Chapter 7: Prevention of central venous line-associated infection

As anaesthesiologists are frequently responsible for the placement of invasive lines in both the theatre and ICU environment, sound guidance with respect to this process will follow. These guidelines particularly focus on interventions which reduce the incidence of infections and sepsis associated with these devices.

Minimisation of catheter use, or alternatives are important aspects of preventing catheter-related bloodstream infections (CRBSIs). Anaesthetists should identify evidence-based indications for the insertion of central venous catheters.[185]

Evidence that simple interventions reduce the incidence of sepsis significantly is key to the implementation of these guidelines.[185] Institutions should be able to produce data on the incidence of CRBSIs and promote care bundles and interventions that have been shown to reduce the incidence of CRBSIs effectively.

The placement and securing of central venous catheters

- The subclavian site is preferred over either the internal jugular or femoral sites in adult patients in order to reduce the incidence of sepsis and of thrombosis.[186-188]
- If the patient has chronic kidney disease, consider the internal jugular vein to avoid subclavian vein stenosis.[189]
- In children and infants there is no preferred venous site to minimise the risk of infection.
- Use ultrasound when possible and when trained operators are available to reduce the time to cannulation, the number of cannulation attempts and the incidence of mechanical complications.[190-193]
- Use a line with the minimum number of lumens necessary to facilitate management of the patient.[194-197]

- When adherence to sterile technique cannot be assured, the line must be removed as soon as possible, but within 48 hours.[198]
- An engineered stabilisation device that is designed specifically to control movement at the catheter hub is recommended, as sutures increase the risk of infection. Standard dressings and tape are not suitable alternatives.[198]
- All lines that are no longer needed should be removed promptly.

Rationale

The optimal insertion site depends on the expected duration of catheterisation and on the type of complication that is most detrimental for the patient overall. The subclavian site has a lower risk of catheter-related bloodstream infections, and a lower thrombotic risk, in comparison to internal jugular and femoral venous sites, particularly for dwell times exceeding five days. The femoral route for central venous access is prone to both infection and thrombosis. The subclavian site is on a flat, relatively immobile portion of the anatomy and is infrequently contaminated with fluids such as saliva, vomit or urine. In addition, the site is usually not subject to the accumulation of sweat. It is important to note that in one study, the subclavian venous site was associated with mechanical complications in 17% of patients when compared to the femoral site.[186,187]

Ultrasound, in the hands of individuals who have been appropriately trained, has been shown to be effective in reducing time to cannulation, the number of attempts, and the mechanical complication rate, whilst increasing the rate of procedural success.

Limited data exist regarding the risk of CLABSI with single- versus multi-lumen central venous catheters. Studies have demonstrated increased infections in various patient populations in whom multi-lumen catheters are present, although a meta-analysis did not find a significant difference.[196] Guidelines tend to recommend using catheters with the minimum number of ports that are essential for patient management.

Non-adherence to sterile technique should not be condoned, and lines must not be placed in such circumstances unless immediately life-saving. Central venous catheters must be secured distally to prevent the loss of venous access and to reduce movement at the insertion site, which increases the risk of bloodstream infections. Sutures are associated with an increased risk of infection as they support the growth of biofilm. Specifically-engineered stabilisation devices are recommended. Standard dressings and tape are not suitable alternatives. Lines that have been removed carry no risk of sepsis whatsoever and forms the first step in managing catheter-related bloodstream infections.

Sterile technique for the placement of central venous catheters

- The operator should scrub, as for a surgical procedure, prior to the placement of a central venous catheter.[197-201]
- Maximal sterile barrier precautions to be used include the use of a cap, mask, sterile gown, sterile gloves and a sterile full body drape.[197-201]
- For skin decontamination prior to catheter insertion, the application of sterile > 0.5% chlorhexidine gluconate in 70% isopropyl alcohol represents standard of care.[194] If there is a contraindication to the use of chlorhexidine, tincture of iodine, an iodophore or 70% alcohol may be used as alternatives.[202-204]
- No comparison has been made between using chlorhexidine preparations with alcohol and povidone-iodine in alcohol to prepare clean skin.[202]
- No recommendation can be made for the safety or efficacy of chlorhexidine in infants aged < 2 months.
- The skin antiseptic must be allowed to dry (at least 30 s) prior to performance of the procedure.[197,198]

Rationale

The use of maximal barrier precautions and a sterile technique have been shown to reduce the incidence of line sepsis. Chlorhexidine-containing solutions appear to be optimal with respect to the reduction of septic complications. It is, however, associated with more cutaneous skin reactions. Severe allergy and anaphylaxis to chlorhexidine, though rare, has been reported. Application technique, correct dose for the skin surface area and drying time (at least 30 s) are important components of adequate skin decontamination. A lower alcohol concentration may improve the skin permeation of the antiseptic

Catheter dressing and site management

- Do not use topical antibiotic ointment or creams on insertion sites as they have the potential to promote fungal infections as well as antimicrobial resistance.[197]
- A sterile, transparent semi-permeable polyurethane dressing must be used to cover the site. Sterile gauze and tape may be used as an alternative.[197,198,205,206]
- Sterile gauze should be used if there is any bleeding, exudate or excessive skin moisture that accumulates around the insertion site.[198]
- The dressing must be replaced immediately if there is any sign that it is becoming loose, if there is any soiling, or if any dampness is noted under the dressing or at the insertion site. When replacing the dressing, the skin must be cleaned with antiseptic and allowed to dry before applying the new dressing.[198]
- Gauze dressings must be replaced at least every two days.[197,198]
- Clear transparent dressings must be replaced at least every seven days.[197,198]
- Line sites must be monitored daily especially at the catheter-skin junction site and surrounding area for pain, erythema, swelling or purulence, which may indicate infection, phlebitis, infiltration, or catheter-associated venous thrombosis.[198]

Rationale

Semi-permeable dressings allow for the evaporation of moisture from below the dressing. Keeping an insertion site dry and

avoiding maceration of the surrounding tissue is of paramount importance in preventing infection. Regular monitoring of the line site leads to early detection of sepsis and thrombosis.

The use of catheters and dressings that have associated antimicrobial activity

Impregnated sponge-type dressings are only recommended if the CLABSI rate is not decreasing despite adherence to basic prevention measures, including education and training. This includes adherence to all of the previously described principles.[207-209] Antimicrobial-impregnated catheters or those with antimicrobial properties may be considered in environments in which the rate of CLABSI is not decreasing, and if lines are likely to remain in place for more than five days.[197]

Rationale

The basic principles of infection control and line management previously described cannot be substituted with the use of catheters or dressings with antimicrobial activity.

The management of lines and administration sets

- In patients not receiving blood, blood products or fat emulsions, replace administration sets that are continuously used, including secondary sets and add-on devices, no more frequently than at 96-hour intervals, but at least every seven days.[209-211]
- Infusion sets that have contained blood or blood products or fat-containing emulsions must be changed within 24 hours of initiating the infusion.[210-212]
- Tubing used to administer sedative drugs with a fat emulsion-based vehicle should be changed when the vial is changed, or at least every 12 hours.[212,213]
- When using needleless connectors, use a luer-locking mechanism to ensure a secure connection to the central venous catheter hub or access site.[198]
- When needleless systems are used, a split septum valve may be preferred over some mechanical valves due to increased risk of infection with the mechanical valves.
- Disinfect needleless connectors prior to each entry into the device.[197,198]
- Use aseptic no-touch technique to change the needleless connector.[198]
- Change the needleless components at least as frequently as the administration set. There is no benefit to changing these more frequently than every 72 hours.[214,215]
- Needleless connectors and access ports on administration sets must be cleaned with 70% alcohol, tincture of iodine or chlorhexidine, prior to injection or connection.[198]
- Access needleless connectors only with a sterile device. [197]

Rationale

The infusion of blood or blood products or fat-containing emulsions increases the risk of infection. The need for a needleless connector placed between the catheter hub and the administration set used for continuous fluid infusion is unknown. The main role of needleless connectors is to protect healthcare personnel by eliminating needles and needlestick injuries when attaching administration sets and/or syringes to the catheter hub or injection site. Unless strict cleaning procedures are adhered to, the use of needleless connectors is no safer from an infection perspective.

The insertion of peripheral catheters

- Strict hand hygiene must be observed before and after the placement, removal or palpation of the catheter-insertion site.[43,216,217]
- Strict hand hygiene is also required before and after accessing or dressing a catheter.[43,216,217]
- Clean gloves, rather than sterile gloves, should be used for the insertion of peripheral venous catheters if the access site is not touched after the application of skin antiseptics.[198]
- Sterile gloves should be used for the insertion of arterial and umbilical catheters.[198]
- Clean gloves must be worn when changing the dressings on intravascular catheters.[198]
- Skin preparation with 70% alcohol, tincture of iodine or chlorhexidine is acceptable for peripheral venous catheter insertion.[218,219]
- A cleaning solution that contains more than 0.5% chlorhexidine in alcohol should be used when inserting arterial catheters.[218,219]
- The upper extremity should ideally be used for the insertion of venous catheters in adults.[198,219]
- The upper or lower extremities, or the scalp, may be used as a catheter insertion site in paediatric patients.[198]
- The radial or dorsalis pedis site is preferred over the femoral or axillary site to reduce the risk of infection in adults.[220,221]
- Remove the peripheral catheters if there is any sign of infection or inflammation at the insertion site. This includes redness, tenderness, purulence or obvious thrombophlebitis.[218,219]
- While many of these recommendations may already be in practice, practitioners should be careful to take heed of statements that are made. The risks, incidence, precipitating factors and preventive strategies are all well researched and subject to a wealth of evidence.
- Extensive reviews and recommendations are published by the Centers for Disease Control and Prevention (CDC) and Healthcare Infection Control Practices Advisory Committee.[222,223]