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Guidelines for preventing infections associated with the insertion and maintenance of central venous catheters

Background

Bloodstream infections associated with the insertion and maintenance of central venous catheters (CVC) are among the most dangerous complications that can occur, worsening the severity of the patients' underlying ill health, prolonging the period of hospitalisation and increasing the cost of care.[1–6] Every year, almost 6,000 patients in the UK acquire a catheter-related bloodstream infection.[5,7]

Catheter-related bloodstream infection (CR-BSI) involves the presence of systemic infection and evidence implicating the CVC as its source, i.e., the isolation of the same microorganism from blood cultures as that shown to be significantly colonising the CVC of a patient with clinical features of bacteraemia. Colonisation of the catheter, or catheter-related infection (CR-infection), refers to a significant growth of microorganisms on either the endoluminal or the external catheter surface beneath the skin in the absence of systemic infection.[7–10]

The microorganisms that colonise catheter hubs and the skin adjacent to the insertion site are the source of most CR-BSI. Coagulase-negative staphylococci, particularly *Staphylococcus epidermidis*, are the most frequently implicated microorganisms associated with CR-BSI. Other microorganisms commonly involved include *Staphylococcus aureus*, *Candida* species and enterococci.[9]

CR-BSI is caused either by cutaneous microorganisms that contaminate the catheter during insertion or migrate along the catheter track, or microorganisms from the hands of health care workers that contaminate and colonise the catheter hub during care interventions.[7]

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The guidelines

These guidelines focus on providing evidence-based recommendations for preventing hospital-acquired infections associated with the use of central venous catheters in patients who are four years of age or older. These recommendations are not detailed procedural protocols and need to be incorporated into local guidelines. Additionally, various important specialist areas of patient management were beyond our remit and are not addressed in these guidelines, e.g., the diagnosis and treatment of CR-BSI.

The recommendations are divided into seven distinct interventions:

1. selection of catheter type;
2. selection of catheter insertion site;
3. aseptic technique during catheter insertion;
4. cutaneous antisepsis;
5. catheter and catheter site care;
6. catheter replacement strategies;
7. antibiotic prophylaxis.

Intervention 1 Selection of Catheter Type

Selecting the right catheter for the right patient can minimise the risk of infection

Different types of CVC are available, i.e.:

- made of different materials;
- have one or more lumens;
- impregnated with antimicrobial or antiseptic agents or heparin-bonded;
- cuffed and designed to be tunnelled;
- having totally implantable ports.

The selection of the most appropriate catheter for each individual patient may reduce the risk of subsequent CR-BSI.

Catheter material

Although catheter material may be an important determinant in the risk of infection associated with CVC,[1] evidence available to HICPAC when developing their guidelines in 1995/6 was inconclusive and they were unable to draw any appropriate conclusions about the contribution of catheter material to CR-infections.[2]

There is no additional evidence that demonstrates conclusively that CR-infection rates vary with different materials.[3] In England, short-term CVC are almost always made of polyurethane and long-term tunnelled catheters are usually made of silicone.

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Number of catheter lumens

HICPAC states that clinicians often preferred multi-lumen CVC because they permitted the concurrent administration of various fluids and medications and haemodynamic monitoring among critically ill

patients.[1] They examined several randomised controlled trials and other studies which suggested that multi-lumen catheters were associated with a higher risk of infection than were single lumen catheters.[2–6] However, other studies examined by HICPAC failed to demonstrate a difference in the rates of CR-BSI.[7–8]

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 CVC manipulation.[4–5] HICPAC also noted that although patients with multi-lumen catheters tend to be more ill than those without such catheters, the infection risk observed with these catheters may have been independent of the patient's underlying disease severity.[6]

1. ***Use a single-lumen catheter unless multiple ports are essential for the management of the patient.*** **Category 2**
2. ***If total parenteral nutrition is being administered, use one central venous catheter or lumen exclusively for that purpose.*** **Category 2**

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Tunnelled and totally implantable ports

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

HICPAC examined multiple studies that compared the incidence of infection associated with long-term tunnelled CVC and/or totally implantable intravascular devices with that from percutaneously (non-tunnelled) inserted CVC.[1] Although in general most studies reported a lower rate of infection in patients with tunnelled CVC,[2–10] some studies (including one randomised controlled trial) found no significant difference in the rate of infection between tunnelled and non-tunnelled catheters.[11,12] Additionally, most studies examined by HICPAC concluded that totally implantable devices had the lowest reported rates of CR-BSI compared to either tunnelled or non-tunnelled CVC.[13–23]

Additional evidence examined studies of efficacy of tunnelling to reduce CR-infections in patients with *short-term* CVC. One randomised controlled trial demonstrated that subcutaneous tunnelling of short-term CVC inserted into the internal jugular vein reduced the risk for CR-BSI.[24] In a later randomised controlled trial, the same investigators failed to show a statistically significant difference in the risk for CR-BSI for subcutaneously tunnelled femoral vein catheters.[25]

An additional meta-analysis of randomised controlled trials analysed data focused on the efficacy of tunnelling short-term central venous catheters to prevent CR-infections.[26] Data synthesis demonstrated that tunnelling decreased catheter colonisation by 39% and decreased CR-BSI by 44% in comparison with non-tunnelled placement. The majority of the benefit in the decreased rate of catheter-sepsis came from one trial

at the internal jugular site. The reduction in risk was not significant when the data from five subclavian catheter trials were pooled. 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 CR-infections. However, a synthesis of the evidence in this meta-analysis does not support routine subcutaneous tunnelling of short-term subclavian venous catheters until its efficacy is evaluated at different placement sites and relative to other interventions.

3. ***Use a tunnelled catheter or an implantable vascular access device for patients in whom long-term (>30 days) vascular access is anticipated.*** **Category 2**

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Antimicrobial impregnated CVC

Early studies demonstrating the efficacy of antimicrobial impregnated/coated CVC to reduce CR-BSIs were considered by HICPAC, especially a large randomised prospective trial among surgical intensive care unit patients conducted in 1991.[1] HICPAC concluded that the antimicrobial impregnated/coated catheters available at that time did not appear to pose any greater risk of adverse effects than did non-coated catheters but suggested additional randomised controlled trials to evaluate their efficacy, determine the appropriate situations for their use, and to assess the risk of toxicity and emergence of resistant bloodstream pathogens.[2,3]

Additional studies have since demonstrated that antimicrobial impregnated/coated CVC can favourably influence the incidence of catheter colonisation and CR-BSI in some situations.

- *Chlorhexidine/silver sulphadiazine impregnated catheters*

A large randomised controlled trial showed that catheters coated externally (extra-luminally) with chlorhexidine and silver sulfadiazine were associated with a 44 percent reduction in colonisation and a 79 percent reduction in CR-BSI.[4] However, other studies failed to confirm the efficacy of these catheters in reducing the incidence of CR-BSI.[5,6] A meta-analysis of these three studies concluded that the use of chlorhexidine/silver sulphadiazine impregnated catheters may decrease the frequency of CR-BSI in those units with a high baseline incidence of CR-BSI (more than 3–4 per 1000 catheters days) but were not effective in reducing the incidence of CR-BSI when the infection rate was low for patients with long-duration treatment, e.g., parenteral nutrition, haematologic malignancy.[7] A larger meta-analysis of twelve randomised controlled trials demonstrated that this combination of antimicrobial agents was effective in reducing catheter colonisation and CR-BSI (by 40 percent) in patients at high-risk.[8] A 'high-risk' patient in this analysis refers to patients in the intensive care unit and those receiving total parenteral nutrition. A later review of this meta-analysis also concluded that the *short-term* use of these catheters reduced the risk for CR-BSI.[9] This last review noted that microorganisms resistant to the antimicrobial agents used in this device had not been demonstrated in clinical studies and that reports of anaphylactic reactions to the chlorhexidine component were rare.[10]

A recent cost-effectiveness study, using data from meta-analyses, other randomised controlled trials, case-control studies, and safety data, estimated the incremental clinical and economic outcomes associated with the use of CVC coated with chlorhexidine and silver sulphadiazine compared with CVC that were not bonded with an antimicrobial agent.[11] This study concluded that the use of CVC coated with these agents in patients at high risk for CR-BSI reduces the incidence of CR-BSI and death and provides significant savings in costs. It recommended that the use of these catheters should be considered as part of a comprehensive nosocomial infection control programme.

- *Minocycline/rifampin coated catheters*

Another major randomised controlled trial, also published in 1997, examined catheters coated intra- and extra-luminally with minocycline and rifampin (active in vitro against both Gram-positive and Gram-negative bacteria and *Candida* species) and demonstrated a reduction in colonisation and CR-BSI, particularly in the first 10 days.[12]

A large, prospective, randomised controlled trial in twelve university-affiliated hospitals in the USA compared the efficacy of chlorhexidine/silver sulphadiazine-impregnated CVC with minocycline and rifampin coated CVC and showed the latter to be significantly superior at preventing catheter colonisation and CR-BSI in high-risk adult patients in whom CVC were in place for three days or more.[13]

Although resistance to minocycline/rifampin coated-catheters has not been demonstrated in clinical studies, population analysis has not yet been used to determine whether subpopulations of skin microorganisms develop resistance after prolonged exposure to this device.[9] One *in vitro* study does suggest that the use of these catheters may lead to drug resistance.[14] Conversely, this risk may be justified in that the use of these devices may reduce the need for systemic antimicrobials, e.g., vancomycin.[9]

Availability

Two types of antimicrobial/antiseptic impregnated CVC are currently licensed for use in the European Community and are available in England. One (Vantex® central venous catheter; Edwards Life Sciences Critical Care Division) uses a unique technology to bond the antiseptic agent (silver ions) with the polyurethane during the manufacture of the catheter. The other (ARROWgard Blue®; Arrow International, Inc.) incorporates two antimicrobial agents (chlorhexidine and silver sulphadiazine) molecularly bonded onto the surface of the polyurethane catheter material.

Others, including a catheter coated with a combination of minocycline and rifampin (Cook Spectrum®; Cook Incorporated), and a CVC with a chlorhexidine and silver sulphadiazine compound molecularly bonded onto the catheter surface and an internal lumen impregnation of chlorhexidine to the catheter body, extension lines and hubs (ARROWgard Plus® Arrow International, Inc.), are likely to be licensed in the European Community within the next twelve months.[15]

4. ***Consider the use of an antimicrobial impregnated central venous catheter for adult patients who require short-term (<10 days) central venous catheterisation and who are at high risk for CR-BSI.*** **Category 1**

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Intervention 2 Selection of Catheter Insertion Site

Selecting the best insertion site for the patient can minimise the risk of infection

Several factors need to be assessed when determining the site of catheter placement, including:

- patient-specific factors (e.g., pre-existing catheters, anatomic deformity, bleeding diathesis, some types of positive pressure ventilation);
- relative risk of mechanical complications (e.g., bleeding, pneumothorax, thrombosis);
- the risk of infection.

HICPAC concluded that the site at which a catheter is placed can influence the subsequent risk of CR-infection.[1] CVC are generally inserted in the subclavian, jugular or femoral veins, or peripherally inserted into the superior vena cava by way of the cephalic and basilar veins of the antecubital space.

Subclavian, jugular and femoral placements

Multiple studies examined by HICPAC concluded that CVC inserted into subclavian veins had a lower risk for infection than those inserted in either jugular or femoral veins, but none of these were randomised controlled trials.[2–7] HICPAC stated that internal jugular insertion sites may pose a greater risk for infection because of their proximity to oropharyngeal secretions and because CVC at this site are difficult to immobilise. They noted, however, that mechanical complications associated with catheterisation might be less common with internal jugular than with subclavian vein insertion.

Although the above studies showed a higher risk of CR-infections associated with internal jugular site CVC insertion, evidence linking the site of catheter insertion to the risk of infection is often contradictory.[8] While one review[9] described four prospective, observational studies examined by HICPAC that found the risk for infection was significantly increased with insertion into the internal jugular vein compared with insertion into the subclavian vein,[6,10–12] another prospective study noted by HICPAC concluded that there was no significant difference in the risk for infection between subclavian, internal jugular and femoral placements, although colonisation of the catheter was more frequent in femoral placements.[13]

There is limited additional evidence in this area. A recent prospective observational study supports an association between catheter colonisation and femoral site colonisation,[14] and a prospective randomised trial found a higher risk of deep vein thrombosis with femoral placements compared with subclavian or internal jugular placements.[15]

Tunnelling may also influence the risk of CR-BSI. In a recent meta-analysis of randomised controlled trials focused on the efficacy of tunnelling short-term CVC to prevent CR-infection,[16] reviewers noted a large, multicentre prospective trial that demonstrated that internal jugular CR-related infections could be reduced by subcutaneous tunnellisation.[17]

There is no additional evidence from randomised controlled trials that assessed the risk for infection associated with catheter insertion into the subclavian, internal jugular, or femoral vein.[9,18]

Antecubital placement

Peripherally inserted CVC (PICCs) may be used as an alternative to subclavian or jugular vein catheterisation. These are inserted into the superior vena cava by way of the cephalic and basilar veins of the antecubital space. HICPAC stated that they are less expensive, associated with fewer mechanical complications, e.g., thrombosis, haemothorax, infiltration and phlebitis, and easier to maintain than short peripheral venous catheters, i.e., a reduced need for frequent site rotation.[1] Additionally, evidence examined by HICPAC suggests that PICCs are associated with a lower rate of infection than that associated with other non-tunnelled CVC,[19,20] perhaps because the antecubital fossa is less colonised by microorganisms, less oily, and less moist than the chest and neck.[20,21] HICPAC also noted that an antecubital placement removes the catheter away from endotracheal and nasal secretions. Finally, they discussed the mean duration of catheterisation for PICCs but noted that further studies were needed to adequately determine how long PICCs could be safely left in place and to determine whether routine replacement influenced the risk of associated infection.[1]

Studies examined by HICPAC also demonstrated that PICCs were associated with a substantially lower risk of CR-BSI compared to Hickman catheters.[19,23]

5. *In selecting an appropriate insertion site, assess the risks for infection against the risks of mechanical complications.* Category 3
6. *Unless medically contraindicated, use the subclavian site in preference to the jugular or femoral sites for nontunneled catheter placement.* Category 2
7. *Consider the use of peripherally inserted catheters as an alternative to subclavian or jugular vein catheterisation.* Category 2

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Intervention 3 Optimum Aseptic Technique During Catheter Insertion

Using optimum aseptic technique during CVC placement will significantly reduce the risk of infection

The primacy of strict adherence to hand decontamination and aseptic technique as the cornerstone for preventing CR-related infection is widely accepted. Although this alone seems adequate for preventing infections associated with the insertion of short peripheral venous catheters, it is recognised that central venous catheterisation carries a significantly greater risk of infection. However, the level of barrier precautions needed to prevent infection during CVC insertion was controversial at the time of the development of the HICPAC guidelines.[1]

Studies examined by HICPAC concluded that if maximal barrier precautions were used during CVC insertion, catheter contamination and subsequent CR-related infections could be significantly minimised.[2–5]

One of these studies was a prospective randomised trial that tested the efficacy of maximal sterile barriers to reduce infections associated with long-term nontunneled subclavian silicone catheters.[5] When maximal sterile barrier precautions were compared with routine procedures, they significantly decreased the risk of CR-BSI.[5]

Maximal sterile barrier precautions involve wearing sterile gloves and gown, a cap, mask and using a large sterile drape during insertion of the catheter as opposed to routine infection prevention procedures that involve wearing only sterile gloves and the use of a small drape. In these guidelines, we refer to this as optimum aseptic technique. However, there is no evidence that wearing a facemask or cap is important in preventing CR-BSI during catheter insertion.

It has been generally assumed that CVC inserted in the operating theatre posed a lower risk of infection than did those inserted on inpatient wards or other patient care areas.[1] However, data examined by HICPAC from two prospective studies suggests that the difference in risk of infection depended largely on the magnitude of barrier protection used during catheter insertion, rather than the surrounding environment, i.e., ward versus operating room.[3,5]

Other expert reviewers who have examined the above evidence agree that maximal sterile barrier precautions are essential during CVC placement to reduce the risk of infection.[6–10]

8. ***Use optimum aseptic technique, including a sterile gown, gloves, and a large sterile drape, for the insertion of central venous catheters.*** **Category 2**

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Intervention 4 Cutaneous Antisepsis

Appropriate preparation of the insertion site will reduce the risk of catheter-related infection

Microorganisms that colonise catheter hubs and the skin surrounding the CVC insertion site are the cause of most CR-BSIs.[1–3] HICPAC guideline developers regarded skin cleansing/antisepsis of the insertion site as one of the most important measures for preventing CR-infection.[4] An important prospective randomised trial of agents used for cutaneous antisepsis demonstrated that 2% aqueous chlorhexidine was superior to either 10% povidone-iodine or 70% alcohol for preventing central venous and arterial CR-infections.[5] An additional study has since confirmed the superior efficacy of 2% aqueous chlorhexidine compared to povidone iodine in substantially reducing central venous catheter colonisation.[3]

Direct comparisons of aqueous versus alcoholic solutions of chlorhexidine have not been undertaken in relation to cutaneous antisepsis for preventing CR-infections. However, an alcoholic solution of chlorhexidine combines the benefits of rapid action and excellent residual activity.[6]

The application of organic solvents, such as acetone or ether, to 'defat' (remove skin lipids) the skin before catheter insertion and during routine dressing changes had been a standard component of many hyperalimentation protocols. However, there was no evidence available to HICPAC to show that these agents appeared to either confer additional protection against skin colonisation or significantly decrease the incidence of CR-infection. Additionally, their use could greatly increase local inflammation and patient discomfort.[4]

Several studies were examined that focused on the application of antimicrobial ointments to the catheter site at the time of catheter insertion, or during routine dressing changes, to reduce microbial contamination of catheter insertion sites.[3] Reported efficacy in preventing CR-infections by this practice yielded contradictory findings.[7–12] There was also concern that the use of polyantibiotic ointments that were not fungicidal could significantly increase the rate of colonisation of the catheter by *Candida* species.[11,13]

9. ***Clean the skin site with an alcoholic chlorhexidine gluconate solution prior to CVC insertion. Use an alcoholic povidone-iodine solution for patients with a history of chlorhexidine sensitivity. Allow the antiseptic to dry before inserting the catheter.*** **Category 3**
10. ***Do not apply organic solvents, e.g., acetone, ether, to the skin before catheter insertion.*** **Category 3**
11. ***Do not routinely apply antimicrobial ointment to the catheter placement site prior to insertion.*** **Category 2**

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Intervention 5 Catheter and Catheter Site Care

Infections can be minimised by good catheter and catheter site care

The safe maintenance of a central venous catheter and relevant care of the catheter site are essential components of a comprehensive strategy for preventing CR-infections in patients. This includes good practice in caring for the patient's catheter hub and connection port, the use of an appropriate catheter site dressing regimens, and using flush solutions to maintain the patency of the catheter.

The catheter hub and connection port are common portals of infection

HICPAC considered evidence demonstrating that contamination of the catheter hub is an important contributor to intraluminal microbial colonisation of catheters, particularly long-term catheters.[1–7]

In a recent overview,[8] additional evidence from a prospective cohort study suggested that frequent catheter hub manipulation increases the risk for microbial contamination.[9] During prolonged catherisation, catheter hubs are accessed more frequently, increasing the likelihood of a CR-BSI emanating from a colonised catheter hub rather than the insertion site.[7] Consequently, the reviewer commented that hubs and sampling ports should be disinfected before they are accessed[10] and noted that both povidone-iodine and chlorhexidine are effective.[11–12] It should be noted that some catheter and catheter hub materials, e.g., polyurethane, silicone, may be chemically incompatible with alcohol or iodine and the manufacturer's recommendations must be complied with.

12. ***Before accessing the system, disinfect the external surfaces of the catheter hub and connection ports with an aqueous solution of chlorhexidine gluconate or povidone-iodine, unless contraindicated by the manufacturer's recommendations.*** **Category 3**

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Choose the right dressing for CVC sites to minimise infection

Because occlusive dressings trap moisture on the skin, and provide an ideal environment for the rapid growth of local microflora, dressings for CVC sites must be permeable to water vapour.[1] The two most common types of dressings used for CVC sites are sterile, transparent, semi-permeable, polyurethane dressings ('transparent dressings'), and gauze and tape dressings. Transparent dressings, e.g., Opsite® IV3000, Tegaderm®, are popular because they reliably secure the CVC, permit continuous visual inspection of the catheter site, allow patients to bathe and shower without saturating the dressing, and require less frequent change than that required for standard gauze and tape dressings, thus saving personnel time.

The potential risk of infection associated with transparent dressings is controversial and studies identified by HICPAC were contradictory.[2] Some suggested their use (for both peripheral venous catheters and CVC) increased both microbial colonisation of the catheter site and the risk of subsequent CR-related infection, while others, including a large controlled trial of peripheral venous catheter dressing regimens,[3] failed to demonstrate any difference in infection risk between transparent and gauze dressings. In one meta-analysis of catheter dressing regimens, CVC on which a transparent dressing was used had a significantly higher incidence of catheter-tip colonisation, but a non-significant increase in the incidence of CR-BSI.[4] HICPAC also noted preliminary data that suggested that newer transparent dressings that permit the escape of moisture from beneath the dressing could be associated with lower rates of skin colonisation and CR-related infection[5] but commented that the length of time that a transparent dressing could be safely left on a CVC site was unknown.

Another expert review[6] cites a variety of studies on the use of transparent dressings on short-term, non-cuffed central venous and/or pulmonary artery catheters that yielded conflicting results, in part, reflecting differences in study protocols. Two randomised studies cited, focusing on the use of transparent dressings on surgically implanted, cuffed Hickman® or Broviac® catheters, suggested that either transparent or gauze and tape dressings could be safely used to cover the insertion sites of these devices. A third study compared the incidence of long-term CR-related infections in bone marrow transplant recipients associated with either dry sterile gauze dressings or transparent dressings, and found that there was no difference between them and concluded that either could be safely used.[7]

Studies focused on the use of antimicrobial ointment applied under the dressing to the catheter insertion site to prevent CVC-related infection do not clearly demonstrate efficacy.[8–9]

13. ***Use either a sterile gauze or transparent dressing to cover the catheter site.*** **Category 2**
14. ***If a gauze and tape catheter site dressing is used, it must be replaced when the dressing becomes damp, loosened, or soiled, or when inspection of the insertion site is necessary.*** **Category 3**
15. ***Do not apply antimicrobial ointment to CVC insertion sites as part of routine catheter site care.*** **Category 2**

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Preventing catheter thrombosis and maintaining catheter patency will minimise opportunities for infection

The relationship between vascular thrombosis, microbial adherence and CR-related infection is well recognised.[1] Flushing CVC with a heparinised saline solution is designed to prevent thrombosis and associated microbial adherence to the catheter, and to prolong the duration of catheter patency. There are four elements involved in flushing CVC that need to be described in local protocols: the type, concentration, and volume of the flush solution and the flush frequency. Heparin diluted in 0.9% sodium chloride solution (heparinised saline) or normal saline solution alone are the two most common types of flush solution.

In considering the use of flush solutions incorporating heparin to discourage microbial adherence to the catheter and prevent CR-BSI, studies examined by HICPAC were contradictory.[2–5] Additionally, HICPAC noted that routine heparin administration, even at doses as low as 250 to 500 units per day, had been associated with bleeding disorders and complications.[6–10] Despite suggesting that clinical trials were needed to further assess the relative efficacy, risks, and benefits of the routine use of various anticoagulant flush solutions in preventing CR-related infection, HICPAC recommended their use.

A meta-analysis of the benefits of heparin in flushing *peripheral* intravascular catheters showed no advantage over normal saline.[11] However, a meta-analysis of randomised controlled trials focused on *central* intravascular catheters concluded that heparin significantly reduced bacterial colonisation and showed a strong but non-significant trend towards reduction of CR-related bacteraemia.[12]

Some types of tunnelled CVC, e.g., Groshong® catheters, may not require routine flushing with an anticoagulant.[1]

16. ***Routinely flush indwelling central venous catheters with an anticoagulant unless advised otherwise by the manufacturer.*** **Category 2**

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Intervention 6 Replacement Strategies

When and how CVC are replaced can influence the risk of infection

A CVC replacement strategy is composed of two elements; the frequency and the method of catheter replacement.

Frequency

HICPAC noted that with short peripheral venous catheters, the risk of phlebitis and catheter colonisation, both associated with catheter-related infection, could be reduced by catheter replacement and site rotation every 48–72 hours.[1] However, decisions regarding the frequency of CVC replacement were more complicated. They considered evidence that showed duration of catheterisation to be a risk factor for infection and which advocated routine replacement of CVC at specified intervals as a measure to reduce infection.[2–5] Other studies, however, suggested that the daily risk of infection remains constant and showed that routine replacement of CVC, without a clinical indication, does not reduce the rate of catheter colonisation or CR-BSI.[6–7] Conclusions from a recent systematic review agree that exchanging catheters by any method every 3 days was not beneficial in reducing infections, compared with catheter replacement on an as-needed basis. [8]

Methods

Two methods are used for replacing CVC; placing a new catheter over a guide wire at the existing site, or percutaneously inserting a new catheter at another site. Guide wire insertion has been the accepted technique for replacing a malfunctioning catheter (or exchanging a pulmonary artery catheter for a CVC when invasive monitoring was no longer needed) as they are associated with less discomfort and a significantly lower rate of mechanical complications than those percutaneously inserted at a new site. Studies of the risks for infection associated with guide wire insertions examined by HICPAC yielded conflicting results. One prospective study showed a significantly higher rate of CR-BSI associated with catheters replaced over a guide wire compared with catheters inserted percutaneously.[6] However, three prospective studies (two randomised) showed no significant difference in infection rates between catheters inserted percutaneously and those inserted over a guide wire.[7,9–10] Because these studies suggest that the insertion of the new catheter at a new site does not alter the rate of infectious complications per day but does increase the incidence of mechanical complications, guide wire exchange is recommended. Most studies examined by HICPAC concluded that, in cases where the catheter being removed is known to be infected, guidewire exchange is contraindicated.[7,9–12] Several methods are available, including recently described techniques, which allow a diagnosis of CR-BSI to be made without the need for catheter removal.[13,14] Such approaches could be used prior to the replacement of a new catheter over a guide wire in order to exclude the possibility of CR-BSI and thus the need to replace a newly inserted catheter.

A recent systemic review concluded that, compared with new site replacement, guidewire exchange was associated with a trend toward a higher rate of catheter colonisation, regardless of whether patients had a suspected infection. Guidewire exchange was also associated with trends toward a higher rate of catheter exit-site infection and CR-BSI. However, guidewire exchange was associated with fewer mechanical complications relative to new-site replacement.[8]

17. ***Do not routinely replace non-tunnelled CVC as a method to prevent catheter-related infection.*** **Category 2**
18. ***Use guide wire assisted catheter exchange to replace a malfunctioning catheter, or to exchange an existing catheter if there is no evidence of infection at the catheter site or proven CR-BSI.*** **Category 1**
19. ***If CR-infection is suspected, but there is no evidence of infection at the catheter site, remove the existing catheter and insert a new catheter over a guide wire; if tests reveal CR-infection, the newly inserted catheter should be removed and, if still required, a new catheter inserted at a different site.*** **Category 1**

20. ***Do not use guide wire assisted catheter exchange for patients with CR-infection. If continued vascular access is required, remove the implicated catheter, and replace it with another catheter at a different insertion site.*** **Category 1**

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Change IV administration sets appropriately

The intravenous administration set includes the area from the spike of tubing entering the fluid container to the hub of the vascular device.[1] A short extension tube may be connected to the vascular device and may be considered a portion of the device to facilitate aseptic technique when changing administration sets.

HICPAC examined three well-controlled studies [2–4] that examined the optimal interval for the routine replacement of intravenous administration sets. Data from each of these studies show that replacing administration sets 72 hours or more after initiation of use is both safe and cost-beneficial. Other studies examined by HICPAC noted that certain intravenous fluids, e.g., blood, blood products, and lipid emulsions, were more likely than other parenteral fluids to support microbial growth if contaminated,[5–8] and suggested that more frequent replacement of intravenous tubing may be required when such fluids are given.

21. ***Replace all tubing when the vascular device is replaced.*** **Category 3**
22. ***Replace intravenous tubing and stopcocks no more frequently than at 72-hour intervals, unless clinically indicated.*** **Category 1**
23. ***Replace intravenous tubing used to administer blood, blood products, or lipid emulsions at the end of the infusion or within 24 hours of initiating the infusion.*** **Category 2**

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Intervention 7 Antibiotic Prophylaxis

Antibiotic prophylaxis is unnecessary

Prophylactic administration of systemic antimicrobials had previously been used to reduce the incidence of CR-BSI, but scientific studies examined by HICPAC on the efficacy of this practice were inconclusive.[1–7] HICPAC was also concerned that such prophylaxis may select for resistant microorganisms, particularly those resistant to vancomycin.

24. ***Do not administer systemic antimicrobials routinely before insertion or during use of a central venous catheter to prevent catheter colonisation or bloodstream infection.***

Category 2

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Glossary

Case-control study
Analytical observational study that aims to investigate the relationship between an exposure or risk factor, e.g., insertion of a CVC, and one or more outcomes, e.g., the occurrence of CR-BSI.

CR-BSI
Catheter-related bloodstream infection; also *catheter-related sepsis* or *catheter-intravascular device-related*) *bacteraemia*
Systemic infection (bacteraemia) *and* evidence implicating the central venous catheter as its source, i.e., the isolation of the referred to as same microorganism from blood cultures as that shown to be *related* (*or* isignficantly colonising the CVC of a patient with clinical features of bacteraemia.[1–3] (See CR-infection)

CR-infection
Catheter-related infection
A significant growth of microorganisms ($\geqslant$15 colony-forming units (CFUs) by semiquantitative methods, or $\geqslant 10^3$ CFUs by quantitative methods) on either the endoluminal or the external catheter surface beneath the skin in the *absence* of systemic bloodstream infection (bacteraemia).[2]

Colonisation of the catheter
Similar to CR-infection but less growth of microorganisms, i.e., $<$15 CFUs (or $<10^3$ CFUs)z.[3]

CVC
Central venous catheter
Intravascular catheters inserted into a variety of sites to allow placement of the catheter tip in the superior vena cava above its junction with the right atrium, with the distal catheter parallel to the vessel wall. CVCs have several uses, e.g., giving multiple infusions of fluids, medication, or chemotherapy, temporary access for haemodialysis, monitoring central venous pressure, frequent blood sampling.

'High risk' patients
Refers to patients at increased risk for CR-infection, e.g., those patients in intensive care units, those receiving total parenteral nutrition, and immunocompromised patients.

PICCs
Peripherally inserted central venous catheters
Used as an alternative to subclavian or jugular vein catheterisation; inserted into the superior vena cava by way of the cephalic and basilar veins of the antecubital space.

Prospective clinical trial
Follow-up or longitudinal study where data on exposure is first collected and patients are followed-up for the development of a given condition or outcome, e.g., CR-BSI.

RCT
Randomised controlled trial
A clinical trial where at least two treatment groups are compared, one of them serving as the control group, and treatment allocation is carried out using a random, unbiased method.

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