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Mini Review



# Catheter-Related Bloodstream Infection (CRBSI) in Intensive Care Unit

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## Abstract

**Introduction:** Infections associated with the presence of intravascular devices are probably the least frequently diagnosed hospital acquired infections. The most studied intravascular catheter, which is associated with a higher risk of infection, is the central venous catheter (CVC). It is the leading cause of morbidity and mortality and the main source of bacteremia and sepsis in hospitalized patients.

**Aim:** The purpose of this work is to review the existing literature and to study the international protocols for the care of intravascular catheters used in ICUs and to review the nursing process for the management of CVCs.

**Methodology:** The pathophysiology of infections associated with the use of intravascular catheters was reviewed as well as the international and local epidemiological data about the impact of these infections. International guidelines for the prevention of these infections were also reviewed. For the study, the protocols recommended by international task forces and organizations on which many countries rely for the reform of their local protocols, were selected.

**Results:** There are detailed protocols on how to treat CVCs and the use of the right equipment, about the hygiene rules for healthcare personnel and the adequate control of all those factors that may increase the risk of spreading the infection.

**Conclusions:** It is important to provide adequate training to healthcare professionals, to maintain the right ratio of nurse to patient in all departments and especially in ICUs. Particular emphasis is given on maintaining good hand hygiene practice and implementing quality control programs to maintain high rates of compliance with these rules in healthcare facilities.

**Keywords:** Infections; Intravascular devices; ICU; Biofilm; Guidelines

## Introduction

One of the most important features of modern medical care is the recovery of access to the intravascular space, with the ultimate goal of administering fluids, drugs and hemodynamic monitoring of patients. Venous catheterization in the Intensive Care Unit (ICU), even if it is considered a daily practice, does not cease to be a necessary step to achieve treatment, as through access to the intravascular space, both therapeutic and diagnostic interventions are performed on patients [1-2]. The device that carries the greatest risk of intravascular infection is the central venous catheter (CVC) in all its available forms. Infections related to the placement of CVC are among the dangerous complications that can occur, as they worsen the outcome of the primary disease of the already stressed patient, prolong the time of his stay in the hospital and consequently increase the cost of the patient's hospitalization [3-4].

## Factors affecting the occurrence of complications

The occurrence of nosocomial infections is favored by various factors related either to the hospital environment and the medical operations performed in it, or to the patients and their underlying diseases (vulnerability to infections in patients with immunodeficiencies). However, the most important risk factor remains the non-compliance of hygiene rules by medical and nursing personnel [5]. Other contributing factors are the widespread use of medical machines or devices to diagnose or treat patients, the increase in intensive care beds, the complexity of various surgical procedures, long hospital stays, as well as the increase in the number of patients receiving immunosuppressive treatment (chemotherapy of neoplasms, administration of corticosteroids [6].

## Risk factors

The sources of pathogens that cause infections are a) intravenous catheters, b) intra-arterial catheters, and c) contaminated intravenous solutions or contaminated parenteral nutrition solutions. During the first 8 days of placement of an intravenous catheter the main route of infection is extraluminal from the skin microorganisms, while after this time period the infection is mainly intraluminal due to prolonged use of the catheter. Infection due to the use of contaminated solutions is rarer [7-8]. Factors associated with the risk of catheter infection include the type of catheter (peripheral, central venous, totally implanted), the location of the catheter (subclavian, jugular, femoral), the degree of immunosuppression of the patient (acquired or congenital), the severity of underlying disease or comorbidities, duration of catheterization, use of the catheter (administration of parenteral nutrition, fluids, animal monitoring), hygiene conditions, and skin colonization [9].

Administration of parenteral nutrition through intravascular catheters increases the risk of CRBSI [7]. Local risk factors such as poor personal hygiene, transparent adhesive, moisture around the catheter exit site, nasal colonization by S. aureus, and concomitant infections support a role for bacterial colonization in the pathogenesis of CRBSI. Also, other risk factors for dialysis catheter-related infection include dilution product or equipment contamination, inadequate water treatment, solvent reuse, older patient age, higher total intravenous iron dose, increased dose of recombinant human erythropoietin, low serum hemoglobin and albumin levels, diabetes mellitus, atherosclerosis, and recent hospitalization or surgery [10].

The most important risk factors for the occurrence of nosocomial infection in a patient are related to the age of the patient (usually elderly patients have more chances of developing an infection, due to a weak immune system), the severity of their pathological condition (e.g. patients with bone marrow suppression show greater risk of infections), his coexisting diseases, his prolonged hospitalization (statistically increases the chances of complications and infections), the increased administration of antibiotics to his patients that make his microorganisms resistant to antibiotics, especially broad-spectrum ones, repeated hospitalizations of the patient, in the frequency of catheterizations and in the general increase in surgical interventions [11].

## Microorganisms of CRBSI

Microorganisms associated with CRBSIs are usually those present in the normal flora of the skin and in particular at its insertion site, which can lead to colonization of the inserted catheter. Colonization of the intravenous catheter tip is frequently observed in ICU patients and may be the source of life-threatening bacteremia and sepsis resulting in multiple organ failure (MODS) [12].

## Bacterial and Fungal infections

From a prospective study on the type of bacteria leading to CRBSI, 64% of pathogens were Gram-positive and 36% were Gram-negative. The most common pathogen was S. aureus 40%, Pseudomonas aeruginosa 16%, methicillin-negative staphylococci 8%, E. coli 8%, Klebsiella pneumoniae 8% and Acinetobacter baumanii 4% [13]. However, in another study, infections with Gram-negative bacilli appeared to predominate (56%) and Gram-positive cocci constituted 27% of infections [14]. The proportion of Gram-negative and Gram-positive CRBSIs appears to vary in different studies. This confirms that each health structure presents variations in the types of microbes it is colonized with, and this should be taken into account in empiric treatment. Equally important are the studies highlighting polymicrobial CRBSIs [15]. Various studies highlight different rates of fungal CRBSI infections. Isolation from CVC Candidasp is reported. in percentages of 11.7% - 16% [13], while there are also studies in which non-albicans Candida spp were isolated [16].

## Diagnosis of CRBSI

The clinical diagnosis of CRBSI in a catheter-bearing patient presents with fever or chills, unexplained hypotension, and possibly without any other signs of focal infection [17]. Catheter exit site infection is depicted by the presence of erythema, swelling, tenderness, and purulent discharge around the catheter exit. Severe sepsis and systemic complications, such as infective endocarditis, septic arthritis, osteomyelitis, and septic emboli, can prolong the course of CRBSI and should be considered in patients who do not respond adequately to treatment [18]. Infective endocarditis should be suspected in patients with a first-onset murmur, repeated positive blood cultures, and if modified Duke criteria are met. A clinical diagnosis can be made after excluding other foci of infection [17]. The diagnosis of CRBSI requires a positive blood culture from a peripheral vein and clear evidence that the catheter is the source of the infection. We have CRBSI when a patient with an endovascular catheter has at least one positive blood culture obtained from a peripheral vein, when there are clinical signs of infection (i.e., fever, chills, or hypotension) and no obvious site of blood infection other than the catheter [19].

## Nurse-to-patient ratio affects the risk of colonization

After studies that have been carried out it was observed that nurses working with a lower nurse-patient ratio had higher compliance scores. From prospective studies, it appears that reducing the nurse-patient ratio would help nurses more carefully follow endovascular catheter care protocols and could improve infection control in hospitalized patients [20]. Intensive care unit nurses face a heavy workload and emotional stress and are required

to make serious and quick decisions about patients' lives. The heavy workload required of ICU patients is a significant source of stress that can influence their decisions and affect the quality of care. Studies describe that increasing the number of patients assigned to a nurse can increase the risk of complications. Attention to the correct patient-to-nurse ratio so that the workload is properly distributed is of utmost importance to ensure that all safety protocols are implemented and to reduce the spread of nosocomial infections. Furthermore, the reduction of the nurse-patient ratio is associated with an increase in the survival rate of patients, a lower risk of complications and, by extension, a reduction in the cost of hospitalization [20-21].

### Education, training, and staffing

Education of health care personnel regarding the indications for the use of endovascular catheters, correct procedures for inserting and maintaining endovascular catheters, and appropriate infection control measures to prevent catheter-related infections is paramount. The implementation of quality control programs is necessary to periodically assess the knowledge of healthcare professionals regarding the prevention of intravascular catheter-related infections and adherence to antisepsis guidelines [20,22].

## Conclusions

It has been shown that nursing and medical practices can pick up transient microorganisms from intact patient skin and from environmental surfaces. Although the amount of contamination is not quantified and the exact impact is not apparent, it is happening. Hand hygiene and aseptic practices before caring for a patient can reduce transient carriage and carriage of microorganisms. The protective benefits of evidence-based infection control are cost-effective and numerous: they not only contribute to better individual patient care outcomes but also protect healthcare workers by maintaining the highest standards in nursing, which they contribute positively to our goal of the best possible health of patients and public health.

## Acknowledgment

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## Conflict of Interest

No conflict of interest.

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