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Comprehensive Management and Infection Prevention in Central Venous Catheters: A Guide for Clinical Practice

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ABSTRACT

Intravascular catheters are essential for critically ill patients, enabling safe administration of medications, fluids, and hemodynamic monitoring. However, they

pose risks of systemic and localized bloodstream infections. This review examines the types of central venous catheters (CVCs), complications associated with their use, and evidence-based practices for catheter management to prevent infections. Complications range from minor issues like occlusions and unintentional removals to severe problems such as phlebitis, infections, and skin damage. Catheter-related bloodstream infection (CR-BSI) is a serious complication influenced by patient, catheter, and institutional factors, with incidence rates of 1-3.1 per 1,000 patient days in adult intensive care units. In Saudi Arabia, a study found a 39.3% complication rate, with phlebitis being the most common (17.6%). Proper CVC management is crucial, focusing on dressing changes, disinfection, assessing patency, flushing, connector usage, blood sampling, and removal techniques. Adherence to evidence-based guidelines and standardized protocols is essential for preventing complications. Nurses' knowledge and institutional practices play a significant role in reducing catheter-related infections. Further research and consistent implementation of best practices are necessary to minimize the risks associated with intravascular catheters and improve patient outcomes.

KEYWORDS: Central venous catheter (CVC), catheter-related bloodstream infection, infection prevention, disinfection protocols, sterile technique, intravenous therapy.

1. Introduction

Intravascular catheters are frequently necessary for the treatment of individuals who are critically ill. They support the safe administration of intravenous fluid resuscitation, the safe administration of medications, and the monitoring of hemodynamic parameters in the treatment of patients with syndromes such as pulmonary hypertension, decompensated heart failure, septic shock, and cardiogenic shock. Intravascular catheters have advantages, but they can also act as entry points for systemic and localized bloodstream infections. Because of this, a lot of work has been done to lower the frequency of bloodstream infections via Intravascular catheters (Bell & O'Grady, 2017).

Several types of CVCs are used in clinical practice, categorized by various factors: expected duration of use (temporary/short-term vs. permanent/long-term), insertion site (such as subclavian, femoral, or internal jugular veins, or peripherally inserted central catheters (PICC)), pathway from skin to vessel (tunneled vs. non-tunneled), catheter length (long vs. short), or additional characteristics (e.g., heparin impregnation or the number of lumens) (N. P. O'Grady et al., 2011).

Intravenous catheter insertions are among the most often performed procedures on hospitalized patients, which leaves them vulnerable to both infectious and non-infectious problems (Peripherally Inserted Central Catheters and Their Use in i.v. Therapy - PubMed, n.d.). Depending on how severe the symptoms are, intravascular catheter problems are divided into minor and major categories. Catheter occlusions, unintentional removals, pain, and needle phobia a dread of sharp catheters are examples of minor problems. Major problems, on the other hand, include phlebitis, infection, extravasation, and even skin damage, which are typically more serious (Johansson et al., 2008). Adult intravascular catheter use has been the subject of

published research using a variety of descriptive, correlational, and randomized controlled trial techniques (Maki et al., 2006; Malach et al., 2006).

Since CVC insertion is an invasive procedure that breaks the skin barrier (integument), it can lead to complications such as exit-site infections and bloodstream infections (Han et al., 2010). One of the more severe complications is catheter-related bloodstream infection (BSI), sometimes referred to as 'catheter sepsis.' The risk of catheter-related BSI is affected by patient-related factors, such as the severity and type of illness (e.g., full-thickness burns vs. post-cardiac surgery), as well as catheter-specific factors (e.g., placement conditions and catheter type) and institutional factors (e.g., hospital size and academic affiliation; (N. P. O'Grady et al., 2011)). Studies estimate that the incidence of catheter-related BSI generally ranges from 1 to 3.1 per 1,000 patient days, especially in adult intensive care units (ICUs) (P et al., 2006; Schwebel et al., 2012). However, incidence rates have been observed to drop to zero with the implementation of infection-control measures such as hand hygiene and skin antisepsis (Han, 2010). In the adult ICU population, the cost of catheter-related BSI can range from USD 3,124 to USD 60,536 per case when considering hospital resources ((Raad et al., 2007; Schwebel et al., 2012); Schwebel, 2012) and is associated with a mortality rate ranging from 0% to 11.5% (Timsit et al., 2011).

According to a systematic review, the incidence of infection was 0.1-0.2/100 catheter days or 0.1-0.2/100 catheters (Maki et al., 2006). Others found that the frequency of phlebitis was 6.2%, the rate of leakage was 12.4%, and the rate of infiltration was 7.4%. They also came to the startling conclusion that the risk of phlebitis increased by 4.4 times when PIVC catheters were restarted (Gallant & Schultz, 2006). Furthermore, it has been discovered that the length of the patient's stay as well as the drug or infusion that they got via Intravascular catheters are directly linked to peripheral intravenous (IV) phlebitis (Malach et al., 2006).

In Saudi Arabia, A recent study sheds light on the prevalence of complications associated with Intravenous catheter insertion. The study, conducted on a cohort of recruited patients, found that 39.3% of them experienced complications related to Intravenous catheter insertion. In total, 273 instances of various complications were recorded, indicating an incidence rate of 32.4 per 100 catheters. Notably, phlebitis emerged as the most common complication, with a striking incidence rate of 17.6%, followed by pain (7.6%) (Abolfotouh et al., 2014).

Nurses' knowledge of evidence-based CVC care needs to be supported by the policies, procedures, and practices of their own ICU. Despite the publication of evidence-based recommendations, changes in practice often lag behind guideline dissemination (Morritt et al., 2006). Another study surveyed 14 ICUs in Australia to determine whether clinical practice reflected the CDC guidelines and found significant discrepancies (Rickard et al., 2004).

The occurrence of complications in these individuals is significantly impacted by the uneven adoption of evidence-based management. Apart from the standards established by the CDC, other available resources instruct bedside nurses on best

practices for preventing complications. Nevertheless, there are variations in hospital protocols and nurses' comprehension of these best practices (Ullman et al., 2014).

As foreign bodies, CVCs require the external part to be sufficiently protected against microbial contamination from the surrounding environment and secured to the skin. Dressings and securement systems are necessary to prevent CVC dislodgement, accidental removal, or movement within the veins. Dislodgement can occur through physical forces applied to the external part of the CVC, forced removal, or accidental "drag" from infusion lines or snagging on environmental objects (Naimer & Temira, 2004). Migration of the CVC from its intended placement can lead to line failure or cardiovascular instability, which, in critical cases, can result in serious consequences for the patient's health, such as during the interruption of vital inotropic support in cases of cardiogenic shock.

Catheter Management

Dressing Management for Central Venous Catheters (CVCs)

The management of a central venous catheter (CVC) dressing focuses on the catheter’s extraluminal track and necessitates a comprehensive understanding of factors such as patient diagnosis, catheter insertion site, antiseptic use, sterile techniques, and dressing materials. The primary aim of a dressing is to maintain a dry, clean insertion site and ensure catheter stability.

Patient condition and treatments influence skin integrity and immune function. For instance, steroids can increase skin fragility, while chemotherapy can severely weaken the immune response, making it difficult to detect skin irritation. Individualizing the dressing change procedure is vital to support or preserve skin integrity, minimize skin irritation associated with dressings, and promote better dressing adhesion.

Skin ecosystems vary and include dry (e.g., arm), moist (e.g., chest, groin), and sebum-rich (e.g., jugular) areas. Moisture fosters bacterial growth and aids in their movement over the skin and along the catheter track through capillary action and diffusion. Gram-negative bacteria, fungi, and viruses thrive in wet or sebum-rich areas. The jugular area is especially exposed to respiratory tract-associated bacteria due to its proximity to the nose, mouth, and, if present, tracheostomy. Common microorganisms in catheter-related bloodstream infections (CR-BSI) include gram-negative bacteria (P. aeruginosa, Klebsiella, Enterobacter), gram-positive bacteria (S. epidermis, S. aureus), and yeast (Candida albicans). These pathogens may originate from the patient’s skin, healthcare worker’s hands, or contaminated infusates. Approximately 80% of skin-dwelling bacteria reside within the first five layers of the stratum corneum, while the remaining 20% are found in biofilms within hair follicles and sebaceous glands (Menyhay & Maki, 2006; Ryder, 2006). Thus, prolonged skin antisepsis is not feasible, as bacteria recolonize the skin within 18 hours even after appropriate antiseptic application. After catheter insertion, the skin around the track initiates an inflammatory response, producing edema and drainage, creating a moist environment that prevents a tight seal around the catheter and facilitates the passive migration of microorganisms via capillary action and diffusion. Additionally, sutures can harbor bacteria; the suture material may carry bacteria as it penetrates deeper

skin layers during placement, fostering colonization and biofilm development. Suturing near the insertion site, especially if covered by the dressing, may serve as a CR-BSI focus.

According to the Centers for Disease Control and Prevention (CDC), all dressings should be replaced if they become damp, loose, or soiled, or if the insertion site needs to be inspected. In adult patients, transparent CVC dressings are typically changed every 7 days, while gauze dressings are changed every 2 days, unless institutional policies dictate otherwise. For pediatric patients, however, the risk of catheter dislodgement may outweigh the benefits of routine dressing changes. When a transparent dressing is intact on three edges but loose around the extension and catheter hub, it should be replaced rather than reinforced.

Maintaining sterility throughout the dressing change process is essential, and each step should be followed meticulously. If exudate or dried blood is present, the insertion site and surrounding skin should be thoroughly cleaned before antiseptic application. Any blood on the catheter itself should be cleaned with an alcohol wipe. The skin area cleaned should extend 4 to 6 inches, slightly larger than the dressing to be applied. Chlorhexidine (CHG) combined with isopropyl alcohol is the recommended antiseptic for the skin, as the alcohol exhibits biocidal activity while wet, and CHG binds to skin proteins for a sustained antimicrobial effect (P. O'Grady, 2002). Skin should be cleaned with friction, either up-and-down or across, rather than in concentric circles as previously practiced. CHG preparations should be allowed to dry completely, typically taking about 2 minutes, to ensure maximum antimicrobial activity. A CHG-impregnated sponge may be applied to maintain continuous microorganism reduction and prevent extraluminal contamination (Timsit et al., 2009; Yokoe et al., 2008). Techniques such as fanning, blowing, or blotting reduce the effectiveness of bacterial elimination. The CDC advises against routine antimicrobial ointment application at insertion sites due to the risk of maceration and fungal growth. Skin protectants can help prevent skin damage from frequent dressing changes and improve dressing adherence, particularly on fragile skin (e.g., elderly patients, those on long-term steroids). Skin protectants should also be allowed to dry, typically taking 1 minute, before dressing application.

Transparent dressings are frequently chosen for central line insertion sites, as they enable site observation, act as a barrier to external moisture, and are comfortable. These dressings differ in their moisture vapor transmission rates (MVTR), allowing skin moisture to pass through but not from the outside. Different patients and brands experience varying levels of moisture accumulation beneath transparent dressings, depending on MVTR. Oncology patients, prone to diaphoresis due to elevated temperatures or chemotherapy-related hypermetabolism, may benefit from high-MVTR dressings like OPSITE 3000 (Smith & Nephew Healthcare Limited, Minneapolis, MN), which can improve adhesion. After application, additional tape around the catheter area can help stabilize the dressing and extend its adhesion. The dressing should be labeled with the date, initials, and other institution-required details. Securing a dressing on an implanted port can be challenging; directing the extension toward the sternum or shoulder rather than downward or toward the arm

can prevent needle displacement and enhance adhesion. Tunneled catheters, such as Hickman (Bard Access Systems, Salt Lake City, UT), require extra care to secure the external catheter segment to avoid accidental tugging.

Connectors

Connectors are categorized into needle-free (NF) and intraluminal protection (IP) types. Within the NF category, connectors can be further divided into two types: those with negative reflux, where blood reflux occurs upon disconnection, and those with positive reflux, where blood reflux happens upon access. The IP category includes a zero-reflux connector, specifically the Invision-Plus Neutral. The Society for Healthcare Epidemiology of America and Infectious Diseases Society of America advises that certain approaches should not be routinely implemented as part of central line-associated bloodstream infection (CLABSI) prevention. Specifically, the routine use of positive-pressure needle-free connectors with mechanical valves should be avoided without thorough risk-benefit analysis, proper training on usage, and evidence on the risk of CLABSI with certain devices, which is not recommended (8). Following these guidelines may help to reduce CLABSI and occlusions.

Access Disinfection

Effective disinfection of IV connectors is essential to prevent bacterial contamination of the intraluminal fluid pathway. The CDC recommends cleaning with 70% alcohol before each access, as alcohol's biocidal action occurs when it is wet, while CHG's biocidal activity is achieved upon drying. Research suggests that complete removal of contamination from the septum surface on NF connectors can be challenging in clinical settings (Menyhay & Maki, 2006), as NF connectors are designed primarily for needle-free access rather than intraluminal protection. Their single-barrier, single-seal, or single-o-ring designs can leave gaps around the septum. In contrast, the IP system has a pressurized, smooth septum that laboratory tests have shown can eliminate 99.99% of septum bacteria when cleaned in a circular motion, mimicking "juicing an orange" three times. This cleaning method (used on the InVision-Plus, RyMed) has been included in infection prevention bundles that have achieved zero CR-BSI (Harnage, 2007, p. 1). A study in pediatrics using an NF connector (Smartsite, Alaris) compared CR-BSI rates with 2% CHG/70% isopropanol and a 30-second scrub against a group using 70% isopropanol alone; the CHG/alcohol group had six CR-BSIs compared to 22 in the alcohol-only group (Soothill et al., 2009). However, maintaining such prolonged scrubbing and drying times may be challenging in acute care settings. The wide variation in connector septum design limits the generalizability of study findings across different connectors, making study reliability difficult to achieve. Swabbing with friction is essential and should include the septum and the connector threads. In alignment with The Joint Commission National Patient Safety Goals, hospitals must have a standardized protocol for disinfecting catheter hubs and injection ports before accessing them.

Assessing Catheter Patency

To verify catheter patency, it is important to check for blood return before each use. If blood return is absent, the catheter should be evaluated to ensure proper function. For partial occlusions, an instillation of alteplase (Cathflo; Genentech, San

Francisco, CA) at 2 mg in 2 mL should be administered and allowed to work for 30 minutes before re-assessment. If there is still no blood return, a second assessment should be done after 90 minutes, with an additional dose if needed. If blood return cannot be restored, the physician should be contacted, and the catheter should not be used.

Flushing

Flushing is the primary method to clear fibrin and residual medications from the intraluminal catheter pathway. With the evolution of NF connectors over the past 15 years, fluid pathway designs have become more complex, increasing the dead space within the fluid pathway. Dead space areas trap fibrin during aspiration, which cannot be fully cleared through flushing due to fluid following the path of least resistance like still water along the edges of a stream. Straight fluid pathways, as in the IP system, can be flushed effectively. The IP system's design helps reduce fibrin buildup, lowering the risk of catheter occlusion and CLABSI (Harnage, 2007). Fibrin deposition on the catheter's intraluminal surface increases susceptibility to coagulase-negative staphylococci infections (Van Rooden et al., 2008). If fibrin buildup is not minimized, catheter occlusion may occur, and thrombosis can raise infection risks (Jacobs, 2003). Catheters with occlusions should not remain in place; for instance, a triple-lumen catheter should not be labelled as "occluded do not use" on one lumen. Instead, the occlusion should be treated using alteplase as mentioned earlier. Failure to address occlusions can lead to therapy interruption, increased x-rays, and possible catheter replacement.

When performing flushes, understanding the relationship between syringe size and plunger pressure is crucial to maintaining catheter integrity. Softer silicone catheters (e.g., some tunneled catheters and PICC catheters) are more susceptible to damage than polyurethane ones. The same applied force on a smaller syringe generates higher pressure than on a larger syringe. Pressure is influenced by factors including plunger force, syringe size, resistance from venous access device length and gauge (greatest with small-gauge PICCs), and fluid viscosity. Resistance increases with partial or total occlusions in the vein or catheter. Partial occlusions, such as muscle contractions along the PICC or arm catheter track, may occur with flexed muscles. When resistance is detected, more force should not be applied to the plunger to avoid catheter damage. The typical syringe size for VAD flushing is 10 mL, and using normal force without occlusion should not damage the catheter. Preservative-free saline (bacteriostatic) is recommended for flushing, with a maximum adult dose of 30 mL in 24 hours when saline with preservatives is used to avoid adverse reactions to benzyl alcohol (Bacteriostatic Saline (Bacteriostatic NaCl), n.d.). Research indicates that a steady, smooth flushing method minimizes fibrin adhesion (Donlan & Costerton, 2002). There is no evidence supporting the push-pause method for flushing. If unusual resistance is encountered, further force should be avoided. Repositioning the patient, asking them to cough, or deep breathing can be attempted before re-flushing. If resistance persists, the source of the restriction must be determined before proceeding with the flush. For IV push drugs, blood return should be confirmed, followed by a 10 mL saline flush. After drug administration, a final

saline flush using smooth, steady action is necessary to clear residual solution from the catheter, preventing incompatible solutions from interacting and forming precipitates.

Connector Clamping Sequence

Reflux associated with connector usage is a significant factor in intraluminal fibrin buildup. To prevent blood reflux with NF or negative reflux connectors, nurses should press the syringe barrel, clamp the catheter, and then disconnect the syringe (Chernecky et al., 2009). Additionally, when accessing the connector, the nurse should apply pressure to the syringe barrel before opening the clamp to prevent reflux. For NF-positive reflux connectors, the opposite clamping sequence is needed: the clamp remains open during connection and is closed after disconnection to enable positive push. If the clamping sequence for negative reflux connectors is used with a positive-pressure connector, the final disconnection push is hindered, which can degrade connector performance over time. IP connectors with zero fluid displacement do not require a specific clamping sequence. Understanding whether a positive or negative reflux system is used is essential for correct nursing practice. Institutions may have various IV connectors or different connectors for central and peripheral catheters. When "float" or agency nurses are employed, consistency in connector handling can be affected.

Changing Connectors

The connector functions as the protective barrier for the intraluminal fluid pathway, where any breach can potentially introduce microorganisms, leading to a catheter-related bloodstream infection (CR-BSI). According to CDC Category II guidelines, connectors should be changed at least as frequently as the administration set and caps should be replaced no more frequently than every 72 hours, unless manufacturer instructions suggest otherwise deciding on a schedule for changing connectors (P. O'Grady, 2002), the entire administration system should be considered. It is critical to attach sterile components to connectors, but maintaining sterility can be challenging with intermittent infusion sets. Therefore, it is essential to develop protocols ensuring the sterility of the luer end if the tubing is left suspended. Practices such as reinserting the tubing needle into the port or using an alcohol wipe wrapper as a cover compromise sterility and should be avoided. If there is any uncertainty about the sterility of tubing, it should be replaced before reconnecting for intermittent therapy. Additionally, non-aseptic practices, such as wearing the same gloves used in non-IV patient care for IV procedures, must be addressed. Gloves used for non-sterile tasks, like blood sampling, should be removed, hands re-sanitized, and new gloves applied before initiating IV care.

Blood Sampling

Blood sampling from central venous catheters (CVCs) is routine in oncology settings, but the process has several steps where complications may arise. Peripheral vein blood draws often utilize a collection system like the Vacutainer (Becton Dickson, Franklin Lakes, NJ), where pre-filled vacuum tubes collect blood to the exact required amount. This method, effective with steel needle systems, may create complications when used with flexible central catheters due to excessive vacuum

pressure, which can cause catheter collapse or movement against the vein wall. Such movement may result in catheter occlusion, vein wall damage, reduced vein longevity, or even infiltration, with silicone central catheters particularly susceptible.

When Vacutainer use in central lines yields irregular blood return, the turbulence can lead to hemolysis, affecting lab results for various assays. Underfilled tubes can disrupt the blood-additive ratio, leading to inaccuracies in lab values, such as prolonged coagulation times for blue tubes or lower cell counts in lavender tubes. It is recommended to use the syringe method for central CVCs as it allows controlled pressure, reducing the risk of damage to the vein wall and enhancing sample quality. Syringe-based blood draws are typically more successful, with smaller syringes (e.g., 5 mL) potentially increasing return success if larger syringes (10 mL) fail. The collected sample should be gently rocked 8 to 10 times, particularly tubes with additives, to ensure proper mixing without rocking red-stopper tubes or shaking any tube.

When drawing blood cultures, which are standard in diagnosing bacteremia, avoiding blood discard is crucial if the catheter is suspected as the infection source to prevent losing potential microorganism evidence. The specimen site and the tube septum must be thoroughly disinfected to avoid false-positive results.

Catheter Removal

Central venous access devices (VADs) should be promptly removed when no longer needed (N. P. O'Grady et al., 2011). When the decision to remove the catheter is based on weighing the risks and benefits; alternative options include antibiotic therapy or a guidewire exchange, although the latter is not CDC-recommended. In the event of catheter integrity loss, except for tunneled catheters, removal is generally necessary, though tunneled catheters can undergo specific repair. Physicians should be responsible for removing tunneled, implanted, or Swan Ganz catheters. If venous thrombosis is suspected, removal should only proceed following imaging to confirm its size and location.

Care should be taken during catheter removal to avoid potential complications such as air embolism. For instance, catheters with a 14-gauge track can transmit about 200 mL of air per second, posing a significant risk. To maintain a closed system during removal, applying a petroleum-based ointment to the dressing site aids in creating an occlusive barrier upon catheter withdrawal (Mermel et al., 2009). Pressure should be maintained over the site for a minimum of 5 minutes to ensure hemostasis, with the occlusive dressing left in place for 12 to 24 hours. When removing jugular catheters, avoid firm pressure or rubbing the neck area, as carotid stimulation can lead to bradycardia. Gentle removal is advised, and patients may perform a Valsalva maneuver during non-cardiac CVC removal to prevent air entry.

For peripherally inserted central catheters (PICCs), pre-removal warm compresses can alleviate venous spasm risks, enhancing blood flow and reducing smooth muscle activation. PICC removal requires slow, parallel-to-skin extraction in 1-inch increments with minimal pressure to avoid catheter damage. If pain or resistance is encountered, the procedure should be stopped immediately. Catheters coated with

fibrin or attached due to thrombus may require surgical intervention.

After complete PICC removal, the insertion site should be lightly pressured to maintain hemostasis, and tape should be applied vertically along the insertion direction. Observing the catheter tip is necessary to confirm its full removal length aligns with original insertion documentation. If a length discrepancy arises, apply a light tourniquet above the insertion site, position the patient on their left side, and notify the physician promptly.

2. Conclusion

Infection prevention and maintenance of central venous catheters (CVCs) are critical in managing patient safety and treatment efficacy, particularly in high-risk clinical settings. This paper has examined best practices for catheter care, from effective disinfection protocols and dressing management to proper techniques for blood sampling and flushing, each essential for reducing catheter-related bloodstream infections (CR-BSI) and improving patient outcomes. The evidence-based protocols highlighted, including the careful selection of connectors and strict adherence to sterile procedures, underscore the importance of comprehensive care in preventing complications such as occlusions, infection, and thrombus formation. By adhering to established guidelines and optimizing catheter management strategies, healthcare providers can significantly reduce CR-BSI risks, ensuring safer and more reliable intravenous therapy for patients.

References

Abolfotouh, M. A., Salam, M., Bani Mustafa, A., White, D., & Balkhy, H. (2014). Prospective study of incidence and predictors of peripheral intravenous catheter-induced complications. Therapeutics and Clinical Risk Management, 993. https://doi.org/10.2147/TCRM.S74685

Bacteriostatic Saline (Bacteriostatic NaCl): Side Effects, Uses, Dosage, Interactions, Warnings. (n.d.). RxList. Retrieved November 13, 2024, from https://www.rxlist.com/bacteriostatic-saline-drug.htm

Bell, T., & O'Grady, N. P. (2017). Prevention of Central Line–Associated Bloodstream Infections. Infectious Disease Clinics of North America, 31(3), 551–559. https://doi.org/10.1016/j.idc.2017.05.007

Chernecky, C., Macklin, D., Casella, L., & Jarvis, E. (2009). Caring for Patients with cancer Through Nursing Knowledge of IV Connectors. Clinical Journal of Oncology Nursing, 13(6), 630–633. Scopus. https://doi.org/10.1188/09.CJON.630-633

Donlan, R. M., & Costerton, J. W. (2002). Biofilms: Survival mechanisms of clinically relevant microorganisms. Clinical Microbiology Reviews, 15(2), 167–193. Scopus. https://doi.org/10.1128/CMR.15.2.167-193.2002

Gallant, P., & Schultz, A. A. (2006). Evaluation of a visual infusion phlebitis scale for determining appropriate discontinuation of peripheral intravenous catheters. Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 29(6), 338–345. https://doi.org/10.1097/00129804-200611000-00004

Han, Z., Liang, S. Y., & Marschall, J. (2010). Current strategies for the prevention and management of central line-associated bloodstream infections. Infection and Drug Resistance, 3, 147. https://doi.org/10.2147/IDR.S10105

Harnage, S. A. (2007). Achieving Zero Catheter Related Blood Stream Infections: 15 months

success in a community based medical center. JAVA - Journal of the Association for Vascular Access, 12(4), 218–224. Scopus. https://doi.org/10.2309/java.12-4-8

Jacobs, B. R. (2003). Central venous catheter occlusion and thrombosis. Critical Care Clinics, 19(3), 489–514. Scopus. https://doi.org/10.1016/S0749-0704(03)00002-2

Johansson, M. E., Pilhammar, E., Khalaf, A., & Willman, A. (2008). Registered nurses' adherence to clinical guidelines regarding peripheral venous catheters: A structured observational study. Worldviews on Evidence-Based Nursing, 5(3), 148–159. https://doi.org/10.1111/j.1741-6787.2008.00105.x

Maki, D. G., Kluger, D. M., & Crnich, C. J. (2006). The risk of bloodstream infection in adults with different intravascular devices: A systematic review of 200 published prospective studies. Mayo Clinic Proceedings, 81(9), 1159–1171. https://doi.org/10.4065/81.9.1159

Malach, T., Jerassy, Z., Rudensky, B., Schlesinger, Y., Broide, E., Olsha, O., Yinnon, A. M., & Raveh, D. (2006). Prospective surveillance of phlebitis associated with peripheral intravenous catheters. American Journal of Infection Control, 34(5), 308–312. https://doi.org/10.1016/j.ajic.2005.10.002

Menyhay, S. Z., & Maki, D. G. (2006). Disinfection of Needleless Catheter Connectors and Access Ports With Alcohol May Not Prevent Microbial Entry: The Promise of a Novel Antiseptic-Barrier Cap. Infection Control & Hospital Epidemiology, 27(1), 23–27. https://doi.org/10.1086/500280

Mermel, L. A., Allon, M., Bouza, E., Craven, D. E., Flynn, P., O'Grady, N. P., Raad, I. I., Rijnders, B. J. A., Sherertz, R. J., & Warren, D. K. (2009). Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 update by the infectious diseases society of America. Clinical Infectious Diseases, 49(1), 1–45. Scopus. https://doi.org/10.1086/599376

Morritt, M. L., Harrod, M. E., Crisp, J., Senner, A., Galway, R., Petty, S., Maurice, L., Harvey, A., Hardy, J., & Donnellan, R. (2006). Handwashing practice and policy variability when caring for central venous catheters in paediatric intensive care. Australian Critical Care, 19(1), 15–21.

Naimer, S. A., & Temira, F. (2004). Evaluation of techniques for intravenous catheter and tubing fixation. Military Medicine, 169(1), 79–81. https://doi.org/10.7205/milmed.169.1.79

O'Grady, N. P., Alexander, M., Burns, L. A., Dellinger, E. P., Garland, J., Heard, S. O., Lipsett, P. A., Masur, H., Mermel, L. A., Pearson, M. L., Raad, I. I., Randolph, A. G., Rupp, M. E., Saint, S., & Healthcare Infection Control Practices Advisory Committee (HICPAC) (Appendix 1). (2011). Summary of recommendations: Guidelines for the Prevention of Intravascular Catheter-related Infections. Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America, 52(9), 1087–1099. https://doi.org/10.1093/cid/cir138

O'Grady, P. (Ed.). (2002). Introduction to relativism. In Relativism (pp. 1–26). Acumen Publishing. https://doi.org/10.1017/UPO9781844653294.002

P, P., D, N., S, B., D, S., H, C., S, C., B, S., R, H., R, W., G, R., J, B., J, K., & C, G. (2006). An intervention to decrease catheter-related bloodstream infections in the ICU. The New England Journal of Medicine, 355(26). https://doi.org/10.1056/NEJMoa061115

Peripherally inserted central catheters and their use in i.v. Therapy—PubMed. (n.d.). Retrieved April 8, 2024, from https://pubmed.ncbi.nlm.nih.gov/10222875/

Raad, I., Hanna, H., & Maki, D. (2007). Intravascular catheter-related infections: Advances in diagnosis, prevention, and management. The Lancet. Infectious Diseases, 7(10), 645–657. https://doi.org/10.1016/S1473-3099(07)70235-9

Rickard, C. M., Courtney, M., & Webster, J. (2004). Central venous catheters: A survey of ICU practices. Journal of Advanced Nursing, 48(3), 247–256.

https://doi.org/10.1111/j.1365-2648.2004.03193.x

Ryder, M. (2006). Evidence-based practice in the management of vascular access devices for home parenteral nutrition therapy. Journal of Parenteral and Enteral Nutrition, 30(SUPPL. 1), S82–S93. Scopus. https://doi.org/10.1177/01486071060300S1S82

Schwebel, C., Lucet, J.-C., Vesin, A., Arrault, X., Calvino-Gunther, S., Bouadma, L., & Timsit, J.-F. (2012). Economic evaluation of chlorhexidine-impregnated sponges for preventing catheter-related infections in critically ill adults in the Dressing Study. Critical Care Medicine, 40(1), 11–17. https://doi.org/10.1097/CCM.0b013e31822f0604

Soothill, J. S., Bravery, K., Ho, A., Macqueen, S., Collins, J., & Lock, P. (2009). A fall in bloodstream infections followed a change to 2% chlorhexidine in 70% isopropanol for catheter connection antisepsis: A pediatric single center before/after study on a hemopoietic stem cell transplant ward. American Journal of Infection Control, 37(8), 626–630. Scopus. https://doi.org/10.1016/j.ajic.2009.03.014

Timsit, J.-F., Dubois, Y., Minet, C., Bonadona, A., Lugosi, M., Ara-Somohano, C., Hamidfar-Roy, R., & Schwebel, C. (2011). New materials and devices for preventing catheter-related infections. Annals of Intensive Care, 1, 34. https://doi.org/10.1186/2110-5820-1-34

Timsit, J.-F., Schwebel, C., Bouadma, L., Gefftroy, A., Garrouste-Orgeas, M., Pease, S., Herault, M.-C., Haouache, H., Calvino-Gunther, S., Gestin, B., Armand-Lefevre, L., Leflon, V., Chaplain, C., Benalt, A., Francais, A., Adrie, C., Zahar, J.-R., Thuong, M., Arrault, X., … Lucet, J.-C. (2009). Chlorhexidine-Lmpregnated sponges and less frequent dressing changes for prevention of catheter-related infections in critically III adults: A randomized controlled trial. JAMA, 301(12), 1231–1241. Scopus. https://doi.org/10.1001/jama.2009.376

Ullman, A. J., Long, D. A., & Rickard, C. M. (2014). Prevention of central venous catheter infections: A survey of paediatric ICU nurses' knowledge and practice. Nurse Education Today, 34(2), 202–207. https://doi.org/10.1016/j.nedt.2013.09.002

Van Rooden, C. J., Schippers, E. F., Guiot, H. F. L., Barge, R. M., Hovens, M. M. C., Van Der Meer, F. J. M., Rosendaal, F. R., & Huisman, M. V. (2008). Prevention of coagulase-negative staphylococcal central venous catheter-related infection using urokinase rinses: A randomized double-blind controlled trial in patients with hematologic malignancies. Journal of Clinical Oncology, 26(3), 428–433. Scopus. https://doi.org/10.1200/JCO.2007.11.7754

Yokoe, D. S., Mermel, L. A., Anderson, D. J., Arias, K. M., Burstin, H., Calfee, D. P., Coffin, S. E., Dubberke, E. R., Fraser, V., Gerding, D. N., Griffin, F. A., Gross, P., Kaye, K. S., Klompas, M., Lo, E., Marschall, J., Nicolle, L., Pegues, D. A., Perl, T. M., … Classen, D. (2008). Executive Summary: A Compendium of Strategies to Prevent Healthcare-Associated Infections in Acute Care Hospitals. Infection Control & Hospital Epidemiology, 29(S1), S12–S21. https://doi.org/10.1086/591060