ASIA PACIFIC SOCIETY OF INFECTION CONTROL

APSIC REVISED GUIDELINES FOR PREVENTION OF CENTRAL LINE ASSOCIATED BLOODSTREAM INFECTIONS (CLABSI)

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I. Understanding CLABSI and prevention of CLABSI

1. Introduction

Use of central lines, or central vascular catheters (CVC) is common in both inpatient and outpatient settings (including long term care facilities and home care). CVC use plays an integral role in modern health care, allowing for the administration of intravenous fluids, blood products, medications, and parenteral nutrition, as well as providing hemodialysis access and hemodynamic monitoring.

A central line is defined as an intravascular catheter that terminates at or close to the heart or in one of the great vessels and is used for infusion, withdrawal of blood, or hemodynamic monitoring. The following are considered great vessels for the purpose of defining a central line; aorta, pulmonary artery, superior vena cava, inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, external iliac veins, common iliac veins or femoral veins; and in neonates, the umbilical artery/vein. Central lines include temporary central lines (non-tunnelled, non-implanted catheters), permanent central line (tunnelled dialysis catheters, implanted catheters [including ports]), and umbilical catheters. A central line may be inserted centrally or peripherally (such as peripherally inserted central catheter [PICC]). Neither the location of the insertion site nor the type of device determines whether a line qualifies as a central line.

Their use, however, is associated with a risk of bloodstream infection, termed central line–associated bloodstream infections (CLABSI). CLABSI is a common healthcare associated infection and associated with increased morbidity, mortality, additional health care costs and prolong hospital lengths of stay. Non-inflation-adjusted costs associated with CLABSIs have varied from $3,700 per infection to $36,441 per infection. A recent CDC estimate set the cost of each CLABSI at $16,550. Detailed comparison of studies between diverse countries is difficult, due to differences in hospital billing systems. However, in all studies, the excess costs are considered substantial and economically relevant.

Approximately half of CLABSIs are considered preventable when evidence-based

guidelines are implemented for the insertion and maintenance of CVCs. Collaborative implementation of evidence-based interventions with stakeholder engagement, communication of opportunities for improvement and engaging local champions with feedback can reduce CLABSI. Hybrid study designs, process evaluation and adherence to reporting guidelines improve compliance with the evidence-base practices.

A. Definition

A central line-associated bloodstream infection (CLABSI) is a primary bloodstream infection (BSI) in a patient that had a central line within the 48-hour period before the development of the BSI and is not bloodstream-related to an infection at another site.

B. Pathogenesis

There are four possible routes for CVC contamination (Fig 1). CVCs can become contaminated by microorganisms colonizing the external surface of the device or the fluid pathway when the device is inserted or during its use. Furthermore, CVCs provide a surface for microorganism biofilm formation which can result in an infection in the bloodstream infection or at a distant site.

In addition, the patient's skin organisms at the insertion site can migrate along the surface of the catheter resulting in colonization of the catheter. More commonly, CVC may be contaminated directly or at any point along the fluid pathway when the intravenous (IV) system is manipulated. It might occur when health care personnel have hand contact with IV solution connection sites, access hubs, needleless connectors, tubing junctions, or contamination with the patient's own skin.

Less commonly, catheters become seeded via the hematogenous route from an infection at distant site, such as a urinary tract infection. Rarely, contamination of the infusate (such as parenteral fluid, intravenous medications, or blood products) can be the source of infection. Infusate can become contaminated during the manufacturing process (intrinsic contamination)

or during its preparation or administration in the patient care setting (extrinsic contamination). This is a rare event, but it is the cause of most epidemic IV-device-related bloodstream infections.

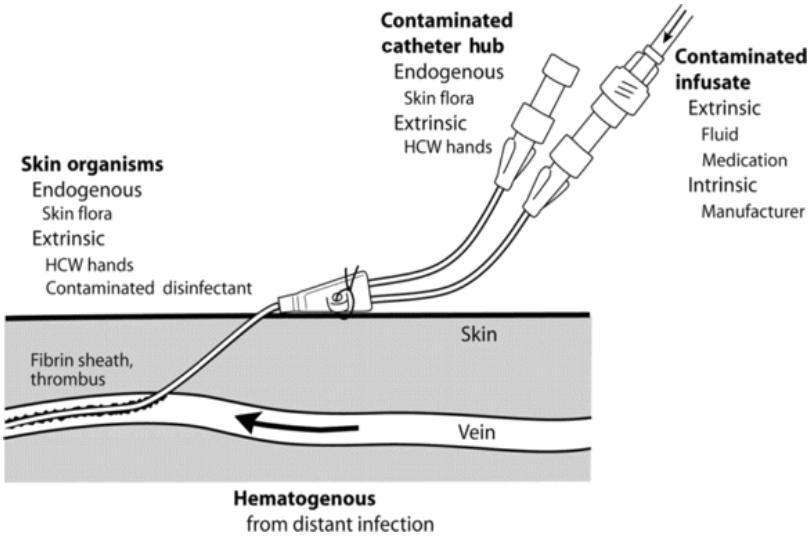

Figure 1 Routes for Central Venous Catheter Contamination with Microorganisms

Source**:** Crnich CJ, Maki DG. The promise of novel technology for the prevention of intravascular device-related bloodstream infection. I. Pathogenesis and short-term devices. *Clin Infect Dis*. 2002; 34:1232–1242. Used with permission.

C. Epidemiology

The incidence of CLABSI varies depending on types of CVCs, the setting and population studied, device management, and therapy administration, but estimates suggest that the incidence is between 0.5 and 5 per 1,000 catheter days. The reported pooled incidence of CLABSI across 630 ICUs across 123 cities in 45 countries in Latin America, Asia, Africa, and Europe from 2015 to 2020 was 4.55 events per 1,000 central line days which were substantially higher than those reported in US. Nevertheless, improving CLABSI rates is possible and feasible even in resource-limited countries. The International Nosocomial Infection Control Consortium (INICC), established in 2002 in 15 developing countries, has been successful in reducing CLABSI incidence by 54% and mortality by 58% by improving adherence to infection prevention and control measures. The investigators instituted process

and outcome surveillance, coupled with staff education and performance feedback to personnel working in 86 ICUs, to facilitate the improvements in CLABSI rates. In addition, antibiotic resistance is a significant issue with common problem pathogens causing CLABSIs, particularly in intensive care units. One in six CLABSIs were caused by urgent or serious antibiotic resistant threats according to a US CDC 2016 report.

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2. What are the risks associated with CLABSI development?

Various factors can increase the risk for developing CLABSI including non-modifiable characteristics of the patient and potentially modifiable factors associated with vascular catheter insertion or maintenance or with the healthcare setting.

A. Patient characteristics

1. **Age**: CLABSI rates are higher among pediatric patients than adult patients. According to the International Nosocomial Infection Control Consortium (INICC) report of health care associated infections in 2024, the pooled mean CLABSI rates among pediatric patients in ICU was 5.37 episodes per 1,000 catheter days versus 4.62 episodes per 1,000 catheter days among adult patients in medical ICU. A recent multinational prospective cohort study in 281 ICU of 9 Asian countries found that, among ICUs, paediatric ICU patients had the highest risk for CLABSI (adjusted OR 2.86, 95% CI 1.71-4.92). Neonates usually have higher CLABSI rates than adult and pediatric patients. However, neonates often receive

different types of central lines compared with adults and therefore the CLABSI rates of neonates and adults may not be comparable.

2. **Underlying diseases or conditions:** Burn, trauma, immunological deficiencies and hematological, gastrointestinal, cardiovascular and renal diseases have been associated with higher risks for developing CLABSI. Burn patients have the highest CLABSI rate. The pooled mean CLABSI rate was 3.4 and 2.4 episodes per 1,000 catheter days in burn critical care units and burn inpatient wards, respectively, according to the 2012 data report of NHSN. It remains undetermined, whether those with a more severe illness on ICU admission leads to a higher CLABSI rate. For infants, low birth weight (<1,500 g) increases the risk of CLABSI. The pooled mean CLABSI rates among infants with a ≤750g, 751-1000g, 1001-1500gbirth weight were 2.3, 1.6 and 1.1 episodes per 1,000 catheter days, respectively, versus 0.6 and 0.8 among those with a 1501 - 2500g and >2500 g birth weight.

B. Risk factors associated with catheter insertion or maintenance

1. **Poor insertion skills:** Staff who insert vascular catheters, but lack of sufficient training in aseptic insertion practices may expose patients to an increased risk of CLABSI.
2. **Insertion site:** The three sites for insertion of central intravascular devices include subclavian, internal jugular and femoral. In adults, there is generally a lower density of skin flora at the subclavian site than those at internal jugular and femoral, hence the subclavian site has a lower risk of CLABSI and the femoral insertion site is associated with an increased risks of CLABSI compared to internal jugular insertion site. However, there are no randomized controlled trials (RCTs) for simultaneously comparing all three insertion sites and CLABSI rates in adults. Available studies which compared two insertion sites, had significant confounding bias and were heterogeneous in study design and two meta-analyses had different conclusions. One by Parienti JJ *et al* demonstrated that subclavian insertion site was associated with a lower risk of CLABSI than the other two insertion sites, while the other by Marik PE *et al* found no differences in CLABSI rates among the three

insertion sites. In constrast, femoral insertion sites have not been associated with increased risks of CLABSI in children.

3. **Multiple vascular catheters:** The simultaneous presence of multiple vascular catheters increases the risk of CLABSI.
4. **Multilumen catheters:** Recent multivariable analysis of 1,892 central venous catheters in adult ICUs found that the use of three or four lumen catheters has a 3.36-fold risk of CLABSI compared to the use of one or two lumen catheters (HR 3.36, 95%CI 1.68–6.71)
5. **Duration of central line:** Prolonged dwell time of a central line increases the risk of CLABSI but the association between dwell time of central line and risk of CLABSI may not be linear. A recent prospective cohort study in 317 ICUs in 9 Asian countries found that while duration of central-line days is an independent risk factor for CLABSI it was also associated with an increase in mortality by 2% per central-line day (adjusted OR 1.02, $p < 0.0001$)
6. **Parenteral nutrition administration**, particularly compounded parenteral nutrition, has been associated with an increased risk of CLABSI.
7. **Blood transfusions** increase risks of CLABSI in pediatric patients.

C. Risk factors associated with healthcare settings

1. Insufficient nurse-to-patient ratio and inadequate infection prevention and control staff result in increased risks of CLABSI.
2. Lack of awareness of infection prevention and control principles and practices among healthcare workers and patients.

Recommendations

1. *Provide appropriate education and training resources for CLABSI prevention and control (IIA)*
2. *Healthcare workers and patients should receive training and demonstrate competence with their roles in CLABSI prevention and control. (IIA)*

3. *Use central venous catheter with minimum number of ports or lumens or connectors as clinically necessary. (IA)*
4. *Minimize central venous catheter dwell time as clinically necessary. (IA)*

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3. How can we prevent CLABSI?

In order to prevent CLABSI, emphasis is placed on two critical stages in the lifespan of a central venous catheters: its insertion and its maintenance. CLABSI prevention bundles are created by combining proven evidence-based best practice interventions for patients with central venous catheters, both during insertion and maintenance. Precautions against

infection during catheter insertion aim to avoid early introduction of infection, while care during the maintenance phase prevents the introduction of microorganisms during repeated access by healthcare providers. Proper maintenance of central lines is also crucial to ensure ongoing patient safety. These evidence-based best practices have been consolidated into central line insertion bundle and central line maintenance bundle that, when implemented together, significantly lowers the risk of CLABSI. For the purposes of the APSIC guidelines, we have the level A evidence interventions (see Appendix) and those that have had a maximum impact on favorable outcomes in the CLABSI prevention.

These bundles have been specifically developed for healthcare personnel responsible for inserting and caring for central venous catheters. Various infection prevention and control organizations and societies, including the Society for Healthcare Epidemiology of America (SHEA), the Centers for Disease Prevention and Control (CDC), the Association for Professionals in Infection Control and Epidemiology (APIC), and The Joint Commission International (JCI), endorse strategies for CLABSI prevention. Compliance with the CLABSI prevention bundle has been shown to be a significant predictor of CLABSI rates reduction.

A. Central line insertion bundle

1. Optimal site selection

No trial has satisfactorily compared infection rates for catheters placed in jugular, subclavian, and femoral veins. Femoral catheters have been demonstrated to have higher colonization rates than subclavian and internal jugular sites in adults and, in some studies, higher CLABSI rates. Femoral catheters should also be avoided, when possible, because they are associated with a higher risk for deep venous thrombosis than internal jugular or subclavian catheters. Thus, in ICU setting, a subclavian site is preferred in adult patients for infection control purposes, though other factors (e.g., potential for mechanical complications, risk for subclavian vein stenosis, and catheter-operator skill) should be considered when deciding on the catheter insertion site. In non-ICU settings, especially in the operating theatre,

the risk of infection among subclavian or internal jugular vein insertion sites is not definitely established. In some situations, priority may be given to life-saving vascular access to secure life as quickly as possible, which could influence the choice of access sites. The evaluation of risk and benefits for different insertion sites must be conducted on an individual basis, considering both infectious and non-infectious complications which subject to clinical scenario.

Catheters also should be inserted as far as possible from open wounds. In one study, catheters inserted close to open burn wounds were 1.79 times more likely to be colonized and 5.12 times more likely to be associated with bacteremia than catheters inserted farther from the wounds.

2. Hand hygiene

Hand hygiene (hand wash or alcohol-based hand rub) before catheter insertion or maintenance, combined with proper aseptic technique during catheter manipulation, provides protection against infection. Use of gloves does not obviate the need for hand hygiene.

3. Alcohol-based chlorhexidine skin preparation

Alcohol-based chlorhexidine agent should be used to prepare the insertion site. In cases where chlorhexidine is contraindicated, consider using alcohol-based povidone-iodine.

A prospective crossover study evaluating 2% chlorhexidine gluconate with 70% isopropyl alcohol in comparison with 10% povidone-iodine in alcohol for the CVC care bundle have shown statistically significant lower rates of insertion site colonization and CLABSI associated with the alcohol-based chlorhexidine preparation in adult patients. A meta-analysis of 10 randomized controlled trials confirmed that chlorhexidine preparation reduced the risk of catheter related infection by 51% (RR 0.49, 95%CI 0.29 to 0.85) relative to povidone iodine in adult patients. However, in neonates, Cochrane database of systematic reviews suggests 2% chlorhexidine in 70% isopropyl alcohol may result in little to no difference in CLABSI compared

to 10% povidone-iodine. A systematic review of the value of quality improvement interventions for CLABSI which include alcohol-based chlorhexidine skin antiseptic in insertion checklist found significant reduction in CLABSI rate (IRR 0.43, 95% CI 0.35–0.51) with increased in net savings USD 1.85 million (95% CI USD 1.30 to USD 2.40 million) per hospital over three years. While alcohol-based chlorhexidine agent has become a standard antiseptic for skin preparation for the insertion of both central and peripheral venous catheters, a randomized unit-crossover study in adult ICU patients found that 5% povidone-iodine in 70% isopropyl alcohol solution for skin disinfection significantly reduced the incidence of central venous catheter colonization (RR 0.38, 95% CI 0.22–0.65, $p < .001$) and central venous catheter related infection (RR 0.34, 95% CI 0.13–0.91, $p < .04$) compared with 10% povidone-iodine in water disinfection.

4. **Maximal barrier precautions**

Maximum sterile barrier (MSB) precautions are defined as wearing a sterile gown, sterile gloves, and cap and using a full body drape (similar to the drapes used in the operating room) during the placement of CVC. Maximal sterile barrier precautions during insertion of CVC were compared with sterile gloves and a small drape in a randomized controlled trial. The MSB group had fewer episodes of both catheter colonization (RR = 0.32, 95% CI, .10–0.96, P = .04). and CLABSI (RR = 0.16, 95% CI, 0.02–1.30, P = 0.06). In addition, the group using MSB precautions had infections that occurred much later and contained gram negative, rather than gram positive, organisms. A study of pulmonary artery catheters also secondarily demonstrated that use of MSB precautions lowered risk of infection. A small trial demonstrated a reduced risk of skin colonization at the insertion site when MSB precautions were used [OR 3.40, 95%CI 1.32 to 3.67]. A prospective multicenter observational study in Japan of 2,383 very low birth weight infants (less than 1,501 gm) whom PICC was inserted (33,713 catheter-days) found that maximal sterile barrier precautions independently contributed to a decrease in CLABSI risk (adjusted hazard ratio 0.20, 95% CI 0.05-0.84)

5. **Chlorhexidine-containing dressings**

Immediately after central venous catheter is inserted, chlorhexidine-containing dressings play an important role not only in reducing central venous catheter colonization or CLABSI but also help securing central venous catheter from dislodgement. Multiple randomized controlled trials and systematic reviews including Cochrane database systematic review found high quality evidence that medication-impregnated transparent semipermeable dressings (preferably chlorhexidine gluconate) reduce the incidence of CLABSI relative to all other dressing types. However, if moist or blood oozing occurs at insertion site then apply sterile gauze/pad covered with a transparent dressing until moisture or oozing blood are resolved and then apply a sterile medication-impregnated semipermeable dressing (preferably chlorhexidine gluconate) as soon as possible.

Recommendations

1. *Recommendations for central venous catheters*
    a. *Weigh the risk and benefits of placing a central venous device at a recommended site to reduce infectious complications against the risk for mechanical complications (e.g., pneumothorax, subclavian artery puncture, subclavian vein laceration, subclavian vein stenosis, hemothorax, thrombosis, air embolism, and catheter misplacement). [IA]*
    b. *Avoid using the femoral vein for central venous access in obese adult patients when the catheter is placed under planned and controlled [IA]*
    c. *In adult ICU setting, subclavian vein catheter insertion is preferred to reduce infectious complications [IA]*
    d. *In adult non-ICU settings, upper body insertion site is preferred to reduce infectious complications and thrombotic complications relative to femoral site [IIA]*
    e. *Use ultrasound guidance for internal jugular catheter insertion [IA]*

f. *No recommendation can be made for a preferred site of insertion to minimize infection risk for a tunneled CVC. [Unresolved issue]*

g. *Place catheters used for hemodialysis and pheresis in a jugular or femoral vein, rather than a subclavian vein, to avoid venous stenosis. [IA]*

h. *Use of ultrasound guidance to place central venous catheters is recommended to improve first insertion-attempt success rates, reduce the number of cannulation attempts and insertion-related mechanical complications. [IB]*

2. *Perform hand hygiene procedures, either by washing hands with liquid soap and water or with alcohol-based hand rubs (ABHR). Hand hygiene should be performed before and after palpating catheter insertion sites as well as before and after inserting, replacing, accessing, repairing, or dressing a central venous catheter. Palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained. [IB]*
3. *Sterile gloves should be worn for the insertion of arterial, central, and midline catheters. [IA]*
4. *Use new sterile gloves before handling the new catheter when guidewire exchanges are performed. [IIA]*
5. *Prepare and clean the skin site with an alcoholic chlorhexidine solution containing a concentration of CHG greater than 0.5% or a 2% chlorhexidine-based preparation before central venous catheter insertion and during dressing changes. If there is a contraindication to chlorhexidine, tincture of iodine, an iodophor, or 70% alcohol can be used as alternatives. [IA]*
6. *Before accessing catheter hubs or injection ports, clean them with an alcoholic chlorhexidine preparation or 70% alcohol to reduce contamination. [IIB]*
7. *Use maximal sterile barrier precautions. [IB]*
8. *Use sterile chlorhexidine-containing dressings to cover catheter insertion site in patients over 2 months of age. [IA]*

9. *If moisture or oozing blood occurs at insertion site, apply sterile gauze/pad with transparent dressing until moisture or oozing blood are resolved and then apply sterile medication-impregnated semipermeable dressing (preferably chlorhexidine gluconate) as soon as possible. [IIB]*

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B. Central line maintenance bundle

Central line maintenance bundle components

CLABSI maintenance bundle components include

1. Daily review of line necessity and replacement
2. Hand hygiene
3. Disinfection of hubs before accessing and changing the access lumens/devices.
4. Aseptic dressing change technique.
5. Change chlorhexidine impregnated dressing at least every 7 days
6. Standardize administration sets changes

1. Daily review of line necessity

Central lines should be reviewed daily for either removal or ongoing need.

For ongoing need

Risk of CLABSIs increase with the duration of time the catheter is left in place, so daily evaluation of the need for the central line/s is an important aspect of CLABSI prevention. Catheters that are no longer needed should be promptly removed.

This can be done during multidisciplinary patient care rounds or by using reminders such as stickers on patient records or order sets or via automated computer alerts.

For replacement

Routine replacement of central lines is not recommended and should only be done as clinically indicated.

a. If the CVC is inserted under emergency conditions and there is suspicion of a breach in asepsis during insertion, a new line should be inserted at a new site as soon as possible, but within 48 hours. The suspicion can be ascertained by any of the items of the insertion checklist being omitted or not used according to protocol for example cap, mask, sterile gloves and gown, full body drape, skin preparation with >0.5% chlorhexidine in 70% isopropyl alcohol.

b. Guide wire exchange:

i. Catheter should be removed or replaced only when clinically indicated.

ii. In case of CVC malfunction, a guidewire-assisted exchange is preferred.

iii. If unexplained fever is observed in a hemodynamically stable patient, catheter may be inserted by a guidewire.

Note: Replacement of temporary catheters over a guide wire in the presence of bacteremia is an unacceptable practice because the source of infection is usually colonization of the skin at the insertion site to the vein.

c. Central lines should be reviewed daily for

i. Signs of local infection at insertion site (tenderness, pain, redness and swelling)

ii. Signs of systemic infection

iii. Suture and dressing integrity

iv. Catheter position

v. Patency of lumens - All attempts are made to avoid blocked lumens by using all lumens for infusions. Unused lumens should be flushed with normal saline/heparin 4 hourly, when not in use, patency of dialysis or hemofiltration catheters should be maintained as per protocol. However, if a lumen becomes blocked, the central line should be removed immediately.

2. Hand Hygiene and aseptic technique

For proper hand hygiene before contacting CVC, hands should be cleaned using either an alcohol-based hand rub or soap and water can be used.

Aseptic technique, is recommended by the evidence-based guidelines for all instances of insertion and care of CVCs. Appropriate Hand hygiene in conjunction with aseptic technique provides protection against infection.

In aseptic technique, only sterile-to-sterile contact is allowed; sterile to non-sterile contact must be avoided. Either clean or sterile gloves can be used for changing the dressing on the

central venous catheters.

3. Disinfection and changing the access lumens/devices

The hubs on CVCs are a common source of bacterial colonization and serve as immediate portal of entry of microorganisms to the intraluminal surface of the catheter. These colonizers from the catheter hub and lumen can be dispersed into the bloodstream resulting in CLABSI. In long term CVCs, the needleless connectors (NCs) and catheter hubs are more frequently accessed and lead to increased chances of CLABSIs. The disinfection of catheter hub surface is therefore, critical every time before they are accessed.

Use of a clean tray for equipment is recommended. Hand hygiene must be performed before accessing the catheter lumen. The hub should be thoroughly scrubbed for at least 5 seconds with either 70% alcohol or a chlorhexidine/ alcohol preparation (≥0.5% CHG w/v in 70% alcohol). Do not touch any other surface after disinfection. Hub cleaning should be performed every time an infusion set is added or removed and before medication administration.

4. Aseptic dressing change technique

Transparent dressings are preferred over gauze dressings as they allow continuous visual inspection of the catheter site. However, gauze dressings are preferred in case there is blood oozing out from the CVC insertion site.

The following practice elements have been recommended:

a) Either sterile gauze or sterile, transparent, semipermeable dressings should be used to cover the CVC insertion site.
b) Skin preparation regimen (>0.5% chlorhexidine with alcohol) should be followed every time the dressing is being changed. Tincture of iodine, iodophor or 70% alcohol can be used if chlorhexidine is contraindicated.
c) For a site that is bleeding or oozing, gauze dressing is preferred.

d) The dressing needs replacement if indications such as dampening, loosening or visible soiling are observed:

e) Short-term CVC dressings should be replaced every 2 days in case of gauze and at least every 7 days if transparent dressing is used.

f) Transparent dressings used for tunneled or implanted CVCs should be replaced no more than once per week.

g) CHG-impregnated dressing should be used for patients older than 2 months having short-term catheters.

h) Regular monitoring of catheter site should be done when changing the dressing or by palpation of intact dressing. Any tenderness, pain, fever (not related to any other site in body) is suggestive of BSI. In such cases, the site should be examined thoroughly after removing the dressing.

5. Standardize administration set changes

Administration sets are used for transfer of fluids, medicines and nutrition to patient's body. Prolonged use of these sets increases the risk of infection. Therefore, routine change of the administration systems (primary and secondary sets and add-on devices) is recommended.

The administration sets used continuously should be changed up to at least every 7 days. If the sets are used for administration of blood, blood products and lipid formulations, they should be replaced every 24 hours. Needleless connectors must be changed with the administration set change.

Recommendations

1. *Designate only trained personnel who have demonstrated competence in insertion and maintenance of central venous catheters. [IA]*
2. *Promptly remove any central venousr catheter that is no longer essential. [IA]*
3. *When adherence to aseptic technique cannot be ensured (i.e. catheters inserted during a*

medical emergency), replace the catheter as soon as possible, i.e. within 48 hours. [IB]

4. *Do not routinely replace CVCs, PICCs, hemodialysis catheters, or pulmonary artery catheters to prevent catheter-related infections. [IB]*
5. *Wear either clean or sterile gloves when changing the dressing on central venous catheters. [IC]*
6. *If antisepic barrier caps are used on needleless connectors, these must be changed after each access. [IIB]*
7. *Administration sets should be changed after every 7 days unless it is used for blood products or lipid formulation. [IA]*
8. *Minimize contamination risk by scrubbing the access port/hubs with 70% alcohol or a chlorhexidine/ alcohol preparation (≥0.5% CHG w/v in 70% alcohol) for at least 5 secs and accessing the port only with sterile devices. [IA]*
9. *Use either sterile gauze or sterile, transparent, semipermeable dressing to cover the catheter site. (IA)*
10. *Change chlorhexidine impregnated dressing at least every 7 days or according to the manufacturer's instructions. [IA]*
11. *In patients not receiving blood, blood products or lipid formulations, replace administration sets that are continuously used, including secondary sets and add-on devices, up to but at least every 7 days. (IA)*
12. *Replace tubing used to administer propofol infusions every 6 or 12 hours, when the vial is changed, per the manufacturer's recommendation. (IA)*

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C. Long term venous catheters

Long term central venous catheters (CVCs) are placed to facilitate venous access to administer intravenous fluids, delivery of drugs and blood products in patients requiring long

term care. Their examples include tunnelled CVCs, apheresis catheter, Peripherally inserted central catheters (PICCs) and Implanted ports.

a. **Tunneled cuffed CVCs** – Tunneled cuffed externally exiting catheters are placed subcutaneously through a tunnel formed under the skin in the chest. It contains a small antimicrobial attachment known as cuff near the entry site that helps to hold the catheter in position and reduces the risk of infection. Examples include Broviac and Hickman catheters with around 1 – 1.6 mm diameter and 25-65 ml/min flow rate. Groshong catheters are different in possessing a slit like orifice adjacent to the distal end, which functions like a valve.
b. **Tunneled Apheresis Catheters** – These catheters are used for hemodialysis in patients without AV fistula or graft as also in blood bank procedures. Examples include Tesio and Permcath. These catheters have larger diameters and usually locked with high concentrations of anticoagulants (heparin 5000 units/ml)
c. **Peripherally Inserted Central Catheter (PICC)** – It is a thin, flexible tube inserted in the upper arm and guided into the superior vena cava. These catheters possess decreased flow rate due to narrow lumen.
d. **Implanted Ports** – It is a device with two parts; a catheter and a port, that is placed under the skin, usually on the chest, when intravenous (IV) therapy and treatment in needed for a long time.

When not being used, the catheter tip should either be clamped to keep the line closed or sealed with a special cap.

Precautions pertaining to the access and maintenance of these catheters are outlined below:

I. **<u>Core strategies for CLABSI prevention</u>**

a. **During access and manipulation of the CVCs**

1. Maintenance of aseptic technique

2. Hand hygiene before and after accessing the central line

3. Scrubbing the access lumen/ device (e.g., needleless connector) with an appropriate antiseptic (e.g., chlorhexidine or 70% alcohol) for 3-5 seconds , and allow to dry.

4. Accessing the lumen with the syringe or IV tubing and opening the clamp when necessary

b. During Maintenance of long term CVCs

1. Hand hygiene prior to accessing supplies, handling vials and IV solutions, and preparing or administering medications.

2. Aseptic technique at all times - parenteral medication administration, medication vial use, injections, and glucose monitoring procedures.

3. Use of chlorhexidine-containing dressings for CVCs in patients >2 months of age.

4. Flushing needs to be practiced if the line is not used for >1 month to maintain patency. The use of heparin flushes, their concentration and frequency of flushing are determined by the manufacturer and the treating clinician. In general, for Groshong catheters, valve catheters, or closed tip catheters, flush with normal saline (0.9%) unless otherwise specified.

5. IV solution containers (e.g., bags or bottles) for the purpose of IV flush solutions (or other purposes) and infusion supplies (needles, syringes, flush solutions, administration sets, or IV fluids) should be separate for each patient.

6. Infusion of lipid containing solutions, lipid emulsions and blood/ blood products should be completed within 24 hours, 12 hours and 4 hours respectively.

II. Additional strategies

1. Implementation of antimicrobial lock therapy

2. **Administration of recombinant tissue plasminogen activator (rt-PA) once weekly following hemodialysis in patients using a central line for hemodialysis.**
3. **Application of antimicrobial ointments to the insertion sites of hemodialysis catheters**

   Use of polysporin "triple" or povidone-iodine ointment is suggested for hemodialysis catheter insertion, provided it is compatible with the catheter material. Mupirocin ointment should be avoided due to the associated risk of mupirocin resistance and potential harm to polyurethane catheters.
4. **Use of an antiseptic-containing hub/connector cap/port protector to cover connectors.**

D. Care of HD catheter at home

Patient education on postsurgical care of an HD access plays a significant role in preventing the postoperative infections. The following instructions must be explained to them -

1. Hand hygiene must be performed before donning gloves, prior to wound care or vascular access.
2. Care should be taken not to touch the catheter site or skin near the site where the catheter enters or where the fistula/graft has been placed.
3. Patient should ensure that the catheter dressing is intact, clean and dry at all times.
4. The patient’s clothes should not impede or compromise the access.
5. The patient and nurse must wear a mask when a catheter (not fistula or graft) is connected or disconnected from the blood lines during hemodialysis.

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II. Implementing the CLABSI prevention guidelines

A. How can you implement a CLABSI prevention program successfully?

Model for improvement

A key success factor to the implementation of central line insertion and maintenance bundles is the adoption of the model of improvement approach involving multidisciplinary process stakeholders. This model has 3 main principles:

i. What are we trying to accomplish? – The mission statement of objective of the project helps to give focus and clarity to the task to be undertaken for improvement.

ii. How will we know that a change is an improvement? – This emphasizes the importance of measurement to help one to ascertain significant improvement arising from interventions implemented.

iii. What changes can we make that will result in an improvement? – This highlights the need to stay open and be willing to accept ideas for change in the process to be improved.

Secondly, the Plan-Do-Study-Act (PDSA) methodology to conduct small-scale tests of change in the ICU i.e. planning a test, trying it, observing the results, and acting on what is learned; is the scientific approach adopted in the implementation. After testing a change on a small scale, learning from each test, and refining the change through several PDSA cycles, the team can implement the change on a broader scale. After successful implementation of a change or package of changes for a pilot population or an entire unit, the team can spread the changes to other ICUs in the organization or to other organizations.

It is best that the senior management of the organization appoint a multidisciplinary team, comprising the ICU doctor and nurses, Infectious Disease physician, the Infection Prevention and Control (IPC) nurse and therapists. The value of bringing diverse personnel together is that all members of the care team are given a stake in the outcome and work to achieve the same goal.

Improvement requires setting aims or goals that are specific, measurable, achievable, realistic and time-specific (SMART). An example of an aim that would be appropriate for reducing CLABSI can be as simple as, “Decrease the rate of CLABISs by 50% within one year by achieving greater than 95% compliance with the central line bundle.”

Recommendations

1. *Implementation of the use of the CLABSI insertion and maintenance bundles is best done using a quality improvement approach with a multidisciplinary team. [BII]*

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Teamwork

Successful reduction of CLABSIs is to engage both frontline and senior leadership champions in the process and outcome improvement plan. The first step is to develop a multidisciplinary team that sets goals, defines the steps in the implementation process, and monitor progress in achieving the goals. Multidisciplinary teams create a balanced approach to improving patient care and safety. CLABSI improvement teams should include all staff involved in CVC insertions and maintenance, clinical champions and opinion leaders, managers, infection control professionals and administrator who allocates resources. Health care personnel must not only be clinically competent, but also be expert team members. Local champions increase the chance for success by engaging and educating peers, thereby increasing buy-in and ownership by all involved. These champions can influence the development of strategies that are a good match with the unit culture. Regular team meetings should be held. Frequent communication between champions and frontline staff is imperative for sharing of the outcome data with each unit resolving barriers and enhancing improvement sustainability.

Recommendations

1. *Build teams which include all staff involved in CVC insertion and maintenance including local champions. [IIB]*
2. *Enhanced communication to share data and take action. [IIB]*

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Creating culture of zero tolerance

This refers to a culture where targeting zero healthcare-associated infections (HAIs) is fully embraced. Targeting zero HAIs encourages all organizations to set the goal of elimination rather than remain comfortable when local or national averages or benchmarks are met.

References to “zero tolerance” today are generally intended as a response to unsafe behaviors and practices that place patients and healthcare workers at risk. In the context of CLABSI, zero tolerance doesn’t mean that people or organizations should be penalized for infections that may not be preventable, but this language may be used to stress the need for accountability and a culture built on inquiry and learning as opposed to punishment.

A culture of targeting zero healthcare associated infections and zero tolerance for unsafe practices is characterized by the following:

a. Setting the theoretical goal of elimination of CLABSI;

b. An expectation that infection prevention and control (IPC) measures will be applied consistently by all healthcare workers, 100% of the time;
c. A safe environment for healthcare workers to pursue 100% adherence, where they are empowered to hold each other accountable for infection prevention;
d. Systems and administrative support that provide the foundation to successfully perform IPC measures;
e. Transparency and continuous learning where mistakes and/or poor systems and processes can be openly discussed without fear of penalty;
f. Prompt investigation of CLABSI of greatest concern to the organization and/or community; and
g. Focus on providing real time data to front line staff for the purpose of driving improvements.

It will require time to build this culture of safety. Leadership plays a major role in creating the environment conducive for culture development. Firstly, leadership needs to educate themselves and their teams about the total impact of HAI. They must believe that zero HAI is an achievable imperative and sustainable for long periods of time. Next, they must set and actively support that goal. It then helps that everyone understands HOW to achieve zero and what is required to sustain that performance. The implementation of the CLABSI prevention guidelines, (insertion and maintenance bundles) will require the support of leadership to make it happen. Healthcare facility leadership need to provide the environment, equipment, human and financial resources to reduce HAI to zero. Next, they are to ensure that when even one HAI occurs, it should trigger immediate concern and a drilldown into potential causes (process breakdown, new equipment, noncompliance, lack of knowledge, etc.)

Recommendations

1. *Hospital leadership and policymakers are to continue providing support to build culture of zero tolerance. [IIIB]*

2. *Lines of accountability need to be established to link everyone in a hospital - from the board to frontline staff - so that everyone has a shared understanding of their organizational goals, knows their role in meeting them, and gets feedback (such as dashboards) on how they are performing. [IIIB]*

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Education and training

Education and training are critical in the implementation of a CLABSI prevention guideline. Change in human behavior is the goal of educational programs about CVC insertion, care, and maintenance. Various educational methods and strategies have been studied and in general these educational interventions showed improvements in CLABSI rates.

Adult learners use multiple ways to learn. Various teaching strategies should be used including simulated training, self-directed study guides, instructor-led courses, and small- and large-group discussions. The educational programs planning group should have representatives from multiple professions, including physicians, nurse managers, staff nurses, infusion nurse specialists, and infection prevention and control professionals.

All healthcare personnel involved with the insertion and maintenance care of CVCs should receive educational programs that address knowledge, critical thinking, behavior and psychomotor skills, and attitudes and beliefs of CLABSI prevention. Educate healthcare personnel regarding the indications for central venous catheter use and appropriate infection

control measures to prevent central venous catheter-related infections.

Training can include printed learning packages; slide presentations and videos; skills labs; journal clubs and nursing grand rounds; and computer, web-based learning packages can be adopted. Reminders such as posters, fact sheets, small pocket card have also been shown to be effective. To enhance patient safety, CVC insertion techniques is best performed in a clinical skill laboratory, a simulated environment, followed by supervised performance on patients later at the bedside. A meta-analysis of 20 studies Ma IW et al using simulation for CVC insertion showed benefits in learner performance, knowledge, and confidence.

All healthcare professionals should have documented competency assessment with CVC insertion, care, and maintenance before being allowed to practice without direct supervision. A competency assessment checklist can be utilized.

New products, devices, or technology used in the insertion and care of CVCs require adequate device training for healthcare personnel who would use the product. Healthcare professionals using CVCs for infusion should have documented competency on maintenance care e.g., catheter stabilization, catheter dressing changes, intravenous administration set management, disinfection of needleless connectors, accessing implanted ports, and flushing and locking the CVC. This can be carried out in a simulation lab or in the clinical setting while being observed by a qualified professional. There should be assessment of educational programs includes the learner's satisfaction with the program, changes in knowledge, and changes in work performance. Education of facility administrators is necessary to ensure adequate funding and implementation of a CLABSI prevention program.

Recommendations

1. *There should be focus on skill development and competency testing in the organization. [IIIB]*
2. *The educational programs should be assessed for their content, relevance, staff knowledge improvement and impact on work performance. [IIIB]*

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B. Cost-Effectiveness Analysis

The core purpose of a cost evaluation for CLABSI is to provide a relative value to different healthcare interventions and to relate the value of the impact of these interventions to the value of specific health outcomes. Cost effectiveness analysis (CEA) remains less frequently used as an analytical tool in efforts to justify healthcare epidemiology and infection prevention and control programs. In CEA the costs and effects of an intervention or program and at least one alternative approach are calculated and presented in a ratio of incremental cost to incremental effect, with the effect being a measurable health outcome.

Cost effective analysis (CEA)

In contrast to cost-benefit analysis which compares the monetary cost of a program with the monetary benefit, CEA does not require that costs and benefits be reduced to a common denominator. As a methodology, CEA methods include outcomes and costs of interventions designed to improve health. Such analyses aid decision making processes that pertain to resource allocations but are limited by not necessarily being able to incorporate all variables relevant to such decisions. Wide variation in cost effectiveness ratios has been noted in CEA from various medical and public heath disciplines.

1. The **cost effectiveness ratio** is a mathematical ratio in which the numerator includes all changes in resource utilization relative to at least one stated alternative, and the denominator includes all the health effects of an intervention relative to the stated alternative(s). The CEA provides ratios that show the cost (in monetary terms) of achieving one unit of health outcome.
    a. Numerator. Variables for the numerator should include the costs of healthcare services, patient time expended for the intervention, paid and unpaid care-giving services, costs associated with lost productivity or illness, costs linked to the non-health impact of the intervention, and time spent seeking an intervention.

b. Denominator. Variables for the denominator include those that are effects of the health intervention, such as subsequent morbidity and length of life.

2. **Costs**

a. **Direct costs** are the value of all resources, goods, and services consumed in the provision of an intervention or in dealing with the consequences of the intervention. These estimates include both medical and nonmedical costs.

b. **Indirect costs** pertain to productivity gains or losses related to illness or death.

c. **Marginal costs** are the extra amount of resource consumption incurred for providing a service as compared with the costs of not providing the same service.

d. **Incremental costs** are the costs of one alternative (comparator) minus the cost of another alternative. The incremental cost effectiveness ratio is the difference in costs between two alternatives compared with the difference in effectiveness between the same two alternatives.

While many IPC programs and activities can be justified given that HAIs result in patient morbidity and lengthy hospital admissions, not every activity or program within IPC should be funded. When determining which programs should be implemented, the efficiency and effectiveness of such programs must be considered. Economic evaluations can determine which IPC strategies are cost-effective and provide reasonable value for money.

Recommendations

1. Cost effective analysis help to justify investment of resources to the IPC program. [IIIB]

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C. What are common barriers and feasible solutions to successful implementation?

Studies suggested that several internal and external factors can affect the success of any improvement initiative to reduce CLABSI. These factors include, but not limited to, leadership, culture of safety, multidisciplinary teams and teamwork, accountability of healthcare personnel, empowerment, resource availability, data collection and feedback of CLABSI rates, policies and procedures, involvement of patients and families.

Common barriers to implement best practices to reduce CLABSI include the barrier at the organizational level (e.g., the lack of leadership support and commitment, lack of a safety culture, lack of available resources), barriers at the unit level (e.g., nurse staffing variables, such as inadequate nurse-to-patient staffing rations and use of non-permanent staff), barriers at staff level (e.g., education, training, experience, and competency of staff). All of which can affect patient safety in several ways. To successfully implement CLABSI prevention program, healthcare workers need to understand the barriers to successful implementation of CLABSI prevention program in their institutions and try to overcome those barriers.

Example of barriers and solutions to implement best practices to prevent CLABSI in developing countries

i. **Barrier**: Lack of active involvement of senior management in developing countries can be a big issue, since in those setting there may be no local surveillance data available to access the scope of CLABSIs and to perform cost analyses.

   Solution: *Conduct surveillance with regular feedback to staff and leadership to raise awareness and support.*

ii. **Barrier:** Lack of clear understanding of variation in safety culture, which include staff characteristics, characteristics of the patient care area, or the organization as a whole.

   Solution: *Know your institutional patient safety culture and partnership with hospital patient safety initiatives.*

iii. **Barrier**: Lack of resources to implement evidence-based CLABSI prevention guidelines may prohibit the implementation of CLABSI insertion bundles in developing countries, where use of outdated technology is not uncommon and sufficient skilled staff are lacking. Reuse of equipment may also be commonly encountered in resource-limited settings.

   Solution: *Demonstrate the benefit and cost reduction of having hospital wide CLABSI prevention program and feedback to hospital leadership.*

iv. **Barrier:** Use of nonpermanent nursing staff, or “float” nurses has also been associated with a significant risk of HAIs.

   Solution: *Focus on continuous CLBASI education and training on staff.*

v. **Barrier**: Inexperienced staff who insert CVCs has been associated with lower adherence to CVC insertions.

Solution: *Focus on competency assessment and continuous education on CLABSI prevention.*

vi. **Barrier**: Not following evidence-based practices may pose significant number of patients to experience preventable harm in resource-limited setting.

Solution: *Provide continuous education together with monitoring and feedback the CLABSI prevention practice for staff.*

Recommendation

1. *Identifying and removing barriers to adherence to IPC practices is essential to a successful implementation of best practices. [IIIB]*

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III. Is there evidence for additional strategies to reduce CLABSI?

Additional strategies to reduce CLABSI could be used in units within hospitals where CLABSI rates remain high despite implementation of all preventive strategies to achieve institutional goals.

A. Antiseptic daily bathing/wiping bath

The innovative practice of bathing patients who have central venous catheters (CVC) with Chlorhexidine Gluconate (CHG) as a total-body bathing solution has been studied as a strategy to lower CLABSI rates. The rationale for the use of CHG bathing (2% CHG-containing skin cleanser or 2% CHG-impregnated paper towel) in place of soap and water bathing relates to the patient's resident skin flora that can enter the bloodstream at the CVC insertion site or the extraluminal surface of the catheter. Reducing skin contaminants should further reduce the risk of CLABSI.

The SHEA/IDSA recommendations suggest that daily bathing of ICU patients older than 2 months of age with a 2% chlorhexidine-impregnated washcloth may be an essential practice before insertion. A recent meta-analysis involving 25 ICUs and 22,850 patients provides evidence that daily patient bathing with CHG washcloths can reduce the incidence of CLABSI. The role of CHG bathing in non-ICU patients is not clear though Tien et al. reported that daily CHG bathing could reduce the risk for CLABSIs in patients with haematological malignancies. The optimal choice of antiseptic agents is unresolved for children under 2 months of age. However, chlorhexidine is widely used in children under 2 months of age. For CHG-based topical antiseptic products, the Food and Drug Administration recommends "use with care in premature infants or infants under 2 months of age; these products may cause irritation or chemical burns." The American Pediatric Surgical Association recommends CHG use but states "care should be taken in using CHG in neonates and premature infants because of increased risk of skin irritation and risk of systemic absorption." Providers must carefully weigh the potential benefits and risks of CHG, recognizing that term and preterm infants may have different risks. Alternative agents, such as povidone-iodine or combinations with alcohol,

can be used in this age group.

Recommendation

1. *Antiseptic daily bathing or wiping bath has been shown to decrease CLABSI in the ICU patients> 2 months of age. [IA]*

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B. Antimicrobial and antiseptic impregnated catheters

A variety of catheters impregnated with antimicrobial (minocycline-rifampin, miconazole-rifampin, teicoplanin or cefozalin), antiseptic (5-fluorouracil, benzalkonium chloride, chlorhexidine-silver sulfadiazine, silver, silver zeolite or silver-platinum-carbon), or anticoagulant (heparin) have been developed. Catheters impregnated with minocycline-rifampin, chlorhexidine-silver sulfadiazine, silver, or silver-platinum-carbon have been assessed by at least three studies, while data on other types of impregnated catheters are very limited. A meta-analysis of 23 RCTs by Wang H *et al* showed that these impregnated catheters were more effective in preventing CLABSIs and catheter colonization when used in combination with bundles in adult patients. Network meta-analysis by Chung HY *et al* suggests the minocycline-rifampicin-impregnated CVC was most effective in the prevention of CRBSI per 1000 catheter-days. Data of antimicrobial and antiseptic impregnated catheters for pediatric patients are limited. Recent meta-analysis by Lai L *et al.* showed antibiotic impregnated catheter in the pediatric patients does not reduce CRBSI as compared to conventional catheters. Data was the analysis of a limited number of heterogeneous studies. More studies on impregnated catheters are required to identify the patient population who can benefit from the use and the timing to use, to assess the cost effectiveness, to compare different types of impregnated catheters for effectiveness and side effects in a head-to-head manner. In addition, adverse effects such as anaphylaxis should be monitored in use of antiseptic-or antimicrobial impregnated CVCs.

Recommendations

1. *Minocycline-rifampin or chlorhexidine-silver sulfadiazine impregnated catheters should be considered in adult patients whose catheter dwell time is expected to be >7 days in units where the CLABSI rate does not meet the set goal, although the prevention bundle of CLABSI has been implemented with a good compliance. [IA]*
2. *Patients using minocycline-rifampin or chlorhexidine-silver sulfadiazine-impregnated*

catheters should be monitored for side effects, such as anaphylaxis. [IIIB]

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C. Antibiotic locks for long term central venous catheter usage

Catheter lock uses a sub therapeutic concentration of an antimicrobial solution to fill a lumen followed by a period until the catheter is accessed again. On the other hand, a catheter flush solution is pushed through the catheter into the blood stream without dwell time.

A variety of antimicrobials (amikacin, cefazolin, cefotaxime, ceftazidime, ciprofloxacin,

cloxacillin, gentamicin, minocycline, vancomycin) or antiseptics (alcohol, taurolidine, trisodium citrate, methylene blue, methylparaben, and propylparaben) have been used either alone or in combination to flush or lock vascular catheters for preventing CLABSI. As flushing antimicrobial or antiseptic solution into bloodstream could result in serious side effects such as cardiac dysrhythmia and even death, locks are preferred to use rather than flushes and the lock solution should be aspirated after use.

There is ongoing research regarding the optimal antimicrobial agent or combinations, their concentrations and duration of use in antibiotic locks. Although many studies show that use of antimicrobial or antiseptic locks reduces the risk of CLABSI, these locks and flushes have the potential for toxicity and untoward effects including cross reactions with medicines given through the central line, anaphylaxis, increased catheter occlusion, breach of catheter integrity and emergence of antimicrobial resistance. Due to these complications, antimicrobial locks as a preventative strategy can be used for

- Patients with long-term hemodialysis catheters who have a history of recurrent CLABSI.
- Patients with limited venous access and a history of recurrent CLABSI.
- Patients with recently implanted intravascular devices such as a prosthetic heart valve or aortic graft.

Recommendation

1. *Prophylactic antimicrobial or antiseptic lock solution should be considered for the following:*
   a. *Patients with long-term hemodialysis catheters [IA]*
   b. *Patients with limited venous access and a history of recurrent CLABSI [IIB]*
   c. *Pediatric cancer patients with long-term catheters [IB]*

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D. Securement of central venous catheters

Catheter stabilization has been recognized as an intervention to decrease the risk for phlebitis, catheter migration, kinking, dislodgement, and may be advantageous in preventing CLABSIs. Catheter stabilization can be done either by suturing or suture less securement devices. Suture less securement devices are gaining popularity because they avoid disruption around the catheter entry site, decrease the bacterial colonization and mitigate the risk of sharps injury to the healthcare provider. This has been reported in various recent trials.

Sutureless securement devices can be classified into two main types: subcutaneous and adhesive. Subcutaneous securement devices utilize a small anchor placed just beneath the skin at the catheter insertion site and are attached to the catheter shaft offering catheter stabilization throughout the dwell time. On the other hand, the tissue adhesives act as a physical barrier to microbes, support adhesion and promote hemostasis. Examples of adhesives include adhesive footplate and device-locking clasp, tissue adhesive cyanoacrylate, and a medical-grade superglue. Recent research studies reported benefits of sutureless adhesives over suturing in preventing catheter related complications. Mazon et. al. evaluated the efficacy of a CVC adhesive fixation device in preventing complications compared to sutures. Results showed that the adhesive system significantly reduced catheter related complications (21.3% vs. 47.2%).

A comparative study between subcutaneous securement versus adhesives reported the latter to be more effective by saving the dressing change time (7.3 min vs 4.3 min). Incidence

rates of migration, dislodgement and catheter-related bloodstream infection were comparable across groups.

In hemodialysis patients, there are limited studies on comparing the effectiveness of sutureless securement devices versus suturing in reducing CLABSI risk. Additional clinical studies are needed to support this evidence.

Recommendation

1. *Use a suture less securement device to reduce the risk of infection for central venous catheters. [IIC]*

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E. Safety connectors and needleless system

Among the needleless connectors, multiple devices are currently available but there is lack of clarity on the optimal design for preventing infections. The original purpose of needleless connectors was to prevent needlestick injuries during intermittent use and there is

no data to substantiate their use with continuous infusions. Additionally, needle-free connectors with 3-way stopcocks may increase the risk of catheter infections.

Possible common risk factors include the design that allows contamination to occur when not in use, the improper cleaning and inadequate frequency of changing the devices. A study modeled on pediatric stem cell transplant patients to investigate the association between needleless connector change frequency and CLABSI rate showed that CLABSI rate was significantly higher in the period of changing needleless connectors every 24 hours compared with the period of changing needleless connectors every 96 hours. (0.41, and 0.03 per 1,000 central line-days vs. 3.56, p = 0.003). Swiping the Luer-activated device with 70% alcohol for only 3 to 5 seconds did not adequately disinfect the septal surface. Some studies have shown that disinfection of the devices with chlorhexidine/alcohol solutions appears to be most effective in reducing colonization.

Use of silver-coated catheter connectors may be associated with reduced intraluminal contamination thereby reducing CLABSI. Clinical evidence is limited regarding the risk reduction with their routine use or use of other antimicrobial catheter connectors.

The SHEA and IDSA joint commission recommended that a thorough assessment of the risks, benefits, and education regarding proper use of positive-pressure needleless connectors should precede their adoption for use. The 2022 SHEA/IDSA guidelines recommended applying mechanical friction for no less than 5 seconds to reduce contamination.

Recommendations

1. *Use of a split septum valve is preferred over some mechanical valves due to increased risk of infection with the mechanical valves [IIB]*
2. *Scrubbing the access port of connectors with an appropriate antiseptic (chlorhexidine, povidone iodine, an iodophor, or 70% alcohol) and accessing the port only with sterile devices. [IA]*
3. *Ensure that all needleless components are compatible to reduce the risk of leaks and*

breaks in the system. [IIB]

4. *Change needleless components at least as frequently as the administration set i.e. up to every 7 days. [IIB]*
5. *Change the needleless connectors no more frequently than every 72 hours, or according to the manufacturer's recommendations. [IIB]*
6. *Use a needleless system to access IV tubing. [IC]*

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F. Antiseptic containing hub / connector cap / port protector

The intraluminal contamination through catheter hubs increases the risk of development of CLABSI. Antiseptic barrier caps (ABCs) are a novel tool in the armamentarium for CVC disinfection, which optimizes needleless connectors disinfection through continuous contact with the disinfectant, thereby an alternative for active scrubbing of hub. A recent meta-analysis in 2023 reported a risk ratio of 0.65, significantly lower in the intervention group (using ABCs) as compared to the standard group (391 Vs 620 CLABSI incidences). Another multicentric study in hemodialysis patients with CVCs reported significant reduction in CLABSI rates in ABCs versus standard CVC caps (0.26 vs 0.59/1000 CVC-days). As per the limited literature available, ABCs are effective, safe, easy to use and cost-effective. More randomised controlled trials may further substantiate their clinical use.

Recommendation

1. Use an antiseptic-containing hub/connector cap/port protector to cover connectors (IIB).

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G. Use of Recombinant tissue plasminogen activating factor (rt-PA) in hemodialysis patients

The major complications of catheters include thrombosis and infection. Approximately 50% of hemodialysis catheters fail within 1 year and up to two thirds of them fail due to thrombosis. The catheter locking solution (heparin) instilled into the central venous catheter lumens after each hemodialysis session is used to prevent thrombosis between two dialysis sessions. However, there is limited literature evidence supporting these findings. Recombinant tissue plasminogen activator (rt-PA) has been used primarily to treat catheter thrombosis and found superior to heparin. Additionally, its use resulted in significant reduction in the incidence of catheter malfunction and bacteraemia.

Recommendation

1. *Use recombinant tissue plasminogen activating factor (rt-PA) once weekly after hemodialysis in patients undergoing hemodialysis through a CVC. [IA]*

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H. Use of antimicrobial ointments for haemodialysis catheter insertion sites

A variety of topical antibiotic or antiseptic ointments have been utilized in attempts to lower the antimicrobial burden at the catheter insertion site. There is evidence from one study in haemodialysis patients that bacitracin / gramicidin / polymyxin B ointment can improve outcome, but significant reference data is not available. In addition, the use of antibiotic ointments that have limited antifungal activity may serve to increase colonization and/or infection due to *Candida* species. Sometimes the ingredients in ointments may interact with the chemical composition of catheters. For example, ointments containing glycol should not be applied to insertion/exit sites of polyurethane catheters.

Recommendations

1. *Do not use topical antibiotic ointment or creams on insertion sites, except for dialysis catheters, because of their potential to promote fungal infections and antimicrobial resistance. [IB]*

2. *Use povidone iodine antiseptic ointment or bacitracin/gramicidin/ polymyxin B ointment at the haemodialysis catheter exit site after catheter insertion and at the end of each dialysis session only if this ointment does not interact with the material of the haemodialysis catheter per manufacturer's recommendation. [IB]*
3. *Mupirocin ointment should not be applied to the catheter insertion site due to the risks of facilitating mupirocin resistance and potential damage to polyurethane catheters. [IB]*

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IV. How do you conduct a surveillance program for CLABSI?

A. How to conduct surveillance

It is essential to use consistent surveillance methods and definitions to allow comparison to benchmark data. National Healthcare Safety Network (NHSN) conducted by US Centers for Disease Control and Prevention is usually regarded as the global standard, however if there is any national surveillance system in the member country, refer to this as well.

Surveillance for outcome (CLABSI) is primary, but surveillance for process should be considered. Several centers have found it useful to monitor adherence to evidence-based central line insertion practices bundle as a method for identifying quality improvement opportunities and strategically targeting interventions for the reduction of CLABSI. Feedback of bundle adherence data has also been a component of multifaceted interventions that have successfully reduced CLABSI rates.

To conduct the CLABSI surveillance, consider the following:

1. Decide the patient population (usually by ward/unit) you wish to survey. Alternatively, if you wish to monitor CLABSI which occurs hospital wide, you may just monitor CLABSI occurrence and not collect the denominator data described below.
2. Decide the method for denominator data collection. Three popular methods are:
    a. To count the number of patients with the central line at the same time (e.g. 3 am) every day. In this method, you can get the denominator (device-days) by adding up the number of patients.
    b. To record the date of central line insertion and removal of every patient in your target ward. In this method, you can get the denominator by calculating the length of insertion of each patient and adding them up.
    c. In advanced medical record management systems, denominator data can be collected by extracting data from the data management systems with/without the help of the system engineer.

3. Consult the laboratory regularly or be informed of any positive blood culture by the laboratory.
4. For each positive blood culture, consult patient record and observation charts to find out whether the criteria for LCBI have been met. If the criteria are met, count the case as CLABSI.
5. Calculate CLABSI rate by using the information below (see section III. B. i.).

To conduct the central line insertion practice bundle surveillance, consider the following:

1. Decide the patient population you wish to survey.
2. For every insertion of central line in the specific patient population, adherence of each practice should be recorded.
3. The recorder may be the infection prevention personnel, the assistant or the insertion or the inserter himself/herself. If you wish to calculate inserter-specific bundle adherence rate, record the name of the inserter.

B. How to calculate

i. CLABSI rate

The CLABSI rate is usually expressed by the figure “number of infections per 1000 central line days”. It is calculated by dividing the number of CLABSI by the number of central line days and multiplying the result by 1000.

The number of patient days in the surveyed ward does not discriminate patients with catheter and without catheter. Since catheter insertion and maintenance is a risk factor for CLABSI, the number of patient days does not reflect the true risk, and its use should be discouraged.

Example: In a certain period at a certain surveyed ward, there were 5 CLABSIs and the total central line days were 2000.

The CLABSI rate is: 5 divided by 2000 multiplied by 1000 makes “2.5”. Therefore, “2.5” is

the CLABSI rate for that period. Note that “2.5” is not expressed by per cent, but by “1000 central line days”.

If there is a surveillance system in your country or region, it usually collects data from participating hospital and provides benchmark data. Using those data, you can calculate standardized infection ratio (SIR) by dividing the actual number of CLABSI in a defined period by the predicted number of CLABSI based on your cohort’s central line use. If the SIR exceeds 1, it means that you are above the standard infection incidence among the hospitals which participate in the surveillance system, and you may need some intervention to decrease CLABSI.

ii. Central line utilization ratio

The central line utilization ratio is a measure of patient days in which central lines were used. It is calculated by dividing the number of central line days by the number of patient days in a specific surveyed ward.

The central line utilization ratio measures the proportion of patients with central lines, which is a known extrinsic risk factor for CLABSI. It can be a good indicator of quality of care because its reductions may indicate reduced duration of catheterization and/or prompt removal of unnecessary catheter.

Example: In a certain period at a certain surveyed ward, there were 2000 central line days and the patient days were 5000.

The central line utilization ratio is: 2000 divided by 5000 makes “0.4” or “40%”.

iii. Central line insertion bundle adherence rate

The adherence rates will be calculated by dividing the number of central line insertions during which all the recommended practice was followed by the total number of central line insertions and multiplying the result by 100.

The adherence rate of each component of the CLIB may be calculated in the same way.

Adherence to the bundle requires a “Yes” to all the following:

- Optimal site selection
- Hand hygiene performed
- Alcohol-based chlorhexidine skin preparation
- All 5 maximal sterile barriers used: Sterile gloves, sterile gown, cap, mask, large sterile drape which covers the patient’s entire body

C. How to analyze and interpret

Variation is expected in all data collected. However, random variation is to be differentiated from special cause variation. Random variation represents the sum of many small variations, arising from real but small causes that are inherent in any real process whilst special cause variation represents variation arising from a single cause that is not part of the process, which therefore can be traced, identified, and eliminated (or implemented). In the analysis and interpretation of data collected for the CLABSI prevention program, a special cause variation noted following an intervention will indicate a statistically significant improvement.

Improvement takes place over time. Determining if improvement has really occurred and if it is a lasting effect requires observing patterns over time. Run charts are graphs of data over time and are one of the single most important tools in performance improvement.

Interpreting a run chart

1. Determine the number of data runs in the chart. A data run consists of one or more consecutive data points on the same side of the median, excluding the median.

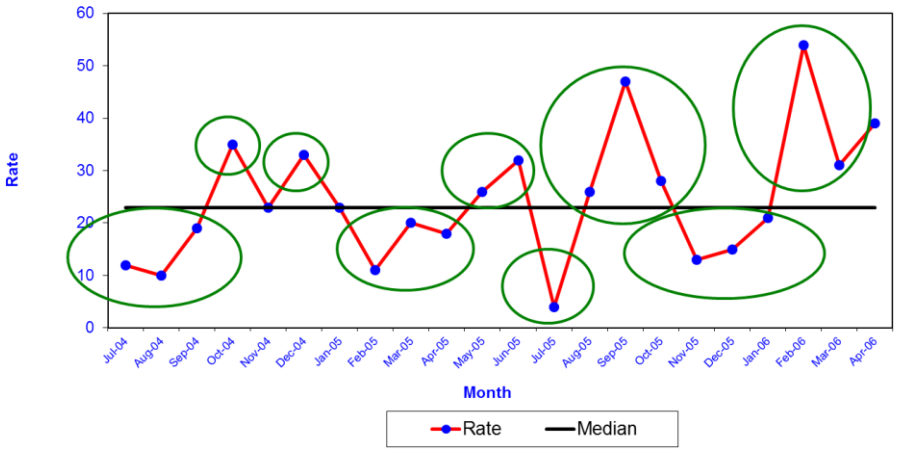

Figure 5 Run chart with 9 data runs

2. Determine the number of useful observations - count the total number of data points on the chart and subtract from that total number of data points that fall on the median.

   Total number of data points – number of data points that fall on median = total number of useful observations

3. Determine if there are too many data points in any data run. A data run with too many consecutive points demonstrates a shift in the process.

   a. When there are < 20 useful observations on a chart, a single run of 7 or more consecutive data points indicates a special cause.

   b. When there are ≥20 useful observations, a special cause exists when there are 8 or more data points in a single run

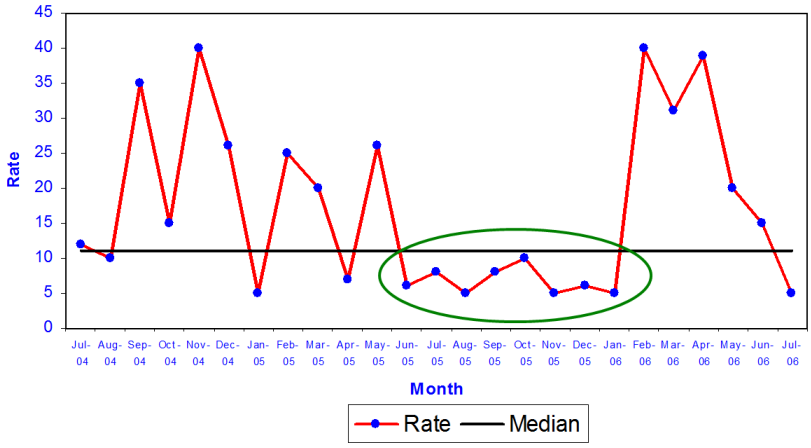

Figure 6 Run chart with a shift indicating a special cause variation (in this example, the data run has 8 data points)

4. Determine if there is a series of consecutive data points that steadily increases or decreases. A series of consecutive data points that steadily increases or decreases in value is called a trend (it includes data points that fall on median).

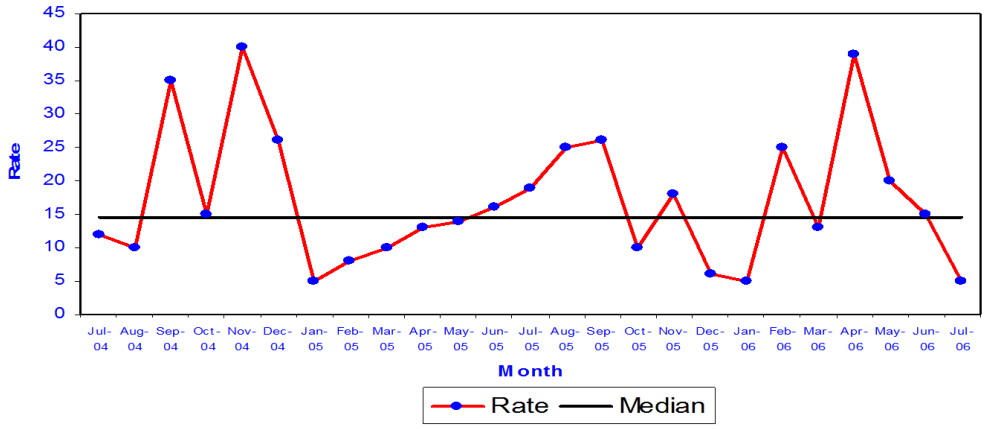

Figure 7 Run chart with a trend signifying a special cause variation

D. How to report and feedback

How often should I present the infection rates at my hospital?

Calculate infection rates on a monthly basis and keep tract of the rates along with investigating an unexpected increase or decrease in the rates.

- Such increase or decreases may be related to new infections or less infections or the changes may also be related to data collection or analysis problems/issues which need

to also be investigated and corrected

Feedback the data in a timely manner to relevant clinical groups so that targeted CLABSI prevention and control measures can be introduced and reported on.

Feedback the data to your hospital Infection Prevention and Control Committee at least bi-monthly or more frequently if the rate is associated with an ongoing outbreak.

The success of prevention and control strategies introduced by staff will encourage participation in ongoing quality improvement interventions to reduce the risk of infection to patients.

How should I present my data at my hospitals?

Not everyone in a hospital setting has a thorough understanding of statistics and statistical analysis. Hence it is important that the data is presented in a format that is easily understood by the audience you are targeting.

Data can be reported in any of the following formats:

- Tables
- Graphs – you can plot interventions on your graphs so that the unit and hospital staff can see how the hospital is tracking
- Run charts

Reference

1. Bloodstream Infection (BSI) Events. National Healthcare Safety Network (NHSN). https://www.cdc.gov/nhsn/psc/bsi/index.html

Appendix Categories for strength of each recommendation

Categories for strength of each recommendation	
CATEGORY	**DEFINITION**
A	Good evidence to support a recommendation for use.
B	Moderate evidence to support a recommendation for use.
C	Insufficient evidence to support a recommendation for or against use
D	Moderate evidence to support a recommendation against use.
E	Good evidence to support a recommendation against use.
Categories for quality of evidence on which recommendations are made	
GRADE	**DEFINITION**
I	Evidence from at least one properly randomized, controlled trial.
II	Evidence from at least one well-designed clinical trial without randomization, from cohort or case-controlled analytic studies, preferably from more than one centre, from multiple time series, or from dramatic results in uncontrolled experiments.
III	Evidence from opinions of respected authorities on the basis of clinical experience, descriptive studies, or reports of expert committees.