World Journal of Case Reports and Clinical Images

DOI: http://dx.doi.org/10.51521/WJCRCI.2022.1104

RESEARCH ARTICLE

Guide to Prevention of Central Line Associated Bloodstream Infections & Health Care-Associated Infections for Strategically Targeting Interventions

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Received Date: 24/02/2022
Revised Date: 16/03/2022
Accepted Date: 28/03/2022
Published Date 10/04/2022

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Citation:
Moi Lin Ling, Anucha Apisarnthanarak, Namita Jaggi, Glenys Harrington, Keita Morikane, Le Thi Anh Thu, Patricia Ching, Victoria Villanueva, Zhiyong Zong, Jae Sim Jeong & Chun-Ming Lee* (2022) Guide for Prevention of Central Line Associated Bloodstream Infections & Health Care-Associated Infections for Strategically Targeting Interventions. World J Case Rep Clin Img. 2022 Feb - Apr; 01(1):1-8.

Abstract

This document is an administrative summary of the APSIC Guide for Prevention of Central Line Associated Bloodstream Infections (CLABSI). It describes crucial substantiation- grounded care factors of the Central Line Insertion and Conservation Packets and its perpetration using the quality enhancement methodology, videlicet the Plan-Do-Study-Act (PDSA) methodology involving multidisciplinary process and stakeholders. Monitoring of enhancement over time with timely feedback to stakeholders is a crucial element to insure the success of enforcing stylish practices. A surveillance program is recommended to cover issues and adherence to substantiation- grounded central line insertion and conservation practices (compliance rate) and identify quality enhancement openings and strategically targeting interventions for the reduction of CLABSI.

Keywords: Central line associated bloodstream infections, CLABSI, Insertion bundle, Maintenance bundle, Quality improvement

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Introduction

Central Line-Associated Blood Stream Infections (CLABSI) are dangerous infections that increase mortality, prolong hospital stay, and increase treatment costs. Practices that prevent CLABSI include aseptic insertion techniques and maintenance of the central line (Figure 1).

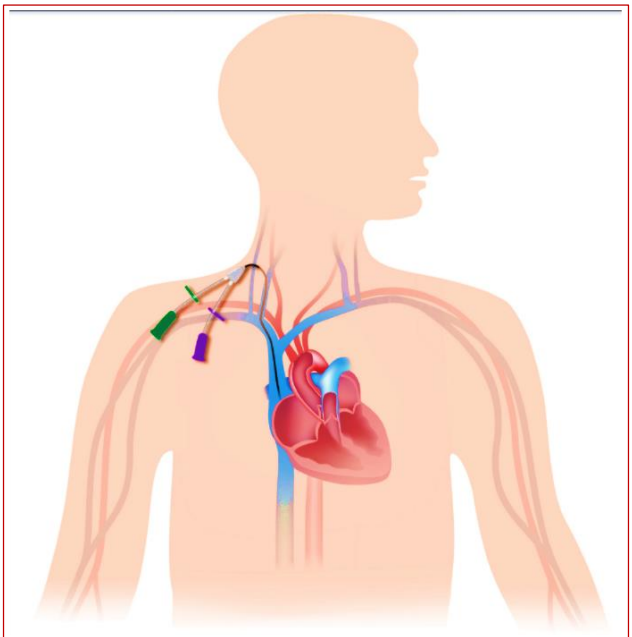

Figure 1: Central Line Associated Blood Stream Infections

Central lines are intravascular catheters similar to an intravenous line that terminate at or near the heart or the great vessels. These may be used for infusions, withdrawal of blood, or hemodynamic monitoring.

Great vessels include the following:

- Aorta
- Pulmonary artery
- Superior vena cava
- Inferior vena cava
- Brachiocephalic veins
- Internal jugular veins
- Subclavian veins
- External iliac veins
- Common iliac veins
- Femoral veins
- Umbilical artery/vein in neonates

Arterial catheters, arteriovenous fistulas and grafts, extracorporeal membrane, hemodialysis catheters, intra-aortic balloon devices, and ventricular assist devices are not central lines.

Central lines may be:

- **Permanent**: tunneled or implantable catheter
- **Temporary**: non-tunneled, non-implanted catheter
- **Umbilical**: used in neonates

Definition

CLABSI is a laboratory-confirmed, primary bloodstream infection in a patient with an eligible central line.

Laboratory-confirmed bloodstream infection is defined:

- When a recognized pathogen, which is not a common commensal, is isolated from one or more blood specimens and presence of the pathogen is not related to infections in any other site.
- When the isolate is commensal, it must be present in two or more blood specimens, and the patient must show signs of infection like fever, chills, or hypotension. The presence of the organism is not related to infections in any other site (Figure 2).

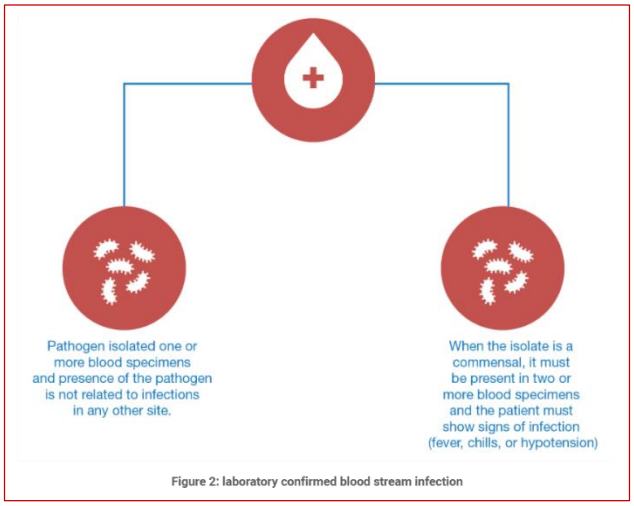

Figure 2: laboratory confirmed blood stream infection

Microbiology

The most commonly reported organisms associated with CLABSI include the following (Figure 3):

- Coagulase-negative staphylococci
- *Staphylococcus aureus*
- *Enterococcus* species
- *Klebsiella* spp.
- *E. coli*
- *Pseudomonas* spp.
- *Acinetobacter* spp.
- *Candida* species

Antimicrobial resistance is a common problem among most isolates. Methicillin-resistant *Staphylococcus aureus*, ESBL producing Enterobacteriaceae, ceftazidime and carbapenem-

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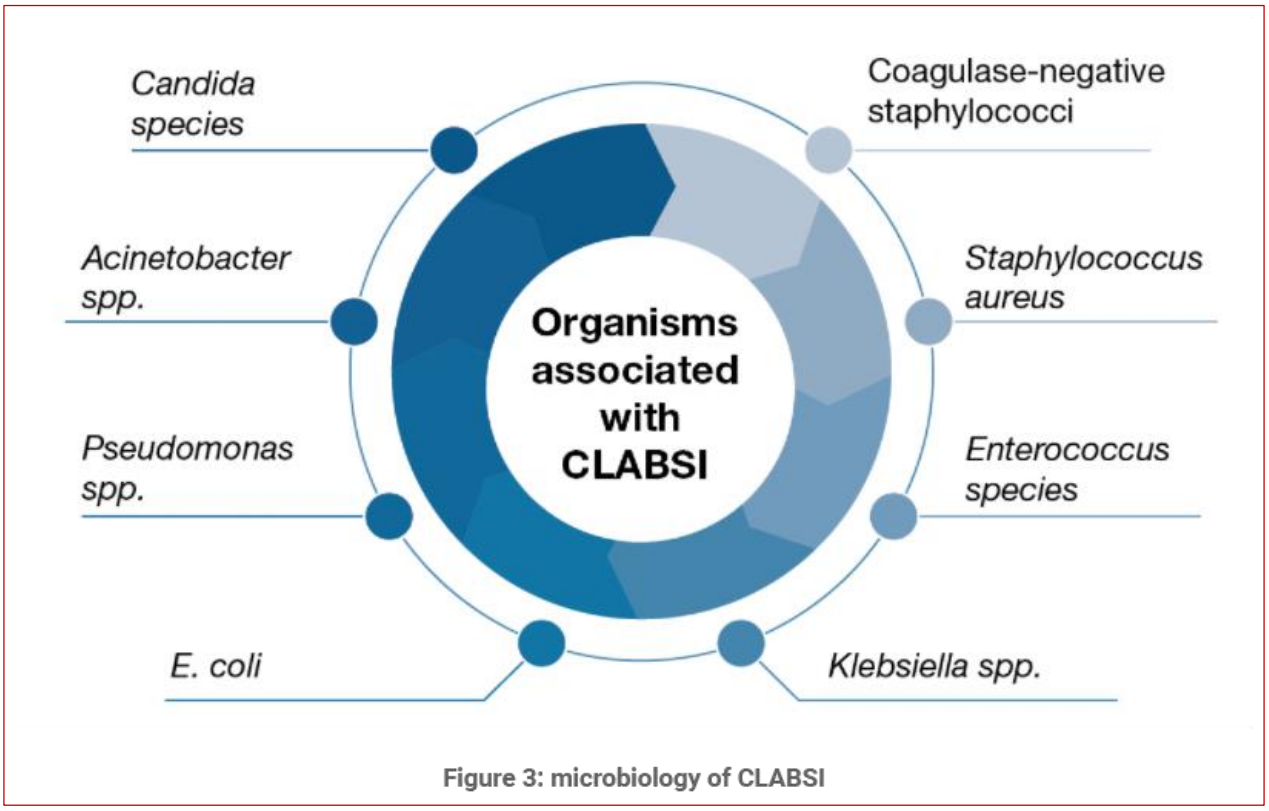

Figure 3: microbiology of CLABSI

resistant *pseudomonas* species, and fluconazole-resistant *Candida* spp. are also being commonly isolated.

Pathogenesis

A CLABSI may occur by any of the following mechanisms **(Figure 4)**.

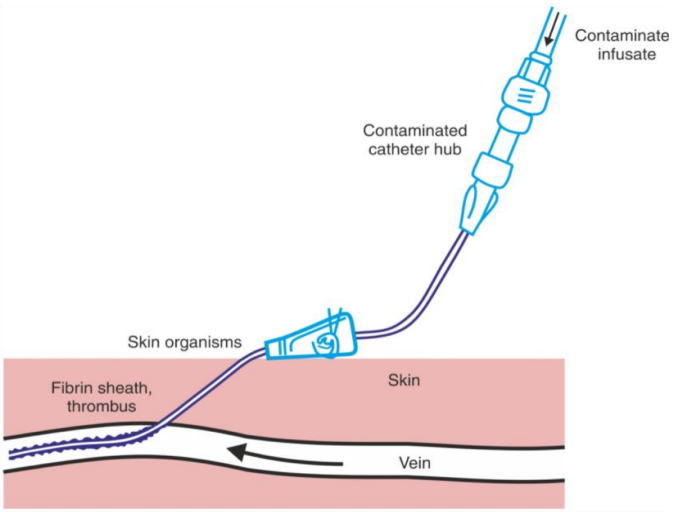

Figure 4: Pathogenesis of CLABSI

Commensal bacteria on the skin's surface may migrate along the catheter insertion tract and colonize the tip. This is the most common route of contamination. The catheter hub or the catheter may be contaminated by direct contact with hands. Organisms may be carried through the bloodstream from another site of infection and seed the catheter. Infusion of a contaminated fluid may lead to a bloodstream infection.

Virulence of the infecting organisms, host defense mechanisms, and the catheter material used determine the severity of the infection. These factors may increase the adherence of the infecting organism to the catheter and promote colonization. Non-tunneled central lines account for a higher number of infections than the tunneled variety.

Factors that increase the risk of CLABSI (Table 1).

Clinical manifestations of CLABSI may be generalized symptoms or signs of inflammation at the site of insertion.

Patients may present with fever and chills, altered mental status, hypotension, lethargy, or fatigue. Pain, swelling, redness, and discharge may be present at the exit site and along the subcutaneous tract.

Diagnosis

- Clinical symptoms of sepsis, like fever, chills, hypotension, apnea, hypothermia, or bradycardia, can be seen in patients with CLABSI.
- Blood cultures are the primary diagnostic modality for CLABSI.

CDC criteria for the diagnosis of CLABSI are as follows:

- In a patient who has an eligible central line:
- · One or more positive blood culture isolation of an organism not commonly present on the skin

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- Two or more positive blood cultures collected on separate occasions when the organism is a skin commensal (the patient has clinical signs of bloodstream infection)

The organisms isolated in both situations must not be related to any other site-specific infection.

Table 1: Factors that increase the risk of CLABSI

Host Factors	Device-related Factors	Procedure-related Factors
Chronic illnesses	Catheter type	Emergent Vs. Elective
Immunocompromised states	Catheter location (femoral > internal jugular > subclavian)	Use of full barrier protection Vs. limited
Malnutrition		Catheter site care
Total parenteral nutrition		The skill of the healthcare worker who inserts the catheter
Elderly		
Neonates		
Burns		

In exit site infections, signs of inflammation are confined to a 2 cm area around the catheter exit site with the presence of culture-positive exudate.

The inflammation extends beyond 2 cm from the exit site and along the subcutaneous track with culture-positive exudate at the exit site in tunnel infections (Figure 5).

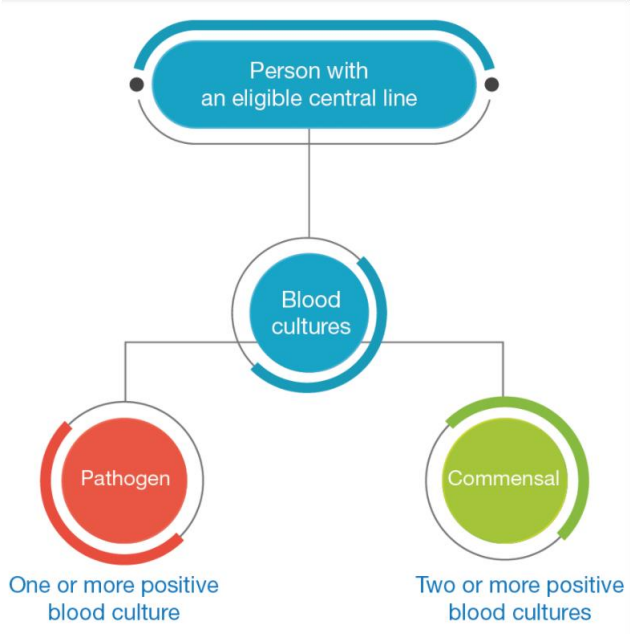

Figure 5: Diagnosis of CLABSI

Management

Empirical therapy must be started in all patients suspected of CLABSI while the blood culture results are awaited. Empirical therapy must not be delayed in these patients and must be most appropriately initiated immediately after drawing the samples for blood culture. Ideally, the hospital antibiogram must guide the choice of empirical therapy. An antibiotic regimen covering gram-positive and gram-negative organisms may be reasonable in most situations.

Suggested regimens may be:

Gram-positive coverage

- If the high prevalence of MRSA or if MRSA is suspected: Parenteral Vancomycin to cover gram positives
- If the low prevalence of MRSA or if MRSA is not suspected: Nafcillin or Cefazolin may be ideal

Gram-negative coverage (choice of antibiotics must be determined by the local susceptibility pattern)

- Beta-lactam/Beta-lactam inhibitor combination
- Cefepime
- Carbapenem ± aminoglycoside

If infection with *Pseudomonas* is suspected (prior colonization, neutropenia, or debilitation is present)

- Ceftazidime
- Carbapenems

If candidemia is suspected (malignancy, transplant recipients, total parenteral nutrition, prolonged broad-spectrum antibiotic coverage, femoral catheterization)

- Intravenous fluconazole
- Echinocandins if azole resistance is suspected (prior use of azoles or prevalence of *C.glabrata* or *C. krusei*)

Prevention

Central Line-associated Blood-stream Infection (CLABSI) is one of the most prevalent hospital-acquired infections seen, especially in intensive care units (ICUs). According to APIC, this HAI accounts for approximately ten to twenty-five thousand preventable deaths and eighty-four thousand to two thousand avoidable infections annually.

Earlier, many institutions set goals for eliminating CLABSI, called **'zero CLABSI'** or **'targeting zero'** programs. Nevertheless, these goals remained challenging to achieve and also to sustain. Hence, recent evidence suggests CLABSI elimination may happen most possibly in ICU patients. One can minimize the rate of CLABSI incidence by following CLABSI prevention bundle strategies in ICUs, hemodialysis patients, and others.

Pediatric patients are more prone to CLABSI due to intrinsic factors such as immature immune systems and birth weight. Frequent and invasive vascular access, either for blood sampling or infusion, patient positioning, and increased hospital stay, are other reasons that increase the risk for CLABSI.

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The risk for CLABSI is highest in patients with congenital heart diseases. Neutropenia, total parenteral nutrition, compromised mucosal integrity in patients with oncologic and hematologic diseases may lead to increased risk of CLABSI. The prevention and management of CLABSI in the Neonatal Intensive Care Unit are very challenging. This is because of the increased vulnerability of the patients and the necessity for invasive devices.

Bathing and oral care might minimize the risk of CLABSI. Skin disinfection can help in preventing CLABSI. However, the selection of disinfectant is crucial both for infection prevention and to preserve the integrity of the skin of pediatric patients.

Prior to insertion of a Central Line:

- All healthcare professionals involved in the insertion of a central line must be educated and trained, and periodically assessed in all procedures involved in the insertion and maintenance of a central line.
- Only trained personnel should be designated for the insertion and maintenance of a central line.
- An optimal nurse to patient ratio must be maintained in ICUs.

During insertion of a Central Line:

- The risks and benefits of insertion of a central line must be considered before insertion to reduce infections.
- A subclavian line must be preferred over a jugular or a femoral site in adult patients when a non-tunneled CVC is placed. A femoral vein must be avoided as much as possible. However, a subclavian line must be avoided in patients with renal disease. Instead, a fistula or graft must be preferred.
    - The appropriate central venous catheter, with the minimum number of ports or lumens, must be chosen.
    - Ultrasound-guided insertion done by experienced personnel can reduce the number of attempts and mechanical complications.
    - Before performing the procedure, scrub your hands with soap and water or an alcohol-based rub. Hand hygiene is the key! Hand hygiene must be performed before and after palpation of the insertion sites and before and after insertion, dressing, accessing, or any other form of manipulation of the central line.
    - Perform the procedure using the aseptic technique. Appropriate barrier precautions including a sterile mask, gown, gloves, cap, and a drape while inserting the central line.
    - Skin antisepsis has to be done with chlorhexidine gluconate and alcohol before inserting a central line.
    - Emergency catheterizations can have an increased risk of CLABSI. In case of emergency insertion where implementation of asepsis cannot be assured, the central line must be replaced within 48 hours.

Prevention during catheter maintenance:

- Remember, hand hygiene is the key. Scrub your hands before manipulating or removal of catheters.
- Strict aseptic conditions have to be maintained during maintenance and care of the central line.
- The site has to be covered with sterile gauze or semi-permeable dressings
- Semi-permeable dressings must be replaced every seven days, while gauze dressings must be replaced every two days. Also, if the dressing is soiled or dampened, replace it.
- Assess the need for the line daily and remove it promptly when not required.

CLABSI Prevention Bundle

- The strategies that form the cornerstone of the prevention of CLABSI constitute the CLABSI bundle. These include (Figure 6):
- Hand hygiene
- Use of barrier precautions during insertion
- Selection of appropriate site (In adult patients, avoid femoral vein)
- Antisepsis of skin with alcohol-based chlorhexidine
- Disinfection of the catheter hub for each access
- Review of the position of a central line periodically
- Removal of unnecessary central lines promptly

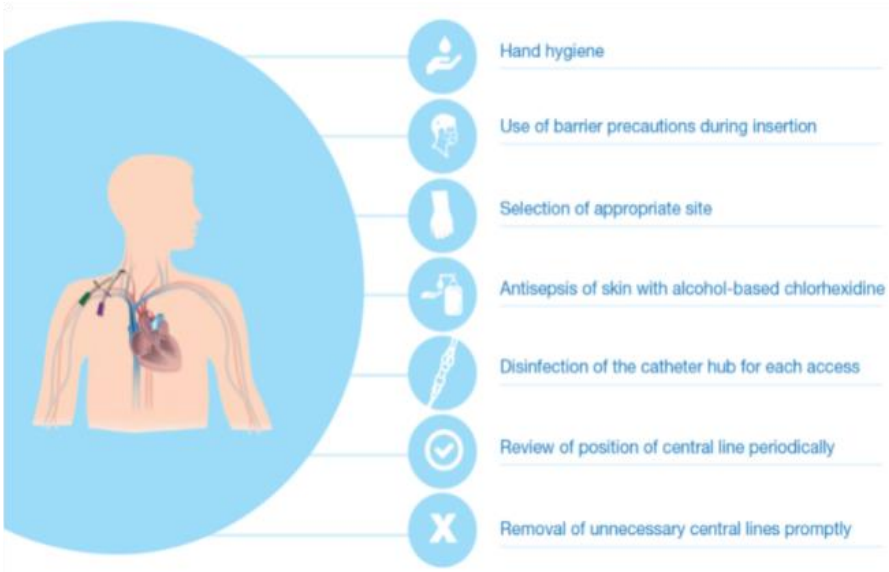

Figure 6: CLABI Prevention Bundle

World Journal of Case Reports and Clinical Images

DOI: http://dx.doi.org/10.51521/WJCRCI.2022.1104

Summary (Figure 7)

Figure 7: Summary of CLABSI

Competing Interests

AA was supported by the National Research University Project of the Thailand Office of Higher Education Commission. The authors declare that they have no competing interests.

Authors' Contributions

LML drafted the manuscript and AA did the initial editing before revised manuscript was seen by other authors for further comments. All authors read and approved the final manuscript.

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