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Risk factors and prevention measurements of central line-associated bloodstream infections

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Abstract

Central line-associated bloodstream infections (CLABSIs) are considered a significant cause of mortality in hospitalized patients; Also, it is associated with high healthcare costs. Microbial pathogens that may cause these infections are different – Staphylococcus spp, *Enterococcus* spp., *Escherichia coli, Klebsiella spp., Pseudomonas, Acinetobacter*, and others. In addition, a significant role plays yeast fungus, *Candida* spp. In this review, some of the risk factors, and prevention measurements are demonstrated.

Keywords: Central line-associated bloodstream infection; Central venous catheters; Bloodstream infections; Risk factors.

1. Introduction

Central line-associated bloodstream infection (CLABSI) is a type of hospital-acquired infection that causes a high mortality rate among patients [1,2] and carries an important financial burden for health services [3.4].

Central venous catheters (CVCs) are essential to medical practice and are commonly used in intensive care units (ICUs). These devices terminate in a large central vein, usually the superior vena cava, and are used to administer intravenous fluids, blood products, medications, and parenteral nutrition, as well as provide access to hemodialysis and hemodynamic monitoring [5,6]. Vascular access is an important risk of iatrogenic diseases in general but in particular CLABSIs. CLABSI incidence mainly depends on the device/central line, patient, and neutropenic days [7,8].

The possibility of bloodstream infections caused by colonized microorganisms from the external surface of the device or fluid pathways when the device is inserted or manipulated after insertion is associated with the use of intravenous catheter veins. These serious infections, CLABSIs, are associated with increased morbidity, mortality, and health care costs [6].

For this reason, intensive care practices are increasingly focused on developing reliable and safe vascular access procedures, which are often underestimated [9]. These infections are considered an important cause of death in hospitalized patients. CLABSIs are defined as laboratory-confirmed blood infections when a central line has been established within 48 hours prior to the development of these infections. Of all health-related infections, CLABSIs are the most costly [6].

The most common causative agents of these infections are coagulase-negative staphylococci (especially *Staphylococcus epidermidis*), *Staphylococcus aureus, Enterococcus* spp., *Escherichia coli, Klebsiella spp., Pseudomonas, Acinetobacter*, other intestinal Gram-negative bacteria, and the yeast fungi, *Candida* spp. Microorganisms mainly enter through the

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concentrator during routine use or catheter insertion. Intraluminal colonization is the most important source of infection after 10-14 days. CLABSIs occurring after this time are usually from infected hands of medical personnel and rarely from the host. The infection is often due to a violation of standard aseptic precautions when accessing the concentrator. Less common mechanisms include the spread of bacteria through blood from another source or from an infected infusion. Other host factors that increase the risk of CLABSIs are immunocompromised conditions (end-stage renal failure, diabetes mellitus, bone marrow transplant), chronic diseases (pulmonary hypertension, hemodialysis, malignancies, gastrointestinal diseases), malnutrition, neutropenia, total parenteral insertion. nutrition, age restrictions, loss of skin integrity, prolonged hospitalization prior to catheter insertion, insertion conditions, catheter site care, catheter type and location (highest femoral line, followed by the internal jugular, then subclavian), and catheter insertion device skills. Important consequences of CLABSIs include prolonged hospital stay, interruption of chemotherapy or other treatment, catheter removal, intravascular thrombosis, endocarditis, sepsis, and rarely death [6].

Healthcare-associated infections pose a serious but often preventable threat to patient safety. Despite significant progress in infection prevention, much remains to be done. HCAIs occur worldwide, affecting hundreds of millions of patients each year [9]. These infections are not only costly for individuals and health care systems; they can significantly increase morbidity and mortality in developed [10] and developing countries [11,12]. Severely ill patients are particularly vulnerable to serious complications due to healthcare-associated infection , which is likely due to factors - increasingly invasive medical technology and complex treatment procedures that increase immunodeficiency and older age, as well as the increasing incidence of antimicrobial resistance [13]. The encouraging news is that many HCAIs are preventable if evidence-based guidelines are incorporated into patient care [6].

CLABSI rates in resource-limited countries are higher than in developed countries and have a significant impact on mortality. Studies demonstrating successful interventions to reduce these infections are few [5].

CLABSI represents a primary bloodstream infection (i.e., no obvious infection elsewhere) that develops in a patient with central catheterization within 48 hours before the onset of a bloodstream infection unrelated to an infection elsewhere [6].

Hand hygiene and educational programs were associated with significant reductions in CLABSI scores [5]. According to CDC protocol, it is important for clinicians to follow proper insertion procedures, maintain hand hygiene before insertion, adhere to aseptic technique; use precautions for sterile barriers (mask, cap, lab coat, sterile gloves, and sterile whole body draping); choose the best insertion site to minimize infections and noninfectious complications based on the individual patient avoid the femoral site in obese adult patients; prepare the insertion site with 0.5% chlorhexidine alcohol, apply a sterile dressing to the injection site, and properly manage and maintain central lines; immediately replace wet, soiled, or dislodged dressings; change gauze dressings at least once every two days or semi-permeable dressings at least once every seven days; change injection sets for continuous infusions. If blood or blood products or fat emulsions are administered, tubes should be changed every 24 hours; unnecessary central lines should be removed in a timely manner; and daily checks should be made to assess whether each central line is still needed.There are specific rules for health care organizations: train and periodically evaluate medical staff knowledge of the indications for central line catheters, proper insertion and maintenance procedures, and appropriate infection prevention measures; re-train staff at regular intervals on central line insertion, handling, and maintenance, and whenever relevant policies, procedures, supplies or equipment change [14].

Increased microbial colonization at the injection site has been documented, which is closely related to the site chosen for injection. Cutaneous flora density is higher in the neck where internal jugular IVCs are inserted than in the upper chest where subclavian IVCs are inserted. [6]. Generally, Gram-positive cutaneous bacteria often include the most commonly reported microbial pathogens of bloodstream infections [16,17].

If catheters have lesions, they can increase the adhesion of certain microorganisms (e.g., Staphylococcus epidermidis and Candida albicans). Other catheters and their construction materials promote fibrin tissue formation, so silicone catheters have a higher risk of infection associated with their use than polyurethane catheters. Some catheters are more predisposed to colonization and infection due to thrombogenic features [15,23].

Study results revealed that coagulase-negative staphylococci and *Staphylococcus aureus* account for 31% and 20%, respectively, of all healthcare-associated bloodstream infections. Various strains of *Enterococcus* and *Candida* rank third and fourth at 9% each [18]. Non-device-related bloodstream infections are acquired in the birth canal and are often multisystemic with high mortality. Risk factors associated with early-onset sepsis are prolonged fetal membrane shedding, prematurity and low birth weight, maternal fever, and chorioamnionitis. The most common pathogens are

group B streptococci, followed by *E. coli* and Staphylococcus species; gram-negative bacteria other than *E. coli* are less common. Late-onset bloodstream infections are usually associated with CVCs. Risk factors were low birth weight and parenteral nutrition therapy. Infections were mostly caused by coagulase-negative staphylococci, *C. albicans* and *E. coli*. Invasive fungal infections are also of increasing concern in very low birth weight infants and are associated with higher mortality than invasive bacterial infections [19]. A quarter of infections were caused by Gram-negative bacteria, the most common were *E. coli* (6%) and *Klebsiell*a. Gram-negative microorganisms were a more frequent cause of CLABSI in some countries. Antimicrobial resistance is an important problem for all common pathogens causing CLABSI, especially in ICUs: Methicillin-resistant S. aureus accounts for more than 50% of all S. aureus isolates isolated in these facilities [6, 18]. In addition, endogenous risk factors for these infections are some hematologic and immunologic deficits, cancer, and cardiovascular and gastrointestinal diseases [20,21].

2. Conclusion

In conclusion, more epidemiological studies are required to estimate the effects of CLABSI and to develop approaches to prevention due to specific measures.

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