ASIA PACIFIC SOCIETY OF INFECTION CONTROL

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

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1. Introduction

A. Definition

Use of vascular catheters is common in both inpatient and outpatient care. In the CVCs play 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; their use, however, is associated with a risk of bloodstream infection caused by microorganisms colonizing the external surface of the device or the fluid pathway when the device is inserted or in the course of its use. These serious infections, termed central line–associated bloodstream infections, or CLABSIs, are associated with increased morbidity, mortality, and health care costs. It is now recognized that CLABSIs are largely preventable when evidence based guidelines are followed for the insertion and maintenance of CVC. This preventability is even more acutely apparent in developing countries, where use of these devices may occur in the absence of the most basic infection prevention and control practices and limited availability of supplies.

Central line

A central line is defined as an intravascular access device or catheter that terminates at or close to the heart or in one of the great vessels. The following are considered great vessels for the purpose of defining a central line; pulmonary artery,

superior vena cava, inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, external iliac veins, common iliac veins or femoral veins. A hollow introducer is considered a central line if the tip is situated in a great vessel.

The line may be used for infusion, or hemodynamic monitoring. Examples include a central line for infusion, pulmonary artery (PA) catheter, sheath/introducer for PA catheter, dialysis or hemofiltration catheter in a great vessel and the peripherally inserted central catheter (PICC).

A central line may be inserted centrally or peripherally (PICC) in the patient. Neither the location of the insertion site nor the type of device determines whether a line qualifies as a central line. The device must terminate one of the great vessels (listed above) or in or near the heart to qualify as a central line.

CLABSI and CRBSI

Two terms, *central line–associated bloodstream infection* (CLABSI) and *catheter-related bloodstream infection* (CRBSI), should be distinguished. Although the terms are often used interchangeably to describe intravascular device (IVD)–related bloodstream infections, there are discrepancies between CRBSI and CLABSI that can be confusing.

CLABSI is a term used only for surveillance purposes to identify BSIs that occur in the population at risk (patients with central lines) by the US Centers for Disease Control and Prevention's (CDC's) National Healthcare Safety Network (NHSN) (see

NHSN CLABSI information at http://www.cdc.gov/nhsn/psc_da.html). A CLABSI is a primary bloodstream infection (that is, there is no apparent infection at another site) that develops in a patient with a central line in place within the 48-hour period before onset of the bloodstream infection that is not related to infection at another site. Culturing the catheter tip or peripheral blood is not a criterion for CLABSI. The CLABSI definition may overestimate the true rate of CVC–related infections, as it can sometimes be difficult to determine infections related to the central line rather than remote unrecognized infections (for example, urinary tract infections, pneumonia, intra-abdominal abscess).

CRBSI is a more rigorous clinical definition and requires specific laboratory testing to identify the catheter as the source of the bloodstream infection, such as culturing the catheter tip or a more elaborate method such as time-to-positivity. CRBSI is used to determine diagnosis, treatment, and possibly epidemiology of BSI in patients with a CVC. Typically, the term CRBSI is more likely to be used in clinical research. Using the CRBSI definition requires more resources than use of the CLABSI definition. Hospitals must have the capacity to correctly collect and label blood culture sets drawn from the CVC and a peripheral phlebotomy as well as culturing the CVC segment/ tips.

CRBSI criteria require one of the following:

1. A positive semi quantitative (>15 colony-forming units [CFU]/catheter segment) or quantitative (>10^3 CFU/catheter segment) cultures whereby the same

organism (species and antibiogram) is isolated from the catheter segment and peripheral blood

2. Simultaneous quantitative blood cultures with a ≥ 5:1 ratio CVC versus peripheral
3. Differential period of CVC culture versus peripheral blood culture positivity of >2 hours

B. Pathogenesis

CVCs can become contaminated with microorganisms via two major routes (see Figure 1):

1. Extraluminally:

The patient's skin organisms at the insertion site can migrate along the surface of the catheter into the cutaneous catheter tract surrounding the catheter, resulting in colonization at the catheter tip. For short-term catheters (non-tunneled CVCs in place less than 10days), this is the most common source of infection.

2. Intraluminally

Most commonly, direct contamination of the catheter or at any point along the fluid pathway when the IV system is manipulated (as might occur when health care personnel have hand contact with IV solution connection sites, access hubs,

needleless connectors, or tubing junctions, or contamination with the patient's own body fluids or skin). This route has been associated with more prolonged CVC dwell time (for example, in place for more than 10 days), including tunneled CVCs such as Hickman and Broviac-type catheters and PICCs.

Less commonly, catheters can become seeded via the hematogenous route from an infection at another site, such as a urinary tract infection or pneumonia. 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.

The catheter material can also influence the development of bloodstream infection. Antibiotic resistance is a problem with all common pathogens causing CLABSIs, particularly in intensive care units. Gram-positive skin organisms often comprise the most commonly reported causative microorganisms of bloodstream infections. Data from a nationwide surveillance study in the United States found that coagulase-negative staphylococci and *Staphylococcus aureus* account for 31% and 20%, respectively, of all health care–associated bloodstream infections. *Enterococcus* and *Candida* species ranked third and fourth, at 9% each. One quarter of the infections was caused by Gram-negative organisms, with *Escherichia coli* (6%) and *Klebsiella* species being the most common. Gram-negative organisms, however,

have been found to be a more important cause of CLABSIs in some areas of the world. For example, Taiwan, the Czech Republic, and Egypt have reported bloodstream infections more often due to Gram negative organisms (50%, 64.8%, and 66% of CLABSIs, respectively), most often due to *E. coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. Antimicrobial resistance is a problem with all common pathogens that cause CLABSIs, particularly in ICUs. Methicillin-resistant *Staphylococcus aureus* (MRSA) accounts for more than 50% of all *S. aureus* isolates obtained in ICUs. Resistance to third-generation cephalosporins has increased significantly among *E. coli* and *K. pneumonia* isolates. Ceftazidime and imipenem resistance is increasingly being found among *P. aeruginosa* isolates.

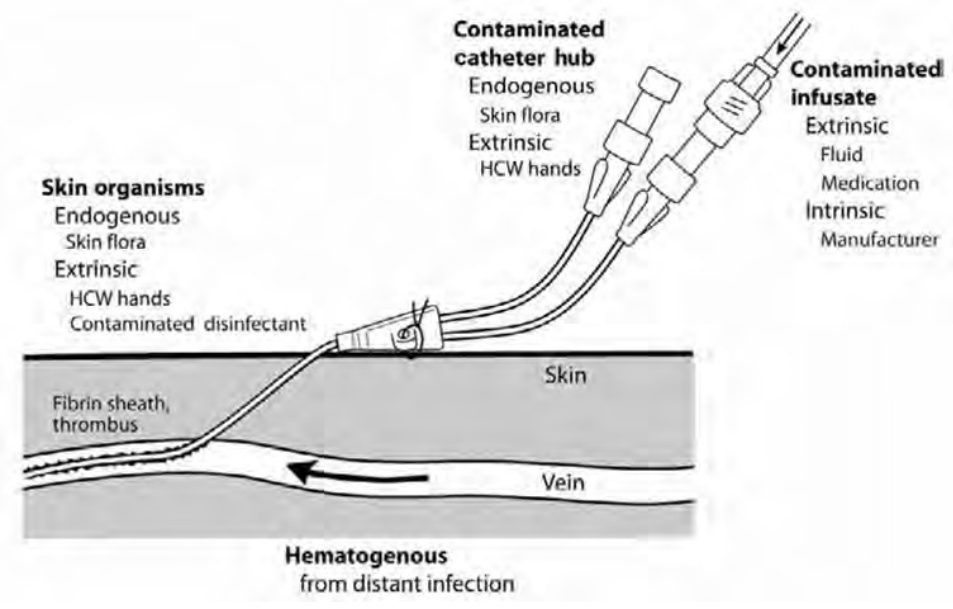

Figure 1 Routes for Central Venous Catheter Contamination with Microorganisms

Potential sources of infection of a percutaneous intravascular device (IVD): the

contiguous skin flora, contamination of the catheter hub and lumen, contamination of infusate, and hematogenous colonization of the IVD from distant, unrelated sites of infection. HCW: health care worker.

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 May 1;34(9):1232–1242. Used with permission.

C. Epidemiology

As with other HAIs, CLABSIs also increase the cost of health care and prolong hospital lengths of stay by up to three weeks. Of patients who get a bloodstream infection from having a central line, up to 1 in 4 die from the infection. 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. In all studies, however, the excess costs are considered substantial and economically relevant.

Bloodstream infections in patients with central lines are largely preventable when healthcare providers use evidence-based infection control steps. The incidence of CR-BSI associated with central lines among patients hospitalized in intensive care units (ICUs) in the United States decreased from 3.64 to 1.65 infections per 1,000 central line days between 2001 and 2009. This amounted to an estimated 18,000

central line-related infections in 2009. A similar trend of decreasing incidence has been observed in Canada. In contrast, the reported pooled incidence of central line-associated BSI across 422 ICUs in 36 countries in Latin America, Asia, Africa, and Europe from 2004 to 2009 was substantially higher, 6.8 events per 1,000 central line days.

But resource-limited countries, improving CLABSI rates is possible. 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. CLABSIs in particular—are more and more being viewed as “preventable” events.

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2. What are the risks for 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 2012 data report of NHSN, the pooled mean CLABSI rates among pediatric patients in medical/surgical ICU and non-ICU medical/surgical wards were 1.4 and 1.1 episodes per 1,000 catheter days, respectively, versus 1.2 and 0.8 among adult patients in medical-surgical ICU of major teaching hospitals and non-ICU medical/surgical wards of all hospitals. 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. Male patients are at increased risks for developing CLABSI.
3. 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, in particular, 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. For ICU patients, whether more severe illness on ICU admission leads to a higher CLABSI rate remains undetermined. 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.

4. Prolonged hospitalization before catheter insertion or prolonged overall length of hospital stay increases risk of CLABSI.

B. Risk factors associated with catheter insertion or maintenance

1. **Incompetent insertion skills:** Clinicians and nurses who insert the vascular catheter but lack of sufficient training could expose their patients to increased risks of CLABSI.
2. **Internal jugular or femoral insertion site rather than subclavian in adults:** There are three routes, subclavian, internal jugular and femoral, for CVC insertion. In adults, as there is generally lower density of skin flora at subclavian site than those at the other two sites, the subclavian site may have lower risks of CLABSI. Femoral site is associated with increased risks of CLABSI compared to internal jugular site for continuous renal replacement therapy in obese patients. However,

caution should be taken as there are no randomized controlled trials (RCTs) for simultaneously comparing all of the three routes for CLABSI rates in adults. Currently available studies, which compared only two routes or were non-RCT, had significant confounding bias and were heterogeneous in study design. As a result, two meta-analyses had different conclusions. One by Parienti JJ *et al* demonstrated that subclavian route was associated with a lower risk of CLABSI than the other two routes, while the other by Marik PE *et al* found no differences in CLABSI rates among the three routes. In constrast, femoral access has not been associated with increased risks of CLABSI in children.

3. **Multiple vascular catheters:** The simultaneous presence of multiple vascular catheters increases risk of CLABSI.
4. **Multilumen catheters:** Use of multilumen slightly increases risks of CLABSI in studies that were performed more than 10 years ago but a more recent study demonstrated that each additional lumen increased the adjusted hazard ratio for CLABSI for four times.
5. **Duration of central line:** Prolonged dwell time of central line increases risk of CLABSI but the association between dwell time of central line and risk of CLABSI may not be linear.
6. **Parenteral nutrition administration**, particularly compounded parenteral nutrition, has been associated with increased risks of CLABSI.
7. **Blood transfusions** increase risks of CLABSI in pediatric patients.

C. Risk factors associated with healthcare settings

1. Lower staff responsiveness and insufficient nurse-to-patient ratio result in increased risks of CLABSI.
2. Lack of awareness among healthcare workers and patients.

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3. **How can we prevent CLABSI?**

A bundle is a set of evidence-based interventions for a defined patient segment/population and care setting. It has been shown that when these interventions are implemented together, one will get results that are significantly better than when these were to be implemented individually. Hence, to prevent CLABSI, the insertion bundle and maintenance bundle are to be used. The 'all or none' compliance measurement that accompanied its use helped to emphasize the importance of implementing all elements in the bundles for best outcome.

The preventive measures focus on two important phases in the life of a central line - its insertion and its maintenance, both of which present opportunities for the introduction of microorganisms. To prevent CLABSIs we use effective and scientifically proven Level A interventions which if implemented together as a bundle result in better outcomes than when implemented individually. These bundles were developed by grouping of individual evidence based best practice interventions for patients with central venous lines, both while insertion and maintenance.

Central venous catheterization is an essential skill for critical care physicians. With the recent sepsis trial hemodynamic monitoring with central lines is likely to increase. Patients requiring vasopressors or high concentrations of potassium for the severely hypokalemic will require CVC. A lack of peripheral venous access for therapy may require CVC, however, ultrasound maybe used to locate a suitable peripheral vein for access.

1. Common indications for Central Venous Catheterization

a. Hemodynamic monitoring - monitoring of the central venous pressure (CVP) in acutely ill patients to quantify fluid balance
b. Hemodialysis
c. Long-term parenteral nutrition especially in chronically ill patients
d. Long-term intravenous antibiotics
e. Chemotherapy
f. Temporary cardiac pacemaker
g. Administration of drugs likely to induce phlebitis, such as:
    - Calcium chloride
    - Chemotherapy
    - Hypertonic saline
    - Potassium chloride (KCL)
    - Amiodarone
    - Vasopressors (e.g. epinephrine, dopamine)
h. Plasmapheresis
i. Peripheral blood stem cell collections
j. Need for intravenous therapy when peripheral venous access is impossible

If an operator is inexperienced in the procedure this is an absolute contraindication to CVC. Coagulopathy is a relative contraindication and certainly the

risk of bleeding and arterial puncture needs to be weighed against the benefits of CVC. Depending on the availability and urgency, ultrasound-guided techniques should be considered in these scenarios.

2. Relative contraindications to CVC

a. Inexperience, unsupervised operator
b. Local infection
c. Distorted local anatomy
d. Coagulopathy
e. Previous radiation therapy
f. Suspected proximal vascular injury

A. The Central Line Insertion Bundle

1. Optimal site selection
2. Hand hygiene
3. Alcohol-based chlorhexidine skin preparation
4. Maximum barrier precautions

1. Optimal site selection

The catheter insertion site affects the risk for catheter-related infection and phlebitis. The effect of site on the risk for catheter infection is partially related to the risk for

thrombophlebitis and the density of local skin flora. Phlebitis has long been recognized as a risk factor for infection. For adults, lower extremity insertion sites are associated with a higher risk for infection than upper extremity sites, and hand veins have a lower risk for phlebitis than wrist or upper arm veins.

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 CRBSI 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, 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.

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.

Recommendations:

1. ***Select catheters on the basis of intended purpose and duration of use, known infectious and non-infectious complications (e.g., phlebitis and infiltration), and experience of individual catheter operators. (IB)***

2. ***Avoid the use of steel needles for the administration of fluids and medication that might cause tissue necrosis if extravasation occurs.(IA)***
3. ***Use a midline catheter or peripherally inserted central catheter (PICC), instead of a short peripheral catheter, when the duration of IV therapy will likely exceed six days. (IB)***
4. ***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 l)***
    c. ***Use ultrasound guidance for internal jugular catheter insertion (II)***
    d. ***No recommendation can be made for a preferred site of insertion to minimize infection risk for a tunneled CVC. (Unresolved issue)***
    e. ***Place catheters used for hemodialysis and pheresis in a jugular or femoral vein, rather than a subclavian vein, to avoid venous stenosis. (IA)***
    f. ***Use ultrasound guidance to place central venous catheters to reduce the number of cannulation attempts and mechanical complications, if this technology is available. (IB)***

2. Hand hygiene

Hand hygiene before catheter insertion or maintenance, combined with proper aseptic technique during catheter manipulation, provides protection against infection. Observes proper hand-hygiene procedures either by washing hands with liquid antiseptic-containing soap and water or with alcohol hand rub. Perform hand hygiene before and after palpating a catheter insertion site, before and after inserting, replacing, accessing, repairing, or dressing an intravascular catheter. Palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained. Use of gloves does not obviate the need for hand hygiene. Maintain aseptic technique for the insertion and care of intravascular catheters. Sterile gloves should be worn for the insertion of arterial and central catheters. When adherence to aseptic technique cannot be ensured, replace all catheters as soon as possible and after no longer than 48 hours.

Recommendations:

1. ***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 an intravascular catheter. Palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained. (IB)***

2. ***Maintain aseptic technique for the insertion and care of intravascular catheters. (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. (II)***

5. ***Wear either clean or sterile gloves when changing the dressing on intravascular catheters. (IC)***

3. Alcohol-based chlorhexidine skin preparation

Two well-designed studies evaluating the chlorhexidine-containing cutaneous antiseptic regimen in comparison with either povidone iodine or alcohol for the care of an intravascular catheter insertion site have shown lower rates of catheter colonization or CRBSI associated with the chlorhexidine preparation. (The comparison of chlorhexidine gluconate alcohol to povidone iodine alcohol has not been done.) When 0.5% chlorhexidine was compared with 10% povidone iodine, no differences were seen in central venous catheter (CVC) colonization or in CRBSI.

In a three-armed study (2% aqueous chlorhexidine gluconate vs 10% povidone-iodine vs 70% alcohol), 2% aqueous chlorhexidine gluconate tended to decrease CRBSI compared with 10% povidone iodine or 70% alcohol. A meta-analysis of 4,143 catheters suggested that chlorhexidine preparation reduced the risk of catheter related infection by 49% (95% CI .28 to .88) relative to povidone iodine. An economic decision analysis based on available evidence suggested that the use of chlorhexidine, rather than povidone iodine, for CVC care would result in a 1.6% decrease in the incidence of CRBSI, a 0.23% decrease in the incidence of death, and a savings of $113 per catheter used. While chlorhexidine has become a standard antiseptic for skin preparation for the insertion of both central and peripheral venous catheters, 5% povidone iodine solution in 70% ethanol was associated with a substantial reduction of CVC-related colonization and infection compared with 10% aqueous povidone iodine.

Recommendations:

1. ***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)

2. ***No recommendation can be made for the safety or efficacy of chlorhexidine in infants aged <2 months. (UI, unresolved issue).***
3. ***Allow povidone iodine to remain on the skin for at least 2 minutes or longer for the antibacterial properties to take effect, if it is not yet dry before catheter insertion. The antibacterial properties of chlorhexidine work on contact, and chlorhexidine does not require a minimum 2-minute drying time before proceeding. Catheter insertion may begin as soon as the chlorhexidine is dry. (IB)***
4. ***After insertion, disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter. (IIB)***
5. ***Before accessing catheter hubs or injection ports, clean them with an alcoholic chlorhexidine preparation or 70% alcohol to reduce contamination.(IIB)***

4. **Maximal barrier precaution**

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 CR-BSI (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. Another study evaluated an educational program directed at improving infection control practices, especially MSB precautions. In this study, MSB precautions use increased and CRBSI decreased. 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].

Recommendations:

1. Use maximal sterile barrier precautions, (IB)

2. Use a sterile sleeve to protect pulmonary artery catheters during insertion. (IB)

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B. Central line maintenance bundle

Introduction

To prevent central line associated blood stream infections the focus is on two important phases in the life of a central line- its insertion and its maintenance, both of which present opportunities for the introduction of microorganisms. These bundles are developed by grouping of individual evidence based best practice interventions for patients with central venous lines, both while insertion and maintenance.

Rationale

Central venous catheters can be in place from a few hours to weeks. Just as observing precautions during insertion of catheters prevents early introduction of infection, care during the maintenance phase of the catheter prevents introduction of microorganisms while being accessed a number of times by staff members. They are accessed to administer fluids, medications and to collect blood specimens. As each entry into the access points in the delivery system is an opportunity to introduce microorganisms, the post-CVC (central venous cannula) insertion period presents multiple opportunities for the risk of infection and the proper maintenance of lines is essential for continued patient safety. It was recently reported to NHSN by Pennsylvania acute care hospitals (2010) that almost 72% of all CLABSIs occurred more than 5 days after insertion suggesting that infection prevention lapses likely occurred in the post insertion care and maintenance of the CVCs.

All these evidence based best practices known to prevent introduction of

microorganisms in the maintenance phase have been grouped together as a bundle which if implemented together have better outcomes. They have been called as a maintenance bundle. They have been developed for healthcare personnel who are involved in the maintenance and care of the central venous catheters. These are also helpful for the infection control professionals responsible for surveillance and control of healthcare associated infections in healthcare settings.

The strategies for prevention of CLABSI have been advocated by various infection control collaborations and societies include SHEA (Society for Healthcare Epidemiology of America), CDC (Centers for Disease Prevention and Control), APIC (Association for Professionals in Infection Control and Epidemiology) and JCI (The Joint Commission International). For the purposes of the APSIC guide we have tried to pick up the five most proven interventions with level A evidences (see Appendix G) and those that have had a maximum impact on favorable outcomes in CLABSI Maintenance Bundle. Compliance with the CLABSI maintenance bundle has been shown to be a significant predictor of improvement in the CLABSI rates.

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 and changing the access lumens/ devices.

4. Proper dressing change technique

5. Standardize administration sets change

These elements have been incorporated into a check list for easy recall for the staff – see Appendix B.

I. Daily review of line necessity

The central lines should be reviewed daily for either an ongoing need or a replacement (only if indicated).

A. For ongoing need

Rationale

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

Practice elements and tools

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.

B. For replacement

Rationale

Routine replacement of central lines is not recommended and should only be

done as clinically indicated.

Practice elements and tools

I. If the CVC is inserted under emergency conditions and there is a suspicion of 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.

II. Re-wiring:

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

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

c. 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 not acceptable replacement strategy, because the source of infection is usually colonization of the skin from the insertion site to the vein.

III. Central lines should be reviewed daily for

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

b. Signs of systemic infection

c. Suture and dressing integrity

d. Catheter position

e. 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.

Recommendations

1. ***Designate only trained personnel who demonstrate competence for the insertion and maintenance of central intravascular catheters. (IA)***
2. ***Promptly remove any intravascular catheter that is no longer essential (IA)***
3. ***Ensure appropriate nursing staff levels in ICUs. Observational studies suggest that a higher proportion of "pool nurses" or an elevated patient–to-nurse ratio is associated with CRBSI in ICUs where nurses are managing patients with CVCs. (IB)***
4. ***Promptly remove any intravascular catheter that is no longer essential (IA)***

5. ***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)***
6. ***Do not routinely replace CVCs, PICCs, hemodialysis catheters, or pulmonary artery catheters to prevent catheter-related infections. (IB)***
7. ***Do not remove CVCs or PICCs on the basis of fever alone. Use clinical judgment regarding the appropriateness of removing the catheter if infection is evidenced elsewhere or if a noninfectious cause of fever is suspected. (II)***
8. ***Do not use guidewire exchanges routinely for non-tunneled catheters to prevent infection. (IB)***
9. ***Do not use guidewire exchanges to replace a non-tunneled catheter suspected of infection. (IB)***
10. ***Use a guidewire exchange to replace a malfunctioning non-tunneled catheter if no evidence of infection is present. (IB)***

II. Hand Hygiene and aseptic technique

Rationale

Hand hygiene is a key component of an effective patient safety and infection prevention program. Routine hand washing before and after patient contact has been advocated as the most important infection control measure in healthcare settings. For

proper hand hygiene either an alcohol-based hand rub or soap and water can be used.

Aseptic technique, a method used to prevent contamination with microorganisms, 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.

Practice elements and Tools

When caring for central lines, appropriate times for hand hygiene include:

1. Before and after palpating catheter insertion sites (Note: palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained.) Please refer to WHO guidelines for correct procedure for hand hygiene.
2. Before and after replacing, accessing, repairing, or dressing a central intravascular catheter
3. When hands are obviously soiled or if contamination is suspected
4. Before and after invasive procedures
5. Before donning and after removing gloves

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 intravascular catheters.

Recommendations

1. ***Use new sterile gloves before handling the new catheter when guidewire exchanges are performed. (II)***
2. ***Perform hand hygiene procedures, either by washing hands with conventional 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 an intravascular catheter. Palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained. (IB)***
3. ***Maintain aseptic technique for the insertion and care of intravascular catheters. (IB)***
4. ***Sterile gloves should be worn for the insertion of arterial, central, and midline catheters. (IA)***
5. ***Use new sterile gloves before handling the new catheter when guidewire exchanges are performed. (II)***
6. ***Wear either clean or sterile gloves when changing the dressing on intravascular catheters. (IC)***

7. ***Use maximal sterile barrier precautions, including the use of a cap, mask, sterile gown, sterile gloves, and a sterile full body drape for guidewire exchange. (IB)***

III. Disinfection and changing the access lumens/devices

Rationale

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.

Practice elements and Tools

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 15-30 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.

Recommendations

1. ***Use a CVC with the minimum number of ports or lumens essential for the management of the patient. (IB)***

2. ***No recommendation can be made regarding the use of a designated lumen for parenteral nutrition. Unresolved issue***

3. ***Use a needleless system to access IV tubing. (IC)***

4. ***Change the needleless components at least as frequently as the administration set or according to manufacturers' recommendations for the purpose of reducing infection rates There is no benefit to changing these more frequently than every 72 hours. (II)***

5. ***Ensure that all components of the system are compatible to minimize leaks and breaks in the system. (II)***

6. ***Minimize contamination risk by scrubbing the access port with an appropriate antiseptic (chlorhexidine, povidone iodine, an iodophor, or 70% alcohol) and accessing the port only with sterile devices. (IA)***

7. ***When needleless systems are used, a split septum valve may be preferred over some mechanical valves due to increased risk of infection with the mechanical valves. (II)***

IV. Proper dressing change technique

Rationale

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.

Practice elements and tools

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 sponge dressing may 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.

Recommendations

1. ***Use either sterile gauze or sterile, transparent, semipermeable dressing to cover the catheter site. (IA)***

2. ***If the patient is diaphoretic or if the site is bleeding or oozing, use a gauze dressing until this is resolved. (II)***

3. ***Replace catheter site dressing if the dressing becomes damp, loosened, or visibly soiled. (IB)***

4. ***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)***

5. ***Do not submerge the catheter or catheter site in water. Showering should be permitted if precautions can be taken to reduce the likelihood of introducing organisms into the catheter (e.g., if the catheter and connecting device are protected with an impermeable cover during the shower). (IB)***

6. ***Replace dressings used on short-term CVC sites every 2 days for gauze dressings. (II)***

7. ***Replace dressings used on short-term CVC sites at least every 7 days for transparent dressings, except in those pediatric patients in which the risk for dislodging the catheter may outweigh the benefit of changing the dressing. (IB)***

8. ***Replace transparent dressings used on tunneled or implanted CVC sites no more than once per week (unless the dressing is soiled or loose), until the insertion site has healed. (II)***

9. ***No recommendation can be made regarding the necessity for any dressing on well-healed exit sites of long-term cuffed and tunneled CVCs.***

   Unresolved issue

10. ***Ensure that catheter site care is compatible with the catheter material. (IB)***

11. ***Use a chlorhexidine-impregnated sponge dressing for temporary short-term catheters in patients older than 2 months of age if the CLABSI rate is not decreasing despite adherence to basic prevention measures, including education and training. (IB)***

12. ***ncourage patients to report any changes in their catheter site or any new discomfort to their provider. (II)***

V. Standardize administration sets change

Rationale

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.

Practice elements and Tools

1. The administration sets used continuously should be changed not more frequently than 96 hours and at least every 7 days. This interval has been set keeping both patient safety and cost factor in concern.
2. If the sets are used for administration of blood, blood products and fat emulsions, they should be replaced every 24 hours.
3. Replace administration sets NOT used for blood, blood products, or lipids at intervals not longer than 96 hours
4. Needleless components require replacement no more often than 72 hours or with the administration set.

Recommendations

1. ***In patients not receiving blood, blood products or fat emulsions, replace administration sets that are continuously used, including secondary sets***

and add-on devices, no more frequently than at 96-hour intervals, but at least every 7 days. (IA)

2. ***No recommendation can be made regarding the frequency for replacing intermittently used administration sets. Unresolved issue***

3. ***No recommendation can be made regarding the frequency for replacing needles to access implantable ports. Unresolved issue***

4. ***Replace tubing used to administer blood, blood products, or fat emulsions (those combined with amino acids and glucose in a 3-in-1 admixture or infused separately) within 24 hours of initiating the infusion. (IB)***

5. ***Replace tubing used to administer propofol infusions every 6 or 12 hours, when the vial is changed, per the manufacturer's recommendation. (IA)***

6. ***No recommendation can be made regarding the length of time a needle used to access implanted ports can remain in place. Unresolved issue***

Maintenance and care of chemoports

The long-term venous catheters include peripherally inserted central catheters (PICCs), tunneled catheters (e.g., Broviac, Hickman, and Groshong catheters), including tunneled apheresis catheters, and implanted ports. The catheters that are placed completely under the skin and connected to a small plastic or metal disc are called a port (known as a port-a-cath), or they may be tunneled under the skin with the tip exiting outside the body so they can be used to give treatments. When not being used, the catheter tip should either be clamped to keep the line closed or sealed with a special cap. The procedures pertaining to the access and maintenance these catheters are outlined below:

Care during accessing the port

1. Maintenance of aseptic technique
2. Hand hygiene before and after accessing the port
3. Scrubbing the access lumen/ device (e.g., needleless connector) with an appropriate antiseptic (e.g., chlorhexidine, povidone iodine, or 70% alcohol), and allow to dry (if povidone iodine is used, it should dry for at least 2 minutes)
4. Accessing the lumen with the syringe or IV tubing (opening the clamp, if necessary)

Frequency of dressing change

1. For short-term use in outpatient settings, a light dressing may be used in place of an occlusive dressing during the infusion; the securement of the needle in the portal septum is carefully ensured.
2. Once healed, tunneled catheters may go without a dressing
3. Flushing: No routine care is needed when there's no needle in the port, but it may need to be flushed if not used for more than a month at a time 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 unless otherwise specified.

Hand Hygiene and Aseptic Technique

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. Designated area for IV medications preparation in a clean zone away from the patient treatment area to avoid contamination.

IV Solutions

1. 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.
2. Infusion of lipid containing solutions, lipid emulsions and blood/ blood products should be completed within 24 hours, 12 hours and 4 hours respectively.
3. Disinfection of IV ports prior to accessing, using 70% alcohol, iodophor, or chlorhexidine/alcohol agent and allowed to dry prior to accessing.

Role of Patients in postsurgical care of an HD Access (Temporary or Permanent)

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

1. Hand hygiene must be performed before donning gloves, prior to wound care or vascular access.
2. The patient should be reminded not to touch the skin at the site where the catheter enters the skin or where the fistula/graft has been placed
3. The area around the new access should be covered with a clean, dry dressing.
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.

References

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3. WHO Guidelines on Hand Hygiene in Health Care: a Summary 2009.

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5. Getting Started Kit: Prevent Central Line Infections, Central Line Associated - Blood Stream Infections (CLA-BSI) Safer Healthcare Now! Campaign (SHN) 2009
6. Central line insertion and maintenance guidelines. Australian Commission on Safety and Quality in Health care 2012.
7. *Access Device Guidelines*: *Recommendations for Nursing Practice and Education (3rd Ed.)*, by D. Camp-Sorrell (Ed.), 2011, Pittsburgh, PA: Oncology Nursing Society. Copyright 2011 by ONS. INS 2011 Infusion Nursing Standards of Practice
8. Basic Infection Control And Prevention Plan for Outpatient Oncology Settings CDC December 2011
9. Guide to the Elimination of Infections in Hemodialysis, An APIC Guide 2010

II. Implementing the CLABSI prevention guidelines

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

A. Model for improvement

A key success factor to the implementation of the 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 Control 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.***

References

1. How-to Guide: Prevent Central Line-Associated Bloodstream Infections.

Cambridge, MA: Institute for Healthcare Improvement; 2012

B. 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, they must 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.***

2) Enhanced communication to share data and take action.

References:

1. Weaver SJ, Lubomksi LH, Wilson RF, Pfoh ER, Martinez KA, Dy SM. Promoting a culture of safety as a patient safety strategy: a systematic review. *Ann Intern Med* 2013;158(5 pt 2):369–374.
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C. 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 HAIs, 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 HAIs;
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 HAI's 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, viz. insertion and maintenance bundles will require the support of leadership to make it happen i.e. leadership are 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, slip in compliance, lack of knowledge, etc.)

Recommendations

1. Hospital leadership and policymakers are to continue providing support to

build culture of zero tolerance.

2. ***Chains of accountability need to be established to link everyone in a hospital—from the board to the 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.***

References

1. Warye KL and Murphy DM. Targeting zero health care–associated infections. Am J Infect Control 2008;36:683-4.
2. Gilbert GL, Cheung PY and Kerridge IB. Infection control, ethics and accountability. Med J Aust 2009; 190 (12): 696-698.

D. Education and training

Education and training is critical in the implementation of 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 and multiple teaching strategies should be used including 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 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 also regarding the indications for intravascular catheter use and appropriate infection control measures to prevent intravascular catheter-related infections.

Different training methods include printed learning packages; slide presentations and videos; skills labs; journal clubs and nursing grand rounds; and computer, web-based packages of learning materials can be adopted. Reminders such as posters, fact sheets, small pocket card are also shown to be effective. To enhance

patient safety, CVC insertion techniques is best performed in clinical skill laboratory a simulated environment followed by supervised performance on patients later by 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 with CVC insertion, care, and maintenance before being allowed to practice without direct supervision using competency assessment checklists.

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 CLABSI prevention.

Recommendations

1. There should be focus on skill development and competency testing in the

organization.

2. ***The educational programs should be assessed for their content, relevance and impact on work performance.***

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E. Cost-Effectiveness Analysis

Despite the ongoing development and expansion of technologic advances in healthcare systems, efforts to control and maintain healthcare costs primarily focus on optimizing resource utilization, reducing waste, and identifying duplication of services. Continued reductions in healthcare budgets have particularly impacted healthcare epidemiology and infection control programs, which do not generate revenue and are challenged to prove their worth. The methods used to determine the costs of healthcare-associated infections have been analyzed in detail with particular emphasis focused on measures to estimate incremental costs. Cost-effectiveness analysis (CEA) remains less frequently used as an analytical tool in efforts to justify healthcare epidemiology and infection 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. The core purpose of a CEA 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-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.

As an example, a case study by Cooper et al may be referred to where the cost-effectiveness of a CLABSI prevention program is estimated. The analysis evaluates a CVC care bundle compared to remaining with current practice.

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2. **What are common barrier to successful implementation?**

Studies suggested that several internal and external factors can affect the success of any improvement initiative to reduce healthcare-associated infections (HAIs), including CLABSIs. These factors included, 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. The success stories showing how CLABSI rates can be reduced, even to zero, continue to grow in number. 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 nonpermanent staff), barriers at staff level (e.g., education, training, experience, and competency of staff). All of which can affect patient safety in several ways.

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

- 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.

- 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.
- Lack of resources may prohibit the implementation of CLABSI insertion bundles in developing countries, where use of outdated technology is not uncommon and sufficient skilled staffing is lacking. Reuse of equipment was also commonly encountered resource-limited settings.
- Use of nonpermanent nursing staff, or “float” nurses has also been associated with a significant risk of HAIs.
- Inexperienced staff who insert CVCs has been associated with lower adherence to CVC insertions.
- Not following evidence-based practices may pose significant number of patients to experience preventable harm in resource-limited setting.

Recommendation

1. ***Although adherence to evidence-based practices reduces inconsistencies in practice and can significantly improve the overall quality of care, healthcare organizations often find it difficult to implement best practices. Thus, identifying and removing barriers to adherence to these practices is essential to a successful implementation of best practices in the era of patient safety.***

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3. **Is there evidence for additional strategies to reduce CLABSI?**

A. Antiseptic bathing/wipes

The innovative practice of bathing patients who have central venous catheters (CVC) with ChlorhexidineGluconate (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 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 US CDC and SHEA/IDSA recommendations suggest that daily bathing of ICU patients older than 2 months of age with a 2% chlorhexidine-impregnated washcloth may be a useful strategy to decrease CLABSI rates in organizations that have unacceptably high CLABSI rates, despite implementation of the basic recommended prevention strategies.

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 benefit

in preventing CLABSI in children under 2 months and the risks of CHG, recognizing that term and preterm infants may have different risks. Alternative agents, such as povidone-iodine or alcohol, can be used in this age group.

With the rise in drug resistant organisms such as methicillin-resistant *Staphylococcus aureus* (MRSA) and the inappropriate and over use of antibiotics, the question of bacterial resistance to CHG should be considered. To date there are no reports of a chlorhexidine-resistant strain of bacteria or fungus in the clinical setting despite its use in healthcare for almost 60 years. Chlorhexidine is highly potent, fast-acting and usually bactericidal in concentrations in which it is used in clinical settings.

CHG is not absorbed through intact adult skin. When used properly, adverse reactions to CHG are rarely reported. Because of its cationic nature, CHG binds strongly to skin, mucosa, and other tissues and is thus very poorly absorbed by any route -- skin or gastrointestinal tract. CHG essentially remains on the skin and is shed with the skin. Most effects noted with CHG use have been local, consisting primarily of mild skin irritation. Organ damage has been described from accidental exposures; these cases are extremely rare, but the following have been reported:

- Corneal injuries and permanent corneal scarring have occurred after inadvertent exposure of the eyes to 4% CHG;
- An esophageal burn occurred after ingestion of a large quantity of highly concentrated CHG;

- Ulcerative colitis was reported after an enema was given with 4% CHG; and
- Contact with the inner ear has caused deafness.

Generalized allergic reactions to CHG have been reported but are extremely rare. Contact dermatitis, urticaria, and anaphylaxis have occurred after repeated skin exposures to this agent. No data from western Europe, where CHG has been used for much longer than in the United States, have yet shown that allergic reactions are more common or are increasing.

Routine daily bathing of intensive care (ICU) patients with topical CHG reduces MRSA acquisition. A similar study was conducted to investigate whether repeated five-day cycles of daily topical octenidine dihydrochloride could result in a similar effect. This was a two-year retrospective, uncontrolled study in a mixed medical and surgical ICU/high dependency unit, demonstrating a 76% reduction in MRSA acquisition but no significant reduction in all ICU-acquired bacteremia. CHG use is increasing but resistance is being reported in MRSA strains. This study found a similar reduction in MRSA acquisition with octenidine dihydrochloride as an alternative to CHG. Further study is required to establish causality.

Recommendation

1. ***Chlorhexidine bathing has been shown to decrease CLABSI, either in addition to maximal barrier precautions or as a single intervention. (IIB)***

B. Antiseptic impregnated dressing

The objective of CHG-impregnated dressings is to continue to suppress bacterial re-growth and to protect the area at the point of catheter insertion, from where it is believed that microorganisms migrate along the catheter insertion tract, to infect the catheter tip.

Based on a large multicenter randomized trial and a meta-analysis, a chlorhexidine-impregnated dressing is now recommended by the Centers for Disease Control and Prevention (grade IB) to decrease CLABSIs when basic prevention measures are inadequate.

It is unclear whether there is additional benefit to using a chlorhexidine-impregnated dressing if daily chlorhexidine bathing is already established and vice versa.

Recommendation

1. ***If the CLABSI rate is not decreasing despite successful adherence to basic prevention measures (education and training, appropriate use of chlorhexidine for skin antisepsis, and maximum sterile barrier precautions), guidelines recommend using chlorhexidine-impregnated dressings for temporary short-term catheters in patients older than 2 months of age. (IB)***

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B. Antimicrobial and antiseptic impregnated catheters

Background

A variety of catheters impregnated with antimicrobial (minocycline-rifampin, miconazole-rifampin, teicoplanin or cefozalin), antiseptic (5-fluorouracil, benzalkonium, chlorhexidine, 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. There is increasing evidence of the benefit of certain antimicrobial or antiseptic impregnated catheters in preventing CLABSI in adult patients. A Cochrane review based on 56 studies by Lai NM *et al* is available for assessing the effect of these impregnated catheters on reducing CLABSI in adult patients. Use of minocycline-rifampin or chlorhexidine-silver sulfadiazine impregnated catheters reduces risk of CLABSI but does not significantly reduce the CLABSI rate, which is calculated by the number of CLABSI cases per 1,000 catheter days. Use of silver impregnated catheters reduces both risk of CLABSI and the CLABSI rate but use of silver-platinum-carbon impregnated catheters does not reduce the two parameters. However, two additional randomized controlled trials (RCTs) did not show the benefit of silver impregnated catheters in preventing CLABSI. Data of antimicrobial and antiseptic impregnated catheters for pediatric patients are limited. Minocycline-rifampin impregnated catheters significantly reduced the CABSI rate in

pediatric burn patients in a retrospective cohort study (n=141) but did not do so for pediatric ICU patients in an observational study (n=225). In a small-scale single-site RCT (n=86), use of a silver zeolite-impregnated umbilical catheter significantly reduced the risk of CLABSI in preterm infants. 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, the availability and approval status of antimicrobial or antiseptic impregnated catheters differ in countries in the Asia Pacific region.

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 / flush

Background

Catheter lock uses an antimicrobial, antiseptic or anticoagulant solution to fill a lumen followed by a period of dwell time until the catheter is accessed again, while in catheter flush, the 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. 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. As flushing antimicrobial or antiseptic solution into blood stream 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.

The major findings of studies on antimicrobial or antiseptic locks are summarized as the following:

1. The use of catheter locks or flushes for hemodialysis patients has been extensively studied. Meta-analyses and recent RCTs have all demonstrated

that use of catheter locks reduces risk of CLABSI in hemodialysis patients. However, which antimicrobial or antiseptic solution should be preferred as the lock and what are the most effective concentrations remain unsolved.

2. For oncology patients, antimicrobial locks or flushes have been associated with decreased CLABSI rates but the benefit is thought to be only marginal. However, two recent RCTs indicate the benefit of taurolidine locks in reducing CLABSI for pediatric patients with cancer.
3. Retrospective studies with a small sample size have demonstrated that use of ethanol or taurolidine locks reduces CLABSI in adult patients receiving parenteral nutrition at home. There is only weak evidence to support the use of ethanol locks to prevent CLABSI in children at risk of parenteral nutrition-associated liver disease due to the small sample size.
4. A recent RCT on patients undergoing major heart surgery (n=200) found that use of ethanol locks has the tendency to reduce CLABSI (2.1 vs 5.2 cases per 1,000 catheter days) but the difference is not statistically significant and the authors argue against routine use of ethanol locks for such patients.
5. For patients had history of recurrent CLABSI, small-scale retrospective studies on patients with hemodialysis or those receiving parenteral nutrition reported that reduction of CLABSI has been achieved by use of antimicrobial locks.

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 intravascular catheters

Background:

Sutureless securement device are used to close skin wounds as an alternative to sutures. Suturing disrupts the skin around the catheter site, leading to inflammation and increase of levels of colonization. Sutureless securement devices avoid disruption around the catheter entry site, decrease the degree of bacterial colonization, thus help prevent CLABSI. Using a sutureless securement device also mitigates the risk of sharps injury to the healthcare provider from inadvertent needlestick injury.

Sutureless securement device have been studied to decrease risk of infection for intravascular catheters, the risk for phlebitis, catheter migration and dislodgement, and to prevent CLABSIs in patients with PICCs, but it is not clear for centrally inserted central lines. In a randomized trial, premature loss of pediatric and adult PICCs due to accidental extrusion and PICC-associated thrombosis were significantly reduced. The incidence of catheter-related BSI was significantly reduced with the use of the novel securement device. The study reviewing 2237 articles investigated 6 methods reduce BSI related to PICC line insertion and in PICCs among nonimmunocompromised adults showed that proper securement with self-adhesive anchoring devices was found to be more effective than suturing for reducing blood stream infections. A prospective study of over 51,000 catheter days investigated the actual incidence of catheter-related complications in cancer patients showed that catheter securement

using sutureless devices reduced the risk of CLABSI and dislocation (P < .001). Crnich Christopher and Dennis G. Maki also showed the effectiveness of sutureness securement device in a meta-analyses of prospective, randomized clinical trials of novel technologies for prevention of CLABSIs.

The novel sutureless device for securing noncuffed vascular catheters available are used recently are StatLock; cyanoacrylate tissue adhesives (TA), SecurAcath. The safety of using these products are also proven. Cyanoacrylate tissue adhesives (TA) were showed to be quick and easy to apply to IVCs, with no irritation or skin damage noted on removal and no bacterial colony growth under either TA. An initial postmarket study of the SecurAcath used with peripherally inserted central catheters was conducted with 68 adult patients at 3 different institutions in the United States. Sixty-two (91.2%) of the patients completed therapy without a securement-related device malfunction or device-related adverse event associated with the securement system. A study in an Australian Intensive Care Unit done by Sundararajan between April 2011 and October 2012 compare the incidence of accidental vascular catheter removal two types of vascular catheters securement were secured either by sutures or by a suture-less securement device (STATLOCK(™), Bard Medical, Covington, GA, USA) in 322 patients (452 vascular catheters. The use of suture-less securement did not seem to increase the risk of accidental vascular catheter removal.

Recommendations

1. Use a sutureless securement device to reduce the risk of infection for

intravascular catheters. (II)

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G. Safety connectors and needleless system

Background

Needleless injection port technology, especially needleless connectors, was introduced in the 1990s to reduce the risk of needlestick injuries. Their designs include blunt cannula systems, split septum, luer activated devices (LAD) including positive pressure LADs. However, there have been an increase of BSI and occurrence of outbreaks when using these connectors. The first type of needleless system connectors consisted of a split septum connector, which is accessed with a blunt cannula instead of a needle. BSI outbreaks occurred when split septum connectors were firstly used which lack of education to healthcare workers was the main cause. Outbreaks stopped and no increase of BSI with the improving of education and practices on using the connectors. The disadvantage of split septum is that when the cannula is removed it may create negative pressure, which may cause blood to be aspirated into the distal lumen, possibly increasing the risk of catheter occlusion or thrombosis. Since 2004, a luer-activated device, which incorporates a valve preventing the outflow of fluid through the connector, was designed to eliminate this problem. However, with a change from split septum technology to various forms of LADs including positive pressure LADs, BSIs have temporally increased. Both negative and positive pressure needleless connectors have been implicated in increasing CLABSI rates, with subsequent decreases in CLABSI with a switch back to split septum needleless connectors.

Possibly common risk factors include the design that allows contamination to occur when not in use, the improper cleaning and frequency of changing the devices. A study modeled monthly pediatric stem cell transplant 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 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. An experimental model of microbial needle connectors contamination to test different scrub times (swipe, 5, 15, 30 seconds) of chlorhexidine-alcohol versus alcohol showed that Chlorhexidine provides long-lasting residual disinfectant activity and swipe with alcohol did not adequately disinfect needle connectors, particularly when contaminated with *Staphylococcus aureus* or *Pseudomonasaeruginosa*. The change from 70% alcohol to the use of 2% chlorhexidine in children treated with parenteral nutrition for >28 days showed a reduce risk of sepsis for central venous catheter connector antisepsis in catheters used for intravenous nutrition. Similarity, povidone-iodine and chlorhexidine gluconate plus isopropanol were more effective than isopropanol in vitro for reducing *Staphylococcus epidermidis* and *Klebsiella pneumoniae* contamination of needless connectors. The effectiveness of

povidone-iodine and chlorhexidine gluconate plus isopropanol was reduced on needless connectors pre-exposed to human serum and prolonged bacterial inoculation.

Silver-coated connector valves have been FDA approved. The total number of micro-organisms present was less in the silver-coated connectors as compared to non-coated devices. Likewise, an antiseptic-barrier cap for needleless connectors has been studied in a laboratory setting and appears to be effective in preventing the entry of microorganisms. The implementation of alcohol-impregnated port protectors and needleless neutral pressure connectors significantly reduced the rates of CLABSIs and CBCs in oncology patient population (2.5% vs 0.2%, relative risk, 0.09; 95% CI, 0.01-0.65; p = 0.002).

Although recommendations to reduce BSI related to needless connectors have published, several issues remain highly controversial and unresolved. Further investigation is needed to determine the risks of the CLABSI associated with the devices and the optimal design for preventing infections. It is recommended that connectors and needleless system should be used with monitors for any effect on CLABSI rates. The FDA required manufacturers of positive-displacement needleless connectors to conduct post market surveillance studies to help clarify the infection risk associated with the devices and to more precisely define their risks and benefits. Design-related features should be considered include the presence of internal or external device mechanisms or structures which may harbor bacteria, the ability of the

device to facilitate non-tortuous fluid pathways and promote or impede complete flushing. 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 2014 SHEA/IDSA guidelines recommended to use an antiseptic-containing hub/connector cap/port protector to cover connectors and the mechanical friction should be applied 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 (II)***
2. ***Scrubbing the access port of connectors with an appropriate antiseptic 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. (II)***
4. ***Change needleless components at least as frequently as the administration set and no more frequently than every 72 hours. (II)***
5. ***Change the needleless connectors no more frequently than every 72 hours, or according to the manufacturer's recommendations. (II)***

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III. 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 may be possible and should be considered. Several centers have found it useful to monitor adherence to evidence-based central line insertion practices (CLIP) as a method for identifying quality improvement opportunities and strategically targeting interventions for the reduction of CLABSI. Feedback of CLIP adherence data has also been a component of multifaceted interventions that have successfully reduced CLABSI rates.

The process surveillance in the NHSN system is called the CLIP surveillance, however, for the purpose of the consistency in this guide, the terms Central Line Insertion Bundle (CLIB) and Central Line Maintenance Bundle (CLMB) are used hereafter.

To conduct the CLABSI surveillance, consider the following:

1. Decide the patient population (usually by ward) you wish to survey.

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) each 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. 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 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 (III. B. i.).

To conduct the CLIB 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 (ward nurse, IV team, etc.), or the inserter himself/herself. If you wish to calculate inserter-specific CLIP rate, record the name of the inserter. If you wish to link the adherence and CLABSI, record the patient identification as well.

To conduct the CLMB 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, the patient is the target for CLMB surveillance. Record adherence of each components of the CLMB. The frequency depends on the components. Daily review of the line necessity and replacement need to be recorded daily. Hand hygiene and disinfection of hubs need to be recorded every time the line is accessed, however this data collection requires large amount of workload of the surveyer. Record hand hygiene and proper dressing change technique every time the dressing is changed. Record whether the administration set was changed according to the facility's policy.
3. The recorder is typically the infection prevention personnel. If you wish to link the adherence and CLABSI, record the patient identification as well.

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.

Although the number of patient days in the surveyed ward may serve as a surrogate, it 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.

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

CLIB adherence rates for specific insertion practices will be calculated by dividing the number of central line insertions during which 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 of 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

iv. Central line maintenance bundle adherence rate

CLMB adherence rates may be difficult to calculate, because some of the component occur once weekly (e.g. proper dressing change technique), while others occur daily (review of line necessity) and many times daily (disinfection of hubs). The adherence rate is calculated for each component, by dividing the number of occasions in which that specific component was followed by the total number of occasions in which that specific component was recommended, and by multiplying the result by 100.

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.

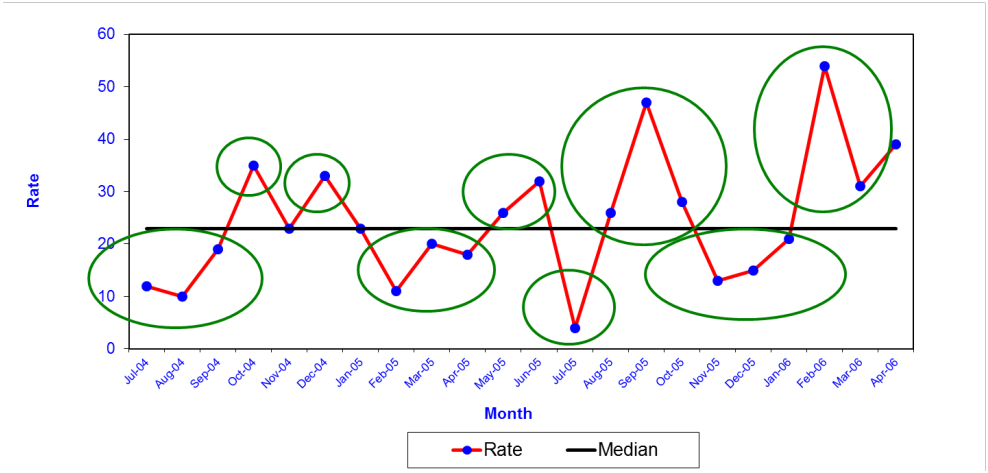

Figure 5 Run chart with 9 data runs

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

1. 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 indicate 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

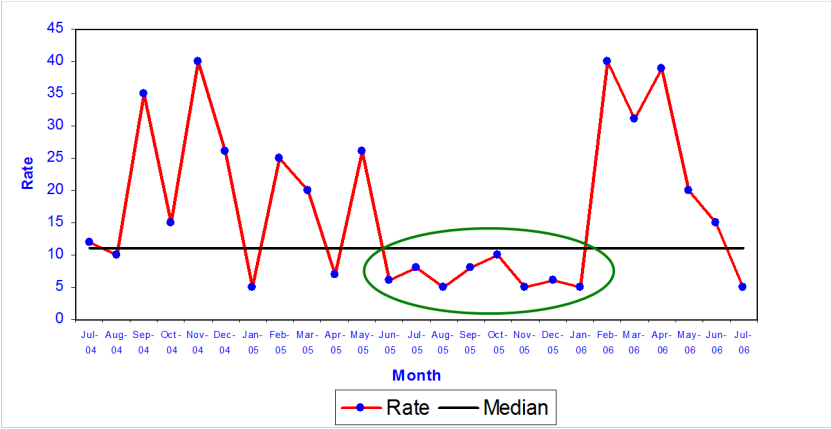

Figure 6 Run chart with a shift indicating a special cause variation (in this example, the data run has 8 data points)

2. 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).

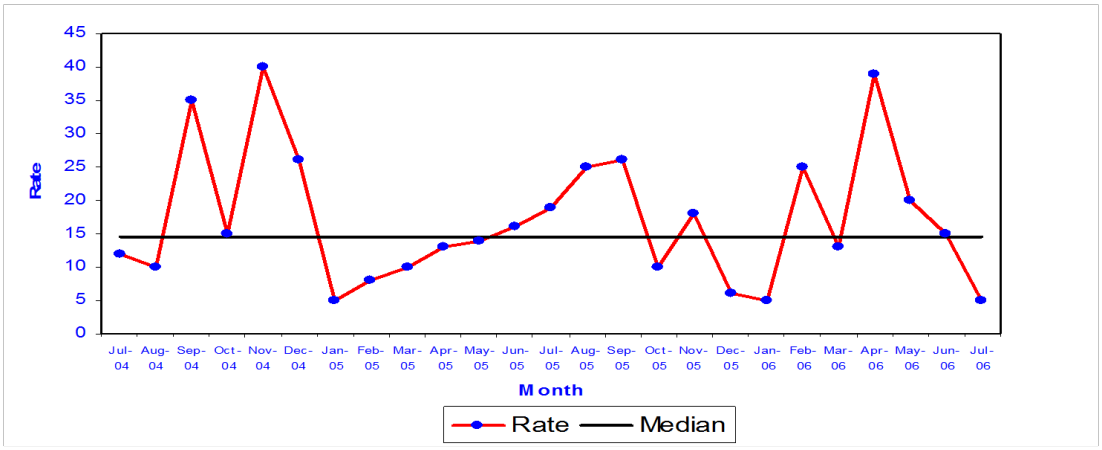

Figure 7 Run chart with a trend signifying a special cause variation

D. **How to report and feedback**

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

Calculate you 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 relate to new infections or less infections or the changes may also 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 Control Committee at least bi-monthly or more frequently if the rates 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

Appendix A Checklist for insertion (sample)

Hospital Name: Version date (YMD) : 2014/09/28

Patient # :

Ward : ☐ICU ☐RCC ☐General

Ward Name : _____

Administration date (YMD) : ___Y___M___D

Checklist of CVC insertion

Insertion date : _____Y_____M_____D

Insertion point : ☐ in patient's administration room ☐ Operation room ☐ Hemodialysis room

Catheter type : ☐1. CVC (other than dialysis)

☐2. Dialysis CVC

☐3. Swan-Ganz

☐4. PICC (peripherally inserted central catheter)

☐5. Port-A

☐6. Others_____(Please identify)

Insertion site : ☐1. Femoral vein (☐Left ☐Right)Reason to choose femoral site:【Select the reason as listed】

☐2. Jugular vein (☐Left ☐Right)

☐3. Veins of lower extremity (☐Left ☐Right)

☐4. Subclavian vien (☐Left ☐Right)

☐5. Veins of upper extremity (☐Left ☐Right)

☐1.There are catheters placed in neck site or subclavian site

☐2. There are wounds or infection in neck site or subclavian site

☐3.Fail to place in neck site or subclavian site, so changed to femoral site

☐4.Others (but comply with the hospital policy (_____)

☐5. None above

Insertion Reason : ☐1.First placement ☐2.Catheter malfunction, replace a new one

☐3.Catheter slip off, need to replace

☐4.The original insertion site was infected (or suspected), need to replace ☐5.Others_____

Annex: Table 1

Yes	Execute after notify	No	
☐	☐	☐	1. Proper hand-hygiene procedures before insertion
☐	☐	☐	2. Disinfect clean skin with an appropriate antiseptic
			2-1 Antiseptic : ☐2% CHG ☐Alc. based Povidone-Iodine ☐Others
☐	☐	☐	2-2 Wait the antiseptict dried up naturally
☐	☐	☐	3. Maximal sterile barrier (MSB)
			3-1 Doctor PPE : ☐mask ☐cap ☐sterile gown ☐sterile gloves (Multiple choices)
			3-2 Nurse PPE : ☐mask ☐cap ☐sterile gown ☐sterile gloves (Multiple choices)
			【Do the nurse help to drapping? Or assist the catheter insertion under the MSB? : ☐Yes ☐No 】
☐	☐	☐	3-3 Patient drape : ☐One hole drape from head to toe
			☐Combined one hole drape with other drapes, from head to toe
☐	☐	☐	4. Catheter-site sterile dressing regimens :
			4-1 Dressing type : ☐Gauze ☐ Sterile transparent IV adv. securement dressing
			☐Sterile transparent CHG IV securement dressing

Can't adhere due to : ☐Medical emergency case (When adherence to aseptic technique cannot be ensured, replace all catheters as soon as possible and after no longer than 48 hours)

☐Others : _____

【Insertion Team】Doctor : _____ Nurse : _____

※**Except there wre notified as multiple choices (such as PPE), others are simple choice.**

1

Appendix B Checklist for maintenance (sample)

CLABSI Maintenance Checklist														
Date:				Time			Location:							
Emergency Procedure		Yes		No			Name of operator:							
The Maintenance														
Days							1	2	3	4	5	6	7	
S/N	Elements													
1	The need for line use has been reviewed and recorded today.													
2	Hand hygiene before and after, is performed on all line maintenance/access procedures.													
3	Alcohol hub decontamination is performed before each hub access.													
4	The dressing is intact and was changed within the past 7 days.													
5	Chlorhexidine gluconate 2% is used for cleaning the insertion site of the Central line as: IJV, Subclavian or Femoral, during dressing changes.													
6	Administration sets not used for blood, products, or lipids at intervals not longer than 96 hours are replaced.													
Sign:														

Appendix C Surveillance data collection tool

SAMPLE: CENTRAL LINE INSERTION BUNDLE CHECKLIST

UR: **SURNAME:** **GIVEN NAME:** **DATE OF Birth:** **SEX: Male / Female**

DATE OF CENTRAL LINE INSERTION	
LOCATION OF CENTRAL LINE INSERTION – WARD, UNIT/DEPARTMENT	
PERSON RECORDING ON CHECKLIST	☐ **Observer** ☐ **Inserter**
OCCUPATION OF PERSON INSERTING THE CENTRAL LINE	☐ **Consultant** ☐ **Fellow/Registrar** ☐ **Resident** ☐ **Medical student** ☐ **IV team** ☐ **Other** _____

CENTRAL LINE INSERTION PRACTICE ELEMENTS	Yes	No
HAND HYGIENE: Did the inserter perform hand hygiene immediately prior to insertion (according to hospital protocol)?		
SKIN ANTISEPTIC: Did the inserter use appropriate skin antiseptic preparation (according to hospital protocol)?		
ALLOW THE SKIN PREPARATION TO DRY: Did the inserter allow the skin preparation agent to completely dry before the first skin puncture?		
MASK: Did the inserter wear a mask that covered their nose and mouth?		
STERILE GOWN: Did the inserter wear a long sleeved sterile gown?		
CAP: Did the inserter wear a cap that covered all their hair?		

STERILE GLOVES: Did the inserter use sterile gloves		
LARGE STERILE DRAPE: Did the inserter use a full body (full length) sterile drape?		

SAMPLE: CENTRAL LINE DEVICE DAYS (DENOMINATOR) MONTHLY WORKSHEET

YEAR_____ Month_____

DATE	NUMBER OF PATIENTS IN THE UNIT	NUMBER OF PATIENTS WITH 0NE OR MORE CENTRAL*
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

31		
TOTAL FOR THE MONTH		

Note: Patients with greater than or equal to two central lines get counted as one central line day
not multiple central line days*

UR:
SURNAME:
GIVEN NAME:
DATE OF Birth:
SEX: Male / Female

SAMPLE: ADULT - LABORATORY-CONFIRMED BLOODSTREAM INFECTIONS (LCBI) CHECKLIST

Date of Admission to Hospital: ___/___/___ Date of Discharge: ___/___/___

Date of Admission to ICU: ___/___/___ Date of Discharge ICU: ___/___/___

CLABSI Definition

CENTRAL LINE: Does the patient have a central line insitu or have they had a central line in situ in the last 48hours (Y or N) → ☐

To be considered a CLABSI one of the following definitions must be meet (i.e. DEFINITION 1 or DEFINITION 2):

DEFINTION 1 - LABORATORY CONFIRMED BLOODSTREAM INFECTION CRITERIA - (RECOGNISED PATHOGEN)

Isolation of one or more recognized bacterial or fungal pathogens from one or more blood cultures (e.g. *Staphylococcus aureus*, *Pseudomonas sp*, *E.coli*, *Klebsiella spp*, *Enterococcus* spp, and *Candida* spp). → ☐

and

Organism cultured from blood is not related to an infection at another site → ☐

DEFINTION 2 - LABORATORY CONFIRMED BLOODSTREAM INFECTION CRITERIA - (POTENTIAL CONTAMINANTS IN PATIENTS AGED > 1 YEAR)

The patient has **one** of the following signs and symptoms:

Fever (>38°C) → ☐

or

Chills or rigors → ☐

or

Hypotension → ☐

and

signs and symptoms and positive blood culture are not related to an infection at another site → ☐

and

The same common skin contaminant is **cultured from two or more blood cultures drawn on separate occasions** (i.e., diptheroids (*Corynebacterium spp), Bacillus spp (not B.antracis) , Propionibacterium spp,* coagulase-negative staphylococci (including *S.epidermidis),* viridans group streptococci, *Aerococcus spp, Micrococcus spp).* These separate occasions must be on same day or consecutive days → ☐

Notes

- **In definition 1**
  - The phrase **"one or more blood cultures"** means that at least **one** bottle from a draw is reported as positive by the laboratory
  - The term **"recognized pathogen" does** not include organisms considered common skin contaminants (see definition 2 for examples)

- **In definition 2**

  - The phrase **"two or more blood cultures drawn on separate occasions"** means:
    - that blood from at least two blood draws were collected within 48 hours of each other **and**
    - at least one bottle from each draw is reported as having grown the same skin contaminant

DEFINTION 3 - MUCOSAL BARRIER INJURY LABORATORY-CONFIRMED BLOODSTREAM INFECTION (MBI-LCBI)

Note: A more specific bloodstream infection definition for oncology patients with mucosal barrier injury (e.g., Graft-versus-host disease (GVHD), neutropenia) who are at high risk for translocation of intestinal organisms to

the bloodstream. These bloodstream infections are **not impacted by CLABSI prevention measures**

Indicated when the underlying conditions (see below) of MBI-LCBI are met.

Must meet one of the <u>following criteria (i.e. MBI-LCBI 1 or MBI-LCBI 2):</u>

<u>MBI-LCBI 1</u>	Patients of any age with at least 1 blood culture growing any of the following intestinal organisms with no other organisms isolated (recognized pathogen or common commensal): bacteroides spp., Candida spp, Clostridium spp, Enterococcus spp, Fusobacterium spp, Peptostreptococcus spp, Prevotella spp, Veillonella spp, or Enterobacteriaceae **and** **patient meets at least one of the following:** 1. is an allogeneic hematopoietic stem cell transplant recipient within the past year with one of the following documented during hospitalization as positive blood culture: a) Grade III or IV gastrointestinal graft versus host disease (GI GVHD) b) ≥ 1 litre diarrhea in a 24hr period (or ≥20 mL/kg in a 24hr period for patients <18 years of age) with onset on or within 7 calendar days before the date the positive culture was collected 2. Is neutropenic, defined as at least 2 separate days with values of absolute neutrophil count (ANC) or total white blood cell count (WBC) <500 cells/mm^3 on or within 3 calendar days before the date the positive blood culture was collected (Day 1)	☐ ☐ ☐ ☐
<u>MBI-LCBI 2</u>	Patients of any age meets **<u>MBI-LCBI 2</u>** when the blood cultures are growing only viridians group streptococci with no other organisms isolated	☐

	and **patient meets at least one of the following:** 1. is an allogeneic hematopoietic stem cell transplant recipient within the past year with one of the following documented during hospitalization as positive blood culture: a) Grade III or IV gastrointestinal graft versus host disease (GI GVHD) b) ≥ 1 litre diarrhea in a 24hr period (or ≥20 mL/kg in a 24hr period for patients <18 years of age) with onset on or within 7 calendar days before the date the positive culture was collected 2. Is neutropenic, defined as at least 2 separate days with values of absolute neutrophil count (ANC) or total white blood cell count (WBC) <500 cells/mm^3 on or within 3 calendar days before the date the positive blood culture was collected (Day 1)	☐ ☐

Appendix D Patient education on CLABSI and prevention

Central Line-associated Bloodstream Infections: Resources for Patients and Healthcare Providers

As with other healthcare-associated infections, central line-associated bloodstream infection (CLABSI) also increases the cost of health care and prolongs hospital lengths of stay by up to three weeks. Of patients who get a bloodstream infection from having a central line, up to 1 in 4 die, yet these infections are preventable.

What is a central line?

A central line (also known as a central venous catheter) is a catheter (tube) that a doctor usually places in a large vein of a patient's neck or chest to give important medical treatments. You may be familiar with intravenous catheters (also known as IVs) that are used frequently to give medicine or fluids into a vein near the skin's surface (usually on the arm or hand), for short periods of time. Central lines are different from IVs because central lines access a major vein that is close to the heart and can remain in place for weeks or months and be much more likely to cause serious infection. Central lines are commonly used in intensive care units and for cancer patients.

What is a central line-associated bloodstream infection?

A CLABSI is a serious infection that occurs when germs (usually bacteria or viruses) enter the bloodstream through the central line. Healthcare providers must follow a strict protocol when inserting the line to make sure the line remains sterile and a CLABSI does not occur. In addition to inserting the central line properly, healthcare providers must use stringent infection control practices each time they check the line or change the dressing. Patients who get a CLABSI have a fever, and might also have red skin and soreness around the central line. If this happens, healthcare providers can do tests to learn if there is an infection present.

What are some of the things that healthcare providers are doing to prevent CLABSI?

Healthcare providers can take the following steps to help prevent CLABSIs:

1. Follow recommended central line insertion practices to prevent infection when the central line is placed, namely:
   - Perform hand hygiene
   - Apply appropriate skin antiseptic
   - Ensure that the skin prep agent has completely dried before inserting the central line
   - Use all five maximal sterile barrier precautions:
     - Sterile gloves

- Sterile gown
- Cap
- Mask
- Large sterile drape

2. Once the central line is in place:
   - Follow recommended central line maintenance practices
   - Wash their hands with soap and water or an alcohol-based handrub before and after touching the line
3. Remove a central line as soon as it is no longer needed. The sooner a catheter is removed, the less likely the chance of infection.

What can patients do to help prevent CLABSI?

Here are some ways patients can protect themselves from CLABSI:

~~1. Research the hospital, if possible, to learn about its CLABSI rate.~~

2. Speak up about any concerns so that healthcare personnel are reminded to follow the best infection prevention practices.
3. Ask a healthcare provider if the central line is absolutely necessary. If so, ask them to help you understand the need for it and how long it will be in place.
4. Pay attention to the bandage and the area around it. If the bandage comes off or if the bandage or area around it is wet or dirty, tell a healthcare worker right away.
5. Don’t get the central line or the central line insertion site wet.

6. Tell a healthcare worker if the area around the catheter is sore or red or if the patient has a fever or chills.
7. Do not let any visitors touch the catheter or tubing.
8. The patient should avoid touching the tubing as much as possible.
9. In addition, everyone visiting the patient must wash their hands—before and after they visit.

Reference

1. http://www.cdc.gov/HAI/bsi/CLABSI-resources.html

Appendix E Definitions (NHSN, as of August 2014)

1. **Laboratory-confirmed bloodstream infection (LCBI 1)**

   Patient has a recognized pathogen cultured from one or more blood cultures

   and

   organism cultured from blood is not related to an infection at another site

2. **LCBI 2** (Criterion elements must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent elements)

   Patient has at least one of the following signs or symptoms: fever (>38 degrees Celsius), chills, or hypotension

   and

   positive laboratory results are not related to an infection at another site

   and

   the same common commensal (i.e., diphtheroids [*Corynebacterium* spp. not *C. diphtheriae*], *Bacillus* spp. [not *B. anthracis*], *Propionibacterium* spp., coagulase-negative staphylococci [including *S. epidermidis*], viridans group streptococci, *Aerococcus* spp., and *Micrococcus* spp.) is cultured from two or more blood cultures drawn on separate occasions

3. **LCBI 3** (Criterion elements must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent elements)

Patient ≤ 1 year of age has at least one of the following signs or symptoms: fever (>38 degrees Celsius, core), hypothermia (<36 degrees Celsius, core), apnea, or bradycardia

and

positive laboratory results are not related to an infection at another site

and

the same common commensal (i.e., diphtheroids [*Corynebacterium* spp. not *C. diphtheriae*], *Bacillus* spp. [not *B. anthracis*], *Propionibacterium* spp., coagulase-negative staphylococci [including *S. epidermidis*], viridans group streptococci, *Aerococcus* spp., *Micrococcus* spp.) is cultured from two or more blood cultures drawn on the same or consecutive days and separate occasions

Notes

1. Condition on central line insertion and continuation in order the LCBI to be line-associated central line (CL) or umbilical catheter (UC) was in place for >2 calendar days on the date of event, with day of device placement being Day 1,

   and

   CL or UC was in place on the date of event or the day before. If a CL or UC was in place for >2 calendar days and then removed, the LCBI criteria must be fully met on the day of discontinuation or the next day. If the patient is admitted or transferred into a facility with a central line in place (e.g., tunneled or implanted central line), and that is the patient's only central line, day of first access as an

inpatient is considered Day1. “Access” is defined as line placement, infusion or withdrawal through the line

2. In 2014, an additional criterion “MBI-LCBI” was introduced into the NHSN system. This stands for “mucosal barrier injury LCBI”, and refers to the condition uniquely observed in patients with hematopoietic stem cell transplant and severely immunosuppressed. It is suggested to discriminate MBI-LCBI from LCBI for comparison of incidence between hospitals [See I, ICHE 2013], however in NHSN surveillance there is no reference data published so far. Also note that MBI-LCBI is still a part of LCBI. Refer to NHSN manual for the detailed information including the definition of MBI-LCBI.

Appendix F Frequently Asked Questions (FAQs)

What is a central line -associated bloodstream infection (CLABSI)?

A central line is a narrow tube inserted by a doctor into a large vein of a patient's neck or chest to give fluids, medications or other treatments. When not put in correctly or kept clean, central lines can become an easy way for organisms to enter the body and cause serious infections in the bloodstream. These infections are called central line-associated bloodstream infections (CLABSI). These infections can result in significant illness and some patients will die from these infections. CLABSIs are mostly preventable when healthcare workers take infection control steps to minimise and prevent these infections during insertion and ongoing care of the devices.

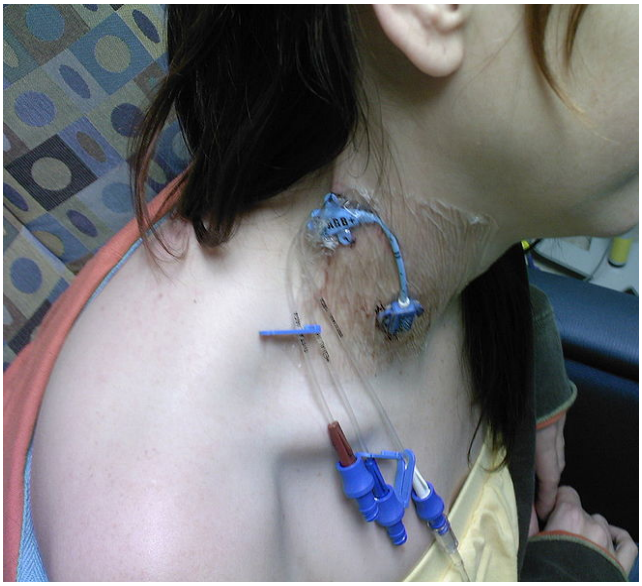

Figure 3

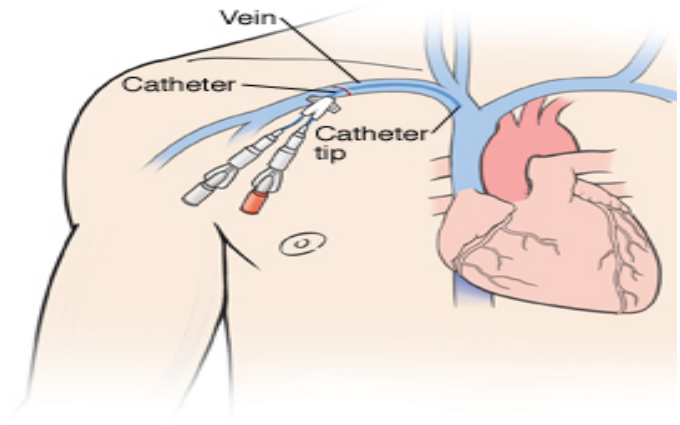

Figure 4

Why should hospitals do central line-associated bloodstream infection (CLABSI) surveillance?

Undertaking surveillance on the use of central lines and establishing infection rates allows hospital staff to identify CLABSI infections, implement CLABSI prevention and control measures and report on the success of prevention and control strategies telling a story about your hospital quality improvements.

What is a common surveillance method that infection control staff and team use?

A common surveillance method used by infection control staff around the world is the National Health Safety Network (NHSN) Patient Safety Component, Centers for Disease Control and Prevention (CDC). This surveillance system began many years ago with 300 hospitals, and now has over 12,000 medical facilities tracking hospital

associated infections.

Current participants include acute care hospitals, long-term acute care hospitals, psychiatric hospitals, rehabilitation hospitals, outpatient dialysis centres, ambulatory surgery centres, and nursing homes, with hospitals and dialysis facilities representing the majority of facilities reporting data.

Resources relating to the National Health Safety Network (NHSN) Patient Safety Component are readily available on the CDC/NHSN web page. http://www.cdc.gov/nhsn/

Where can you undertake central line-associated bloodstream infection (CLABSI) surveillance?

Central line-associated bloodstream infections (CLABSI) surveillance can be undertaken in areas where there is high of use of central lines. These areas include critical care or intensive care units (ICU), neonatal intensive care units (NICU), step down units and other speciality care units like haematology/oncology wards, bone marrow transplant units, and solid organ transplant units where denominator data can be collected.

Appendix G 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.