consumer-focused approach to quality improvement at all levels within the system is vital.

QIC has initiated a coordinated national approach to quality improvement to address quality and safety problems within public hospitals because the greatest risks are in this part of the health care system. There are, however, more quality improvement opportunities than there are resources to address them, so programmes have been prioritised to achieve value for money and higher quality services. Each of the priority programmes has a lead DHB for implementation.

More information on QIC and the NQIP can be found on the QIC website http://www.qic.health.govt.nz/.

The Infection Prevention and Control Programme

The Infection Prevention and Control Programme is part of New Zealand's response to the fact that infections contracted in the health care system are a significant problem worldwide.

The Programme is strongly influenced by the June 2003 report of the Controller and Auditor-General '*Management of Hospital-acquired Infection*'.[ii] That report noted that, internationally, up to 10 percent of patients admitted to modern hospitals in the developed world acquire one or more infections.

This is very significant in terms of avoidable patient mortality and morbidity, occupational risks to healthcare workers and health risks to the wider community. In 2003, it was also estimated that annual cost of such infections in New Zealand could be almost $140m nationally.[1]

Chapter 5 of the Ministry of Health 2006 publication '*Scoping Priorities for Quality Improvement in the Health and Disability Sector*' sets out the national programme for infection prevention and control.[iii] That publication notes that "since the landmark reports from the Institute of Medicine in 1999[2] and 2001[3] that documented the deficiencies in quality and safety of care, healthcare has turned to '*high reliability organisations*' (eg,

[i] QIC is a statutory committee established under the New Zealand Public Health and Disability Act 2000. QIC members are appointed by, and accountable to, the Minister of Health.

[ii] http://www.oag.govt.nz/2003/hospital-infections/

[iii] http://www.qic.health.govt.nz/moh.nsf/pagescm/847/$File/prioritiesforquality5.doc

aviation) who have achieved a high degree of safety or reliability despite operating in hazardous conditions."

The Ministry publication goes on to note that, in healthcare, an opportunity for a defect usually translates to a population of patients at risk of the medical error or adverse event. To begin to understand exactly what reliability means in healthcare and how we know if it is reliable, a study was undertaken at Johns Hopkins University by the Quality and Safety Research Group to develop a model of reliability focusing on rate-based measures of safety in a specific clinical area.

The model to improve reliability includes:

- identifying interventions associated with an improved outcome in a specific patient
- selecting interventions that have the biggest impact on outcomes and convert these into behaviours
- developing measures to evaluate reliability
- measuring baseline performance
- ensuring patients receive evidence-based interventions.

The Catheter-related Bloodstream Infection (CRBSI) Project

The New Zealand CRBSI Project builds on substantial international experiences in reducing healthcare-acquired infections. The aim of the New Zealand CRBSI Project is to provide information to assist healthcare staff to prevent central venous catheter (CVC) - related bloodstream infections. In particular, through the piloting and publication of this New Zealand-specific guidance information on CVC 'care bundles'.

Further information on the project is provided throughout the body of this document, in the appendices, or on the project website www.infectioncontrol.org.nz.

After initial, wide consultation and updated draft of this guidance document was piloted by the Auckland, Counties Manukau and Canterbury DHBs during September – November 2009. The primary purpose of the pilot work was to assess the utility of the guidance material so it can be revised and finalised in light of the real-world experience of units and clinicians who utilise central venous catheters (as opposed to demonstrating the effectiveness of implementation of the guidance material in reducing CRBSI – that is because a pilot programme carried out within such a short timeframe cannot develop the statistical power to demonstrate the effectiveness of guidance material implementation).

Accordingly, this final version of the guidance material has been be prepared and published following analysis of feedback from the pilot sites. All DHBs participating in the pilot were supported by the CRBSI Project Team, as outlined in the points below, throughout their participation in the pilot.

- an introductory training seminar, in August 2009, immediately before pilot activities commenced
- the ability to interact directly with project team members through a telephone 'helpline'
- access to printed and electronic resources to be used as is, or adapted for use as appropriate, to meet individual DHB requirements (eg, this guidance document and other reference materials, checklist templates and worked examples).

A multi-disciplinary project team, reporting to me as the DHB Chief Executive with lead responsibility for this national project, carried out the CRBSI project work. I am therefore

delighted to sign-off on this updated draft of the guidance document as a further step in the development of a consistent national approach to CRBSI control.

Effective infection control practices throughout all our hospitals and other healthcare providers will benefit our patients, healthcare workers and the wider community. They also help to ensure that scarce health sector resources are not unnecessarily consumed by healthcare-acquired infections.

Garry Smith
Lead Chief Executive
NQIP Infection Prevention and Control Programme

Introduction

Intravenous catheters are medical devices which travel from outside a patient's skin to the inside of a blood vessel. These devices are vital to modern medical practice, allowing optimal delivery of treatments, such as fluids and medications, as well as close monitoring of the patients' progress.

The two major classes of these devices are CVCs (also known as 'central lines') and peripheral intravenous catheters (also known as 'IV lines'). The tips of CVCs lie in large blood vessels near the heart while the tips of IV lines remain in the peripheral blood vessel into which they are inserted.

By their nature, these devices breach the body's skin defences and create a potential entry point for infection. Of particular concern are catheter-related bloodstream infections (CRBSI). That is where a patient's bloodstream becomes infected with bacteria that have been able to enter the bloodstream due to the presence of an intravenous device. This problem occurs in between 0.1 to 22.5 percent of IV lines (depending on device type), with rates of 0.5 to 4.8 CRBSI per 1000 catheter days.[4]

All types of IV lines are associated with CRBSI, however CVCs are associated with a higher rate of CRBSI than IV lines[5] and therefore interventions to reduce the rate of CVC-related blood stream infection are especially important. The term 'CVC', in this guidance document refers to temporary percutaneous, peripherally inserted (PICC), tunnelled and implanted CVCs.

Given the higher incidence and better evidence base for interventions to reduce CRBSI related to CVC as compared to IV lines, the guidance material contained in this document is focused entirely on prevention of CVC-related CRBSI, and all use of the term "CRBSI" in this document henceforth refers to CVC-related CRBSI. The general principles are however applicable to and may be adapted to IV line care.

This guidance document is not intended to be a comprehensive description of CVC management or to replace clinical judgement. Rather, the intent of this guidance document is to:

- highlight the best critically appraised evidence currently available for the prevention of CRBSI
- provide an opportunity to encourage and support a consistent, evidence-based approach nationally to the prevention of CRBSI.

Healthcare professionals responsible for leading and facilitating practice change will find the recommended guidance valuable for the development of policies, procedures, protocols, educational programmes, assessments and documentation tools related to CVC management.

Guidance is provided on an evidence based approach to preventing CRBSI and suggestions on how to implement practice change. The suggested interventions are based on the concept of 'bundles' of care components. Bundles are groupings of evidence based practice interventions, which individually improve care but, when applied together, result in a significantly greater improvement.

The term 'bundles' is used in this guidance document to be consistent with the increasing use of the term in international literature and practise. It is acknowledged that individuals and organisations may prefer to use different terminology when developing their policies, procedures or protocols.

This guidance document reflects substantial international experience in reducing CRBSI. Implementation of the CVC insertion bundle has resulted in significant reductions in the rate of CRBSI in many hospitals. Berenholtz et al[6] and Provonost et al[7] demonstrated that Intensive Care Units (ICUs) that implemented CVC insertion care bundles have nearly eliminated CRBSIs. Subsequently, the Institute for Healthcare Improvement has led the promotion of widespread use of a CVC insertion bundle involving five components aimed at preventing CRBSI in its '100K lives' and then '5 million lives' campaigns.[iv]

Institute for Healthcare Improvement CVC Insertion Bundle.[iv]

1. Hand hygiene.
2. Maximal barrier precautions.
3. Chlorhexidine skin antisepsis.
4. Optimal catheter site selection, with avoidance of using the femoral vein for central venous access in adult patients.
5. Daily review of line necessity, with prompt removal of unnecessary lines.

The Canadian Collaborative, Safer Healthcare Now[v], expanded the initial CVC insertion bundle to eight components and divided them into an insertion and maintenance bundle with four components in each bundle.

Safer Healthcare Now CVC Insertion Bundle.[v]

1. Hand hygiene.
2. Maximal barrier precautions.
3. Chlorhexidine skin antisepsis.
4. Optimal catheter site selection.

Safer Healthcare Now CVC Maintenance Bundle.[v]

1. Daily review of line necessity and prompt removal of unnecessary lines.
2. Dedicated lumen for total parenteral nutrition (TPN).
3. Access the CVC lumens aseptically.
4. Checking entry site for inflammation with every change of dressing.

There are several consequent success stories of significant decreases and almost elimination of CRBSIs.[v]

Healthcare organisations in Australia and the United Kingdom have also launched general patient safety programmes and specific CRBSI programmes based on the success of the Institute of Healthcare Improvement '5 Million Lives' campaign.[iv] The bundle approach is sufficiently established to be considered the standard of care.[vi]

The original implementation of the CVC bundles occurred within adult intensive care. The Child Health Corporation of America [vii] and the Canadian ICU Collaborative paediatric teams[v] have, however, successfully implemented the CVC bundles within paediatric intensive care. The California Children's Hospital Association Neonatal Intensive Care Unit

[iv] http://www.ihi.org/

[v] http://www.saferhealthcarenow.ca/Default.aspx?folderId=82&contentId=184

[vi] http://www.health.vic.gov.au/sssl/

[vii] http://www.chca.com/thekidscampaign/documents/Prevent%20Central%20Line%20Infections/Additional%20Resources/BSI%20How%20To%20Guide%20Pediatric%20Supplement%20-%20100K%20Lives%20-%20August%202006.pdf

(NICU) Collaborative[viii] has also successfully implemented CVC care bundles within neonatal intensive care.

The focus of attention over the past two decades has been the ICU setting. Recent data, however, suggest that the greatest numbers of patients with central lines are in units outside of the ICU; and there is a substantial risk of CRBSI.[8,9] Consequently, many hospitals have applied the bundle approach to all areas where central lines are inserted and maintained (eg, oncology, renal, medical, surgical services and operating theatres).

The bundles proposed in this guidance are consistent with the American Society of Anaesthesiologists [ix] and the Australia and New Zealand College of Anaesthetists (ANZCA)[10] recommendations for insertion and maintenance of CVCs. The bundles appear to work equally well in any of the hospital settings referred to above and with any catheter whose tip lies in a central vein.[v]

Further information on bundles and how they work can be accessed from the Institute for Healthcare Improvement's website at http://www.ihi.org/IHI/Topics/CriticalCare/IntensiveCare/ImprovementStories/WhatIsaBundle.htm

Case for change

The magnitude of the potential for CVCs to cause morbidity and mortality resulting from infectious complications remains unclear when considering ICU patients exclusively. However, a Centers for Disease Control and Prevention (CDC) report acknowledges that if entire hospitals are assessed, the attributable mortality is estimated at 12 to 25 percent for each infection[5], (ie, it is estimated that 12 to 25 percent of patients with CRBSI die as a direct result of the CRBSI infection). The Australia and New Zealand Co-operative on Outcomes in Staphylococcal Sepsis (ANZCOSS) study[11] showed that 13.1 percent of all episodes of *Staphylococcus aureus* bacteraemia in Australia and New Zealand were due to central vascular catheters and that the 30-day all cause mortality was 16.7 percent. *Staphylococcus aureus* is one of the most common bacteria causing CRBSI.

The cost per episode of CRBSI in the United States healthcare system has been estimated at US$25,000[4] per episode. Unpublished data from Auckland District Health Board (ADHB) puts the excess cost of an episode of hospital-associated CRBSI at approximately NZ$20,000 per episode.

It is clear that CRBSI impose a significant cost and morbidity burden on the New Zealand healthcare system. For example, ADHB data demonstrates that, despite an active infection control programme, there were 229 CRBSI (203 related to CVCs and 26 related to IV lines) at ADHB in 2007. This represents a substantial burden on the healthcare system, and shows that at ADHB, CVC-related CRBSI were almost 8 times more prevalent than CRBSI related to IV lines.

International research has repeatedly shown that, with a variety of prevention approaches, over half of CRBSI are preventable.[12 13] Recently some units have achieved and sustained CRBSI rates of zero, despite the ongoing and necessary use of CVCs.[7] Using the ADHB 2007 figures, a 50 percent reduction in CRBSI in 2007 would have translated to:

- approximately 114 fewer episodes of CRBSI
- additional healthcare cost-avoidance of over NZ$2 million.

[viii] http://www.dhcs.ca.gov/provgovpart/initiatives/nqi/Documents/CentralCathBun.doc
[ix] http://www.asahq.org/publicationsAndServices/infectioncontrol.pdf

CRBSI should not be regarded as an inevitable complication of intravenous catheter use. Interventions to reduce CRBSI are highly effective and evidence-based. Even in units with low rates of CRBSI, potential costs and morbidity associated with CRBSI is significant and the impact on affected patients may be devastating.

New Zealand healthcare providers who utilise intravenous catheters can act and be effectively supported and encouraged to reduce CRBSI.

Most DHBs have individual protocols related to prevention of CRBSI. As part of the NQIP Infection Prevention and Control Programme (see www.infectioncontrol.org.nz), the Government has mandated the development of national CRBSI guidance material. The national approach aims to further reduce the incidence of CRBSI throughout New Zealand.

The national guidance material has been developed taking into account a range of national and international literature, as well as local appropriateness and applicability. It promotes international evidence based best practice such as the work of Pronovost et al.[7] This includes the use of groups of evidence-based interventions designed to minimise CRBSI rates.

The evidence based intervention bundles

The evidence based interventions which make up this guidance material include all five components of the Institute of Healthcare Improvement [iv] '5 million lives' campaign's CVC insertion bundle and the three additional components included by the Canadian Collaboration.[v] These are presented as separate insertion and maintenance bundles with four components in each.

The two bundles are not intended to be a comprehensive list of CVC care. Rather, implementing the bundles allows a focused approach to prevention of CRBSI and has been most successful when all elements of the bundles are executed together.

There are also risks to healthcare professionals from exposure to blood during CVC insertion and certain aspects of CVC care. Standard precautions including needle stick injury prevention and protection from exposure to body fluids are important practical considerations.

Compliance with the CVC care bundles can be measured by simple assessment of the completion of each bundle component. This is most easily accomplished using a checklist (refer to Appendices).

Central venous catheter insertion bundle

1. Optimal catheter site selection.
2. Hand hygiene.
3. Chlorhexidine skin antisepsis.
4. Maximal barrier precautions.

Optimal catheter site selection

The risk and benefit of infectious and non-infectious complications and duration of catheter requirement must be considered on an individual basis when determining which insertion site to use.[14]

Whenever possible and not contraindicated, the subclavian venous site should be preferred over the jugular and femoral sites for non-tunnelled catheters in adult patients.

There is some evidence that the subclavian vein site is associated with a lower risk of CRBSI[15] compared to the jugular site with no difference in haemothorax, pneumothorax or vessel occlusion. Practice and experience is, however, usually greater with the internal jugular site.

The use of a femoral insertion site in adults is associated with a higher risk of CRBSI and therefore use of this site should be discouraged unless alternative sites are not available.[5,16] If the femoral insertion site is used, then shorter dwell times should apply.

Consideration should also be given to the use of a PICC when the catheter is likely to be required for a longer duration.

It is important to consider other factors when determining which site to use, eg:

- the internal jugular vein is the site of choice for central haemodialysis catheters (tunnelled or non-tunnelled) because of the consequences of subclavian stenosis or thrombosis
- optimal catheter site selection in neonates and children is more complex and no recommendation can be made for the preferred site of central access in neonates and children to minimise the risk of infection.[17] Site preference in neonates and children needs to be individualised.

The inclusion of optimal site selection as part of the CVC insertion checklist and noting the appropriate clinical indication for choice of site can be used to ensure adherence to this care bundle component and allow for audit and feedback.

Hand hygiene

To decrease the likelihood of CVC infections, proper hand hygiene using an alcohol based hand product or an antiseptic soap and water is required.[5] When caring for CVCs, appropriate times for hand hygiene include:

- before putting on and after removing gloves
- before and after palpating catheter insertion site prior to commencing the aseptic procedure
- before and after any CVC manipulation.

Further information on appropriate hand hygiene technique can be accessed at www.handhygiene.org.nz

Chlorhexidine skin antisepsis

Application of a cutaneous antiseptic solution that will effectively disinfect the site of insertion before placing a CVC is an important method of preventing catheter-related infection. Skin antisepsis with chlorhexidine gluconate provides better antisepsis than other antiseptic agents.[5,18]

For adults and children, the preferred approach is to use a single patient application of 2 percent chlorhexidine gluconate in 70 percent isopropyl alcohol and allow to dry prior to inserting the CVC.[18] However, 10 percent povidone iodine, alcoholic tinctures of iodine, or 70 percent alcohol are acceptable if there is a contraindication to chlorhexidine gluconate.[5]

Optimal skin antisepsis for the neonatal population is unknown as the evidence is inconclusive. While one study found that 0.5 percent chlorhexidine in 70 percent isopropyl alcohol was no more effective than 10 percent povidone-iodine[19], another study suggested that 0.5 percent chlorhexidine in 70 percent alcohol was superior to 10 percent povidone iodine.[20] An antiseptic should be used with the choice of agent based on clinical judgement.

To ensure adherence to this care bundle component it is recommended that:

- a single use 2 percent chlorhexidine gluconate and 70 percent isopropyl alcohol antiseptic preparation, or appropriate neonatal preparation as required, is included on the CVC procedure trolley or kit (some brands of CVC kits already have this preparation in them).

Maximal barrier precautions

A key component of the bundle is to apply maximal barrier precautions in preparation for line insertion. Mermel et al[21] demonstrated that the odds ratio was 2.2 times greater for infection without maximal barrier precautions, while Raad et al[22] demonstrated a 6.3 times greater likelihood for infection without maximal precautions.

For the person inserting the CVC and for those assisting in the procedure, maximal barrier precautions means:

- cap
- mask
- sterile gown
- sterile gloves.

For the patient:

Cover the patient, as much as is safe to do so, with large sterile drapes with a small opening for the site of insertion. Ensure an adequate sterile field is provided to ensure that the catheter or guide wire is not exposed to contamination during the insertion procedure. If an ultrasound is used to guide insertion of the catheter, the probe should be inserted into a sterile sleeve.

All healthcare organisations should have a written protocol for insertion which clearly identifies the standards required for maximal barrier precautions, including having a CVC procedure trolley or kit with all the required items

Compliance with maximal barrier precautions is a shared clinical responsibility. Clinicians inserting a CVC should stop the procedure, if safe to do so, if a healthcare professional assisting with the procedure highlights a breach in aseptic technique including inadequate hand hygiene, skin antisepsis or maximal barrier precautions.

Healthcare staff can use a CVC checklist to ensure adherence to the bundle components at the time of CVC insertion and for ongoing audit and feedback on adherence to infection prevention practices.

Exceptions to insertion bundle practice

In acute resuscitation circumstances, where a patient's life is at risk and urgent CVC placement is required, adherence to all elements of the insertion care bundle may not be

possible. Strict adherence to the insertion bundle may actually compromise patient wellbeing by delaying the establishment of venous access.

Whilst the bundle represents established best practice, its application in acute resuscitation situations needs to be based on clinical judgement. Breaches of best practice in such situations should be recorded and notified to the medical team caring for the patient, and the CVC should be replaced with a device inserted according to best practice as soon as it is safe and practical to do so.

CVCs placed in emergency situations present a higher risk of infection than those placed in non-emergency situations.[18] This relative contra-indication to adherence to the CVC insertion bundle should be clearly documented in the CVC insertion protocol.

Central venous catheter maintenance bundle

The CVC maintenance bundle focuses on the post insertion management of CVCs related to preventing CRBSI.

1. Daily review of line necessity and prompt removal of unnecessary lines.
2. Dedicated access for total parenteral nutrition (TPN).
3. Access the CVC lumens aseptically.
4. Daily review of entry site for inflammation.

Daily review of line necessity and prompt removal of unnecessary lines

International guidelines strongly recommend prompt removal of unnecessary CVCs.[5] A daily review of CVCs necessity during multidisciplinary rounds will prevent unnecessary delays in removing catheters that are no longer needed.

Many times, central lines remain in place simply because they provide reliable access and because healthcare staff have not considered removing them. It is clear, however, that the risk of infection increases the longer the catheter remains in place and that the risk of CRBSI is eliminated once the catheter is removed.

The CDC does not recommend routine replacement of functioning CVCs that have no evidence of local or systemic complications; however, CVCs that are malfunctioning or have evidence of local or systemic complications should be removed.[5]

Dedicated access for total parenteral nutrition

TPN increases the risk of developing a CRBSI.[23] The first preference is for a dedicated single lumen CVC not previously used for other intravenous medication or fluid, based on clinical judgment balancing the reduced risk of infection versus the risk of complications of a new catheter.

The second preference is to have a previously unused lumen on a multi-lumen CVC. A lumen dedicated to TPN is recommended to minimise the number of times that lumen is manipulated which reduces the risk of contamination and may decrease the risk of infection.

These preferences may not always be feasible in neonatal and paediatric patients due to lack of venous access and competing demands. Everything possible should, however, be done to limit the number of times a TPN infusion is interrupted.

The need for a dedicated TPN lumen should be included in all procedural documents relating to parenteral nutrition. Adherence to a dedicated TPN line or lumen can be reviewed and re-emphasised as part of daily multidisciplinary rounds.

Access the CVC lumens aseptically

Prior to any manipulation of the CVC proper hand hygiene using an alcohol based hand product or antiseptic soap and water is required.[5] Accessing CVCs using an aseptic technique is strongly recommended by international guidelines.[5] The risk of CRBSI decreases with standardisation of aseptic care.[18] All CVC manipulation should be performed according to a standardised aseptic approach.

An example of a systematic approach to maintaining asepsis is aseptic non-touch technique (ANTT). ANTT emphasises good hand hygiene, non-touch technique and use of appropriate standard precautions to maintain asepsis.[18]

Before accessing catheter hubs or injection ports, cleaning with 2 percent chlorhexidine gluconate in 70 percent isopropyl alcohol preferably, or 70 percent alcohol is important to reduce contamination. A number of centres have found it helpful to reduce possible error in skin and catheter antisepsis by making only chlorhexidine antiseptic wipes available.[v]

Daily review of entry site for inflammation

Central catheter site infections may initially go unnoticed. It is clear, however, that the sooner an infection is identified, the more quickly the CVC can be removed and treatment initiated.

The Canadian Collaboration recommends assessing the catheter entry site for inflammation at each dressing change.[v] With the use of a semi-permeable transparent intravenous dressing, daily review of the insertion site is achievable and can prevent unnecessary delays in providing appropriate interventions in patient care. Daily and with every dressing change site assessment findings should be clearly documented in the patient's clinical record. Site assessment findings can contribute to a more comprehensive assessment and resultant clinical decision on whether CVC removal is appropriate.

Adherence to the maintenance bundle can be achieved by adding the CVC maintenance bundle components to daily goal checklists to be sure all processes related to CVC maintenance are carried out. Clinical areas which don't currently utilise daily goal sheets may incorporate adherence to the bundle into the multidisciplinary round using a stamp to facilitate checking each component.

Information on CVC dressing management best practice is outside the scope of this guidance document. Further information is available in the CDC [5] and EPIC[18] National Guidelines.

Other issues to be considered

Education

Well-organised educational programmes are critical to the success of strategies designed to reduce the risk of CRBSI. The risk of infection has been shown to decline with standardised aseptic care and there is some evidence that the insertion and maintenance of CVCs by inexperienced staff may increase the risk for CRBSI.[5] Additionally, relatively simple education programmes focused on training healthcare workers to adhere to local evidence-based CVC protocols has been shown to decrease patients' risk of CRBSIs.[24]

All healthcare staff with responsibility for the insertion of CVCs should be trained and supervised until assessed as competent in CVC insertion, including consistent adherence

to the infection prevention practices described in the insertion care bundle. It is recommended that if rotating through neonatal, paediatric and adult services, competency is assessed for each population.[25] Healthcare professionals who assist with CVC insertion should receive education on the insertion care bundle and checklist.

All healthcare staff caring for patients with a CVC should be trained, and assessed as competent in using and consistently adhering to infection prevention practices and as being aware of the signs and symptoms of clinical infection. A systematic standardised approach to asepsis must be used for all catheter site care and when accessing the system[18].

Antimicrobial catheters

Antimicrobial coated and impregnated CVCs are associated with a lower risk of CRBSI when compared to standard CVCs.[5] The authors of a recent systematic review determined that although heparin coated or antibiotic-impregnated CVCs reduce CRBSI, there was no benefit determined for antiseptic coated catheters.[26]

Authors of a different meta analysis observed "many shortcomings in methodological quality"[27] of studies and concluded that the available evidence supports the recommendations of the CDC[5] and EPIC[18] guidelines that antimicrobial coated or impregnated CVC's are useful if the incidence of CRBSI is above institutional goals despite full implementation of infection prevention interventions.[26]

Consideration should also be given to the use of antimicrobial CVC for patients who are at high risk for CRBSI. Factors associated with increased risk of CRBSI[28] are:

- insertion of the catheter in an emergency situation
- excessive manipulation of the catheter
- prolonged hospitalisation before catheterisation
- prolonged duration of catheterisation
- neutropenia
- administration of TPN.

Antimicrobial locks

Antimicrobial lock solutions have been recently shown to be effective in reducing the rate of CRBSI in patients undergoing haemodialysis via CVCs.[27,29] Dialysis units should consider the regular use of antimicrobial locks to reduce the rate of CRBSI in those patients who dialyse via CVCs.

Alcohol locks

There is some recent evidence that intraluminal ethanol locks may prevent CRBSI in immunosuppressed haematology patients.[30] Implementation of this strategy is limited due to compatibility issues with some CVC's and careful consideration is required prior to instituting this practice.

Chlorhexidine impregnated dressing

The use of a chlorhexidine impregnated dressing may be considered if the CRBSI rate is above institutional goals despite full implementation of infection prevention interventions.

Practice change /implementation

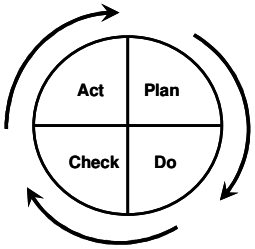
Clinical Practice Improvement Model[31]

The Clinical Practice Improvement Model is a useful tool to guide continuous improvement of care delivery and has much in common with the process of clinical care. The model involves the:

- identification and diagnosis of a problem
- measurement of the scope and size of the problem
- identification of a number of interventions that may reduce the problem
- implementation of the intervention(s)
- re-measurement to ascertain whether the interventions have been effective.

Use the Plan-Do-Study-Act (PDSA) cycle to conduct small-scale tests of change in real work settings by:

PLAN plan the change that is to be trialled
DO conduct a trial of the proposed change
STUDY evaluate the impact of the trial
ACT implement the changes that have been proven to be effective.



Successful implementation of any practice change is by motivated leadership and commitment to provide adequate resources. Prior to the implementation of a CRBSI practice change, local healthcare organisations need to consider the following:

- engaging senior leadership support
- determining the best structure for a team
- customising and trying out resources, eg, CVC trolley or box, checklists
- integrating the best practice guidance into local policies and protocols on CVC insertion and maintenance
- providing education and training on the bundles and checklists
- establishing feedback mechanisms
- developing methods for measuring the strategy's effectiveness.

The team

The aim is to have a multidisciplinary team based on key stakeholders working towards the common goal of preventing CRBSIs. Identify and work with champions who want to work on the project, rather than trying to convince those personnel who don't. The team will depend on the clinical area, however, it must include representation from those who insert the CVCs (eg, intensivist, consultant anaesthetist), nursing and healthcare staff who assist with insertion and provide ongoing care, infection control clinicians, nurse educators and staff with a particular focus on patient safety and practice improvement.

It is important that someone is nominated as the Project Co-ordinator as, after the practice change is embedded, it will be necessary to ensure ongoing review in light of further knowledge development and to ensure long term integrity of the project.

The goal

The team can set goals to help them stay on track. How an individual DHB chooses to express its goal is a matter of choice. Agreeing on the goal is crucial as is allocating the people and resources necessary to accomplish the goal. The goal should be time-specific, population specific, and measurable, eg, "Decrease the rate of CRBSI's by 50 percent in the children's oncology service within one year." Another example may be to "target zero" infections and monitor days without a CRBSI.

The strategy

Once a team has prepared the way for change by studying the current processes, creating a climate of collaboration and teamwork, preparing the required resources, and educating the affected staff the next step is to begin implementing the CVC bundles.

At the beginning of implementation, it is suggested that teams start small so team members can learn quickly what works or how changes need to be refined before full implementation.

- Select one venue (eg, ICU, operating theatre, radiology).
- Begin using the bundles with one patient from the time of catheter insertion.
- Work with each healthcare professional who cares for the patient to be sure they are able to follow the bundles and implement the checklist.
- Make sure that the approach can be carried over from shift to shift.
- Acknowledge and process feedback and incorporate suggestions for improvement.
- Once the bundle has been applied to one patient and several shifts, increase utilisation to the remainder of the ward/unit.
- Engage in additional PDSA cycles to refine the process and make it more reliable.
- After achieving a reduction in CRBSI in the pilot ward/unit, spread the changes to other wards/units, and eventually to all areas in the hospital where CVCs are inserted and managed.
- Implementing a CVC insertion checklist will help to ensure a reliable process. Healthcare professionals assisting with insertion should observe the preparations using the checklist prior to CVC insertion and request the clinician to stop the process if necessary. The checklist should be completed every time a CVC is inserted and used to track compliance and provision of feedback.
- A strategy that may be effective for assessing compliance with the maintenance bundle is to incorporate the components within a daily goals assessment sheet or a 'Maintenance Bundle' stamp within the clinical record. This form or stamp can be completed during daily multidisciplinary rounds on the patient.

Measurement

The individual teams that implement the bundles are encouraged to measure ongoing compliance with the bundles in addition to measuring the effectiveness of the bundle implementation. The checklists discussed in this guidance document can be used to track compliance. Suggestions are given below for how success can be tracked to provide feedback against the goals set for the team. [iv,v]

It should be noted that collecting CVC day data is time consuming and therefore may require allocation of specific resource to ensure it is collected accurately.

Central line insertion bundle compliance

Goal: 95 percent of all patients with a CVC inserted receive all elements of the CVC insertion bundle.

In international campaigns, this level of reliability has been achieved by using an insertion checklist and empowering staff assisting in the procedure to stop the procedure if all elements of the insertion bundle are not achieved.

This measure is an assessment of how well the team is adhering to the CVC insertion bundle and is a measure of compliance with an entire bundle.

Over a defined period of time, select all the patients who have had a CVC inserted and assess them for compliance with the CVC insertion bundle. If even one element is missing, the case is not in compliance with the bundle.

For example, if central lines were inserted in seven patients over the defined time frame, and six have all four bundle elements completed, then 6/7 (86 percent) is the compliance with the bundle. If all seven had all elements completed, compliance would be 100 percent. If all seven were missing even a single item, compliance would be 0 percent. This measure is always expressed as a percentage.

$$\frac{\text{No. of CVCs inserted with ALL four elements of CVC insertion bundle}}{\text{No. of CVCs } \textbf{inserted} \text{ during sampling period}} \times 100 = \textit{CVC } \textbf{\textit{insertion}} \textit{ bundle compliance}$$

Compliance with individual components can also be measured and tracked by auditing completed checklists. Components which are least often complied with can be identified and interventions to improve overall compliance can be specifically targeted at those components.

Central line maintenance bundle compliance

Goal: 95 percent of all patients with a CVC receive all elements of the CVC maintenance bundle.

In international campaigns, this level of reliability has been achieved using multi-disciplinary rounds and a daily goal checklist. Within New Zealand, a maintenance bundle checklist has been used.[x]

This measure is an assessment of how well the team is adhering to the CVC maintenance bundle.

On a given day, select all the patients with CVCs and assess their daily goal sheet / maintenance checklist for compliance with the CVC maintenance bundle. If a daily goal sheet/maintenance checklist is not part of the implementation plan, spot check compliance can be measured using an audit form.

[x] Contribution of ICU team at Counties Manukau District Health Board appreciated.

No. of patients with CVCs with
ALL four elements of
CVC maintenance bundle
---------- X 100 = *CVC **maintenance** bundle compliance*
No. of patients with CVCs on the day
of the sample

The audit form can also be use to measure and track compliance with individual components. The components which are least often complied with can be identified and specific interventions can target these components to improve overall compliance.

CRBSI rate per 1000 central catheter-days

Goal: The rate of CRBSI will decrease by 50 percent in one year using the CVC insertion and maintenance bundles.

This measure is a rate for a particular time period.

To calculate the denominator (catheter-days), an utilisation ratio is a cost-effective method. In larger units, a statistically valid sample can be obtained by counting how many patients have a central line in situ on 3-5 days of each week. At the end of the month, the overall proportion of patients with a central line is calculated to determine the central line utilisation rate. This is multiplied by the total unit inpatient days for the month, which yields the total number of central line days.

CRBSI rate per 1000 central line days can be calculated:

CRBSI number
Number of central line days X 1000 = *CRBSI rate per 1000 catheter days*

Appendix 1: Example of insertion checklist

This example checklist on the following page is focused on adherence to the components of the insertion bundle. Individual units may wish to add further steps to the checklist, such as the performance of an x-ray to check CVC position or the use of an antimicrobial locking solution. It is not intended to be an exhaustive checklist and should be adapted to local CVC insertion needs. It is a useful tool, however, containing important assessment of adherence to best practice, and these should not be removed.

Other examples of insertion checklists can be found at the following sites:

http://www.health.qld.gov.au/chrisp/icare/insert_ckl.pdf

http://www.cec.health.nsw.gov.au/pdf/CLAB/CLAB_InsertionChecklis_July07.pdf

http://www.saferhealthcarenow.ca/Default.aspx?folderId=82&contentId=184

http://www.ihi.org/IHI/Programs/Campaign/CentralLineInfection.htm

http://www.health.vic.gov.au/sssl/downloads/cvc_audit.doc

Central Line Insertion Checklist

Purpose:	To decrease central catheter-related blood stream infections
When:	During **all** central venous catheter insertions.
By whom:	Nurse / personnel assisting with the procedure

If there is a breach of aseptic technique, catheter placement should stop immediately and the practice corrected. Any concerns contact relevant consultant / Team Leader. If a correction is required, please provide details at the bottom of the page.

	Patient's name and NHI number or sticker				
	Name of person inserting the catheter				
	Department		ED / ICU / Theatre / Radiology / Ward_____		
	Today's date		_____/_____/_____		
	Is the procedure:		Elective	Emergency	
	Ultrasound guidance used:		Yes	No	
	Placement	Internal Jugular	Subclavian	Femoral	PICC
	Rationale for choice of placement				
	Size of catheter				
	Number of lumens	Single	Double	Treble	Quad
			Yes	Yes after reminder	
	Before the procedure, did the person inserting the catheter: Perform hand hygiene (chlorhexidine or soap) immediately prior? Clean procedure site (2% chlorhexidine and 70% alcohol)? Drape the patient in an aseptic fashion ensuring an adequate aseptic field?				
	During the procedure, did the person inserting the catheter: wear a: • hat? • mask? • sterile gown? • sterile gloves? • maintain an aseptic field? Did all personnel assisting follow the above precautions?				
	After the procedure: Was a sterile dressing applied to the site				

Was a correction required to ensure compliance with Infection Control or Occupational Safety practices? **Yes** **No**

Explain:

Please return completed form to the designated location.

Appendix 2: Insertion Bundle Compliance Audit Summary

Key ✓= compliant X = non compliant

Data collection period		__/__/__ to __/__/__																			% compliance
Patient/Chart number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Optimal catheter site selection																						
Hand hygiene																						
Skin antisepsis																						
Maximal barrier precaution	Cap																					
	Mask																					
	Sterile gown																					
	Sterile gloves																					
	Large drape																					
Please✓if 100% bundle compliant																						

To meet bundle compliance

- Optimal catheter site selection: involves, wherever possible, selection of the subclavian over the jugular and femoral sites for CVC insertion (or rationale provided for choice otherwise).
- Hand hygiene: involves hand wash with an antiseptic soap prior to insertion of CVC, and using an alcohol based waterless hand cleaner at all other times.
- Maximal barrier precautions: involves covering the patient with large sterile drapes, the operator exercising strict compliance with hand hygiene and wearing cap, mask, sterile gown and sterile gloves.
- Skin antisepsis: involves cleaning the insertion site with 2 % chlorhexidine/70 % alcohol and allowing solution to dry completely before puncturing the site.

Appendix 3: Maintenance Bundle Compliance Audit Summary

Key ✓= compliant X = non compliant

Data collection period	__/__/__ to __/__/__																				% compliance
Patient/Chart number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Daily review of catheter necessity																					
Dedicated line or lumen for TPN																					
Access the CVC lumens aseptically																					
Daily review of CVC site																					
Please✓if 100% bundle compliant																					

To meet bundle compliance

- There is documented evidence that the CVC has been reviewed and deemed necessary each day.
- If TPN is being administered this is via a dedicated catheter or lumen of a multi-lumen catheter.
- Nursing staff are observed to manage CVC using an aseptic technique.
- There is daily documentation of the condition of the CVC site.

Appendix 4: Example of a Daily Goals Chart

This daily goals chart is intended to show the addition of the CVC maintenance care bundle being added to a daily goals sheet. It is not intended to replace existing goal sheets but to provide an example of adding this simple and important set of goals to an existing sheet.

Date____/____/_____

Patient Sticker

---Initial as goals are reviewed ----

GOAL	NOTES	0700 - 1900	1900 - 0700
What needs to be done for the patient to be discharged?			
What is this patient's greatest safety risk?			
Central line maintenance bundle The catheter necessity is reviewed			
There is a dedicated lumen for TPN			
The lumens are accessed aseptically following a standardised approach			
The catheter entry site is checked for inflammation			
Volume status goal for next 12 hrs			
Neuro: Pain mgt / Sedation			
GI: Nutrition / Bowel regimen			
Bed rest / Mobilisation /			
ID: cultures, drug levels			
Medication changes (can any be stopped?)			
Tests / Procedures			
Any catheters / tubes to be removed			
Skin care issues addressed			
Family updated			
Social issues to address			
Emotional/spiritual issues			
Parameters for notifying medical staff			

Appendix 5: Example of a Maintenance Bundle Checklist

Central Line Definition: Any catheter whose tip terminates in a great vessel	Patient Name NHI Number ***Use patient Label***

Date Line Inserted:	
Insertion Site:	
Date Line Removed:	***Reason for Removal:***

MAINTENANCE BUNDLE:
To be completed daily on all Central Lines.

Today's Date:	Line Day:	Yes	No	NA	Comments
Was the Central Line reviewed for necessity today?					
Is there a dedicated port being used for the TPN? **(If no TPN infusing then please tick NA)**					
Did you check the site today for inflammation? **(If any signs of infection are seen the catheter should be reviewed promptly)**					
Before accessing injection ports, did you clean with 2% chlorhexidine gluconate in 70% alcohol?	Shift One				
	Shift Two				
	Shift Three				
RN Signature: (Shift One)	RN Signature: (Shift Two)	RN Signature: (Shift Three)			

Today's Date:	Line Day:	Yes	No	NA	Comments
Was the Central Line reviewed for necessity today?					
Is there a dedicated port being used for the TPN? **(If no TPN infusing then please tick NA)**					
Did you check the site today for inflammation? **(If any signs of infection are seen the catheter should be reviewed promptly)**					
Before accessing injection ports, did you clean with 2% chlorhexidine gluconate in 70% alcohol?	Shift One				
	Shift Two				
	Shift Three				
RN Signature: (Shift One)	RN Signature: (Shift Two)	RN Signature: (Shift Three)			

Today's Date:	Line Day:	Yes	No	NA	Comments
Was the Central Line reviewed for necessity today?					
Is there a dedicated port being used for the TPN? **(If no TPN infusing then please tick NA)**					
Did you check the site today for inflammation? **(If any signs of infection are seen the catheter should be reviewed promptly)**					
Before accessing injection ports, did you clean with 2% chlorhexidine gluconate in 70% alcohol?	Shift One				
	Shift Two				
	Shift Three				
RN Signature: (Shift One)	RN Signature: (Shift Two)	RN Signature: (Shift Three)			

Today's Date:	Line Day:	Yes	No	NA	Comments

Was the Central Line reviewed for necessity today?					
Is there a dedicated port being used for the TPN? **(If no TPN infusing then please tick NA)**					
Did you check the site today for inflammation? **(If any signs of infection are seen the catheter should be reviewed promptly)**					
Before accessing injection ports, did you clean with 2% chlorhexidine gluconate in 70% alcohol?	Shift One				
	Shift Two				
	Shift Three				
RN Signature: (Shift One)	RN Signature: (Shift Two)	RN Signature: (Shift Three)			
Today's Date:	Line Day:	Yes	No	NA	Comments
Was the Central Line reviewed for necessity today?					
Is there a dedicated port being used for the TPN? **(If no TPN infusing then please tick NA)**					
Did you check the site today for inflammation? **(If any signs of infection are seen the catheter should be reviewed promptly)**					
Before accessing injection ports, did you clean with 2% chlorhexidine gluconate in 70% alcohol?	Shift One				
	Shift Two				
	Shift Three				
RN Signature: (Shift One)	RN Signature: (Shift Two)	RN Signature: (Shift Three)			
Today's Date:	Line Day:	Yes	No	NA	Comments
Was the Central Line reviewed for necessity today?					
Is there a dedicated port being used for the TPN? **(If no TPN infusing then please tick NA)**					
Did you check the site today for inflammation? **(If any signs of infection are seen the catheter should be reviewed promptly)**					
Before accessing injection ports, did you clean with 2% chlorhexidine gluconate in 70% alcohol?	Shift One				
	Shift Two				
	Shift Three				
RN Signature: (Shift One)	RN Signature: (Shift Two)	RN Signature: (Shift Three)			
Today's Date:	Line Day:	Yes	No	NA	Comments
Was the Central Line reviewed for necessity today?					
Is there a dedicated port being used for the TPN? **(If no TPN infusing then please tick NA)**					
Did you check the site today for inflammation? **(If any signs of infection are seen the catheter should be reviewed promptly)**					
Before accessing injection ports, did you clean with 2% chlorhexidine gluconate in 70% alcohol?	Shift One				
	Shift Two				
	Shift Three				
RN Signature: (Shift One)	RN Signature: (Shift Two)	RN Signature: (Shift Three)			
Today's Date:	Line Day:	Yes	No	NA	Comments
Was the Central Line reviewed for necessity today?					
Is there a dedicated port being used for the TPN? **(If no TPN infusing then please tick NA)**					
Did you check the site today for inflammation? **(If any signs of infection are seen the catheter should be reviewed promptly)**					
Before accessing injection ports, did you clean with 2% chlorhexidine gluconate in 70% alcohol?	Shift One				
	Shift Two				
	Shift Three				
RN Signature: (Shift One)	RN Signature: (Shift Two)	RN Signature: (Shift Three)			

Appendix 6: Example of CVC trolley or kit

This is an example of the contents list for a CVC trolley or kit. It is not exhaustive and will need to be adapted to individual unit practice.

CONTENTS

- Surgical caps
- Surgical masks
- Sterile gloves (x2 pairs of each size)
- Sterile gowns
- Large sterile drapes

- Single use 2 percent chlorhexidine and 70 percent alcohol skin preparation
- Sterile CVC Insertion Pack or equivalent aseptic field
- Needle holder (may be in insertion pack)
- Forceps (may be in insertion pack)
- Gauze swabs (may be in insertion pack)
- Scalpel handle and blade
- Sutures (variety of sizes)

- Central lines (variety of sizes)
- Sterile ultrasound probe cover
- Guide wires (variety of sizes)

- Lignocaine 1 percent for local analgesia if required
- 0.9% sodium chloride for injection (for flushing catheters)
- Heparin 50 units / 5ml for injection
- Variety of needles
- Variety of syringes
- Needle free access device or equivalent

- High moisture semi-permeable transparent dressing (variety of sizes)
- CVC stabilising device if required
- Steri strips if required

- Hair clipper
- Medication added label
- Variety of extension sets
    - PICC
    - Pressure line extension
    - 3 way tap and extension set.

Appendix 7: Abbreviations

ADHB	Auckland District Health Board
ANZCA	Australia and New Zealand College of Anaesthetists
ANZCOSS	Australia and New Zealand Co-operative on Outcomes in Staphylococcal Sepsis
ANTT	Aseptic non-touch technique
CDC	Centers for Disease Control and Prevention
CVC	Central venous catheter
CRBSI	Catheter-related bloodstream infection
DHB	District Health Board
ICU	Intensive Care Unit
IV lines	peripheral intravenous catheters
NICU	Neonatal Intensive Care Unit
NQIP	National Quality Improvement Programme
PDSA	Plan-Do-Study-Act cycle of clinical quality improvement model
PICC	Peripherally inserted central catheter
QIC	Quality Improvement Committee
TPN	Total Parenteral Nutrition

Appendix 8: Centers for Disease Control and Prevention
CRBSI Definition

Clinical Definition of CRBSI

Bacteraemia/fungemia in a patient with an intravascular catheter with at least one positive blood culture obtained from a peripheral vein, clinical manifestations of infections (ie, fever, chills, and/or hypotension), and no apparent source for the BSI except the catheter. One of the following should be present:

- a positive semi quantitative (>15 CFU/catheter segment) or quantitative (>103 CFU/catheter segment catheter)
- culture whereby the same organism (species and antibiogram) is isolated from the catheter segment and peripheral blood
- simultaneous quantitative blood cultures with a >5:1 ratio CVC versus peripheral
- differential period of CVC culture versus peripheral blood culture positivity of >2 hours.

Surveillance Definition of CRBSI

Should meet at least one of the following criteria:

Criterion 1: Patient has a recognized pathogen cultured from one or more blood cultures, and the pathogen cultured from the blood is not related to an infection at another site.

Criterion 2: Patient has at least one of the following signs or symptoms: fever (>100.4º F [>38º C]), chills, or hypotension, and at least one of the following:

1. common skin contaminant (eg, diphtheroids, *Bacillus* spp., *Propionibacterium* spp., coagulase-negative staphylococci, or micrococci) cultured from two or more blood cultures drawn on separate occasions
2. common skin contaminant (eg, diphtheroids, *Bacillus* spp., *Propionibacterium* spp., coagulase-negative staphylococci, or micrococci) cultured from at least one blood culture from a patient with an intravenous line, and the physician institutes appropriate antimicrobial therapy
3. positive antigen test on blood (eg, *Hemophilus influenzae, Streptococcus pneumoniae, Neisseria meningitides,* or group B streptococcus).

and signs and symptoms with positive laboratory results are not related to an infection at another site.

Criterion 3: Patient aged <1 year has at least one of the following signs or symptoms: fever (>100.4º F [>38º C]), hypothermia (<98.6º F [<37º C]), apnoea, or bradycardia, and at least one of the following:

1. common skin contaminant (eg, diphtheroids, *Bacillus* spp., *Propionibacterium* spp., coagulase-negative staphylococci, or micrococci) cultured from two or more blood cultures drawn on separate occasions
2. common skin contaminant (eg, diphtheroids, *Bacillus* spp., *Propionibacterium* spp., coagulase-negative staphylococci, or micrococci) cultured from at least one blood culture from a patient with an intravenous line, and the physician institutes appropriate antimicrobial therapy

3. positive antigen test on blood (eg, *Hemophilus influenzae, Streptococcus pneumoniae, Neisseria meningitides,* or group B streptococcus).

and signs and symptoms with positive laboratory results are not related to an infection at another site.

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Published in December 2009 by:

National Quality Improvement Programme
Catheter-related Bloodstream Infection Project
C/- Auckland District Health Board
Private Bag 92189
Victoria Street West
Auckland 1142
New Zealand

This manual is also available on the Infection Prevention and Control Programme website:
www.infectioncontrol.org.nz

ISBN: 978-0-473-16365-5 (web)