

Guidelines: central venous access devices

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Bloodstream infections associated with the insertion and maintenance of central venous access devices (CVADs) are highly dangerous, worsening the severity of the patients' underlying ill health, prolonging hospitalisation and increasing the cost of care (Emerson et al, 1996; Waghorn, 1994; Pittet et al, 1994; Arnow et al, 1993; Smith et al, 1991; Martin et al, 1989;).

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Every year, almost 6,000 patients acquire a catheter-related bloodstream infection (CR-BSI) (Fletcher and Bodenham, 1999a; Waghorn, 1994; Pittet et al, 1994).

CR-BSI involves the presence of systemic infection and evidence implicating the CVAD as its source - the same microorganism must be isolated from blood cultures as that colonising the patient's CVAD. Catheter colonisation refers to a significant growth of microorganisms on the inner or outer catheter surface beneath the skin in the absence of systemic infection (Fletcher and Bodenham, 1999a; Farr, 1999a; PHLS, 1998; Pearson, 1996).

The microorganisms that colonise catheter hubs and the skin adjacent to the insertion site are the source of most CR-BSIs. Coagulase-negative staphylococci, particularly *Staphylococcus epidermidis*, are the most frequently implicated. Other microorganisms commonly involved include *Staphylococcus aureus*, *Candida* species and enterococci (PHLS, 1998).

CR-BSI is generally caused either by skin microorganisms contaminating the catheter during insertion or migrating along the cutaneous catheter track, or microorganisms from the hands of healthcare workers contaminating and colonising the catheter hub during care interventions (Fletcher and Bodenham, 1999a).

Infusate contamination or haematogenous seeding from site of infection elsewhere in the body is more rarely implicated as a cause of CR-BSI.

These guidelines, which are split into two parts, apply to caring for all adults and children over the age of one year in NHS acute care settings with CVADs which are being used for the administration of fluids, medications, blood components and/or total parenteral nutrition (TPN).

They should be used in conjunction with the recommendations on standard principles for preventing healthcare-associated infections (HCAIs). Although they describe general principles of best practice that apply to all patients in whom CVADs are used, they do not specifically address the more technical aspects of the care of patients receiving haemodialysis, who generally receive care in dialysis centres. The recommendations describe broad general statements of best practice, and should be adapted and incorporated into local practice guidelines. The first part contains recommendations in the following intervention categories:

- Education of healthcare workers and patients;
- General asepsis;
- Selection of catheter type;
- Selection of catheter insertion site;
- Maximal sterile barrier precautions during catheter insertion;
- Cutaneous antisepsis;
- Catheter and catheter site care;
- Catheter replacement strategies.

General principles for catheter management are discussed in the second part of the CVAD guidelines.

Education of healthcare workers and patients

To improve patient outcomes and reduce healthcare costs, it is essential that everyone involved in caring for patients with CVADs is educated about infection prevention. Healthcare workers in hospitals need to be confident and proficient in infection prevention practices and aware of the signs and symptoms of clinical infection.

Well-organised educational programmes are critical to the success of any strategy designed to reduce the risk of infection as the risk for infection declines with standardised aseptic care and increases when the maintenance of intravascular catheters is undertaken by inexperienced healthcare workers (CDC, 2002a).

Additional evidence demonstrates that relatively simple education programmes focused on training healthcare workers to adhere to local evidence-based CVAD protocols may decrease patients' risk of CR-BSIs (Eggimann et al, 2005; East and Jacoby, 2005; Lobo et al, 2005; Warren et al, 2004; Rosenthal et al, 2003).

CVAD1	Healthcare workers caring for a patient with a CVAD should be trained, and assessed as competent in using and consistently adhering to the infection prevention practices described in this guideline.	Class D
CVAD2	Before discharge from hospital, patients with long-term catheters and their carers should be taught any techniques they may need to use to prevent infection and safely manage a CVAD.	Class D/GPP
CVAD3	Follow-up training and support should be available to patients with CVADs and their carers.	Class D/GPP

General asepsis

Good standards of hand hygiene and antiseptic technique can reduce the risk of infection. The potentially serious consequences of catheter-related infections (CRIs) mean enhanced efforts are needed to minimise the risk of infection. For this reason, hand antisepsis and proper aseptic non-touch technique (ANTT) are required for changing catheter dressings and accessing the system (CDC, 2002a; 2002b).

Hand antisepsis can be achieved by washing hands with an antimicrobial liquid soap and water or using an alcohol-based handrub (CDC, 2002b). When hands are visibly dirty or contaminated with organic material such as blood and other body fluids or excretions they must first be washed with liquid soap and water if alcohol-based handrubs are going to be used to achieve antisepsis.

Appropriate ANTT does not necessarily require sterile gloves; a new pair of disposable non-sterile gloves can be used in conjunction with a non-touch technique, for example, in changing catheter site dressings (CDC, 2002a). The standard principles for preventing HCAs described in the first of these guidelines gives further advice on hand decontamination and the use of gloves and other protective equipment.

CVAD4	An aseptic non-touch technique (ANTT) must be used for catheter-site care and for accessing the system.	Class B
CVAD5	Before accessing or dressing CVADs, hands must be decontaminated either by washing with an antimicrobial liquid soap and water, or by using an alcohol handrub.	Class A
CVAD6	Hands that are visibly soiled or contaminated with dirt or organic material must be washed with liquid soap and water before using an alcohol handrub.	Class A

CVAD7	Following hand antisepsis, clean gloves and an ANTT or sterile gloves should be used when changing the insertion site dressing, line manipulation or intravenous drug administration.	Class D
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Selection of catheter type

Selecting the right catheter for the right patient can minimise the risk of infection. Different types of CVAD are available:

- Made of different materials;
- Have one or more lumens;
- Coated or impregnated with antimicrobial or antiseptic agents or heparin-bonded;
- Cuffed and designed to be tunnelled;
- Having totally implantable ports.

Selection of the most appropriate catheter for each individual patient can reduce the risk of subsequent CRI.

Catheter material

Although catheter material may be an important determinant of infection associated with CVADs (Tebbs et al, 1994), evidence available to the US Healthcare Infection Control Practices Advisory Committee (HICPAC) when developing its guidelines was inconclusive and the committee was unable to draw any specific conclusions about the contribution of catheter material to CRIs (CDC, 2002a). Teflon and polyurethane catheters have been associated with fewer infections than those made of polyvinyl chloride or polyethylene. There is no additional evidence that demonstrates conclusively that CRI rates vary with different materials (Fletcher and Bodenham, 1999a). In England, short-term CVADs are almost always made of polyurethane and long-term tunnelled catheters are usually made of silicone.

Number of catheter lumens

Clinicians often prefer multi-lumen CVADs because they permit the concurrent administration of various fluids and medications, hyperalimentation, and haemodynamic monitoring among critically ill patients. HICPAC examined several randomised controlled trials (RCTs) and other studies, which suggested that multi-lumen catheters were associated with a higher risk of infection than were single lumen catheters (Pearson, 1996; Clarke-Christoff et al, 1992; Hilton et al, 1988; Yeung et al, 1988; McCarthy et al, 1987; Pemberton et al, 1986). However, other studies examined by HICPAC failed to demonstrate a difference in the rates of CR-BSI (Dezfulian et al, 2003; Farkas et al, 1992).

HICPAC noted that multi-lumen catheter insertion sites may be particularly prone to infection because of increased trauma at the insertion site or because multiple ports increase the frequency of CVAD manipulation (Hilton et al, 1988; Yeung et al, 1988). The committee also noted that although patients with multi-lumen catheters tend to be more ill than those without, the infection risk observed with these catheters may have been independent of the patient's underlying disease severity (Clarke-Christoff et al, 1992).

Our systematic reviews identified two additional studies. A systematic review and quantitative meta-analysis focused on determining the risk of CR-BSI and catheter colonisation in multilumen catheters compared with single-lumen catheters. This reported that although CR-BSI was more common in patients with multilumen catheters, when confined to high-quality studies that control for patient differences, there is no significant difference. This suggests that multilumen catheters are not a significant risk factor for increased CR-BSI or local catheter colonisation compared with single-lumen CVADs (Dezfulian et al, 2003).

Another systematic review and quantitative meta-analysis tested the impact on catheter colonisation and CR-BSI of single and multiple lumen catheters. This concluded that there is some evidence from five RCTs with data on 530 CVADs, that for every 20 single-lumen catheters inserted, one CR-BSI will be avoided which would have occurred had multi-lumen catheters been used. As the authors were only able to analyse a limited number of trials, further large RCTs are needed to confirm these findings. In the meantime it may be reasonable to choose a single-lumen catheter whenever there is no indication for a multi-lumen catheter (Zurcher et al, 2004).

CVAD8	Use a single-lumen catheter unless multiple ports are essential for the management of the patient.	Class A
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CVAD9	If a multilumen catheter is used, identify and designate one port exclusively for hyperalimentation to administer parenteral nutrition.	Class D/GPP
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Tunnelled and totally implantable ports

Surgically implanted (tunnelled) CVADs such as Hickman catheters, are commonly used to provide vascular access (and stable anchorage) to patients requiring long-term intravenous therapy. Alternatively, a totally implantable intravascular devices such as Port-A-Cath are also tunnelled under the skin but these have a subcutaneous port or reservoir with a self-sealing septum that is accessible by needle puncture through intact skin.

In developing its 1996 guidelines, HICPAC examined multiple studies that compared the incidence of infection associated with long-term tunnelled CVADs and/or totally implantable intravascular devices with that from percutaneously (non-tunnelled) inserted CVADs (Pearson, 1996). Although most studies reported a lower rate of infection in patients with tunnelled CVADs (Shulman et al, 1988; Weightman et al, 1988; Rannem et al, 1986; Darbyshire et al, 1985; Pessa and Howard, 1985; Schuman et al, 1985; Press et al, 1984; Abraham and Mullen, 1982; Shapiro et al, 1982), some studies (including one RCT) found no significant difference (Andrivet et al, 1994; Raad et al, 1993). Additionally, most studies concluded that totally implantable devices had the lowest reported infection rates compared with tunnelled or non-tunnelled CVAD (Groeger et al, 1993; Pegues et al, 1992; Van der Pij and Frissen, 1992; Kappers Klune et al, 1989; Carde et al, 1989; Wurzel et al, 1988; McDowell et al, 1986; Brickner and Saeter, 1986; Lokitch et al, 1985; Khoury et al, 1985; Gyves et al, 1984).

Additional evidence was obtained from studies of efficacy of tunnelling to reduce CRIs in patients with short-term CVADs. One RCT demonstrated that subcutaneous tunnelling into the internal jugular vein reduced the risk for CR-BSI (Timsit et al, 1996). In a later RCT the same investigators failed to show a statistically significant difference in the risk for CR-BSI for subcutaneously tunnelled femoral vein catheters (Timsit et al, 1999).

An additional meta-analysis of RCTs focused on the efficacy of tunnelling short-term central venous catheters to prevent CRIs (Randolph et al, 1998). Data synthesis demonstrated that tunnelling decreased catheter colonisation by 39% and CR-BSI by 44% compared with non-tunnelled placement. The majority of the benefit came from one trial of CVADs inserted at the internal jugular site. The reduction in risk was not significant when pooled with data from five subclavian catheter trials. Tunnelling was not associated with increased risk of mechanical complications from placement or technical difficulties during placement. However, these outcomes were not rigorously evaluated. This meta-analysis concluded that tunnelling decreased CRIs, but a synthesis of its evidence does not support routine subcutaneous tunnelling of short-term subclavian venous catheters and this cannot be recommended unless efficacy is evaluated at different placement sites and relative to other interventions.

CVAD10	Use a tunnelled or implanted CVAD (one with a subcutaneous port) for patients in whom long-term (more than 3-4 weeks') vascular access is anticipated.	Class A
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Antimicrobial impregnated catheters and cuffs

Some catheters and cuffs are marketed as anti-infective and coated or impregnated with antimicrobial or antiseptic agents such as chlorhexidine/silver sulfadiazine, minocycline/rifampin, platinum/silver, and ionic silver in subcutaneous collagen cuffs attached to central venous catheters. Evidence reviewed by HICPAC indicated that the use of antimicrobial or antiseptic-impregnated CVADs in adults whose catheter is expected to remain in place for more than five days can decrease the risk for CR-BSI (Mermel, 2000; Colin et al, 1999; Dariouche et al, 1999; Veenstra et al, 1999b; Heard et al, 1998; Haxhe and D'Hoore, 1998; Maki et al, 1997; Logghe et al, 1997; Oda et al, 1997; Veenstra et al, 1999a; Raad et al, 1997).

This may be cost-effective in high-risk patients (intensive care, burn and neutropenic patients) and in patient populations in which the rate of CR-BSI exceeds 3.3 per 1,000 catheter days despite implementing a comprehensive strategy to reduce rates of CR-BSI (Maki et al, 1997). The comprehensive strategy should include the following three components: educating persons who insert and maintain catheters; use of maximal sterile barrier precautions and a 2% chlorhexidine preparation for skin