35. PREVENTION OF CATHETER-RELATED INFECTIONS

Hend A. Hanna and Issam I. Raad

During the pre-intravascular catheter era, administration of drugs for critically ill patients used to take place through a small peripheral venous line. This practice was often complicated by extravasation of vesicants and toxic agents which eventually led to thrombosis of peripheral veins; and with the necrosis and scarring of the veins, they were rendered useless for further intravenous therapy. Since the introduction of the Broviac catheter in the early 1970s [1], followed by various forms of tunneled silicone catheters, physicians and patients alike have become dependent on the use of central venous catheters (CVCs) especially for the management of critically ill and cancer patients. CVCs are used frequently for the administration of blood products, fluids, parenteral nutrition, antibiotics, chemotherapeutic drugs, as well as for monitoring the hemodynamic status of critically ill patients.

However, the enthusiasm and benefits associated with these useful and essential tools are often clouded by the morbidity and mortality attributed to catheter-related infections, particularly catheter-related bloodstream infections.

Rates of Catheter-Related Bloodstream Infections (CRBSI)

It is estimated that more than five million CVCs are inserted annually in the United States [2]. About half a million of these are cuffed silastic catheters [3]. It is difficult to evaluate with accuracy the rate of CRBSI [3]. It ranges from 4% to 14% for noncuffed CVCs [4–7], yet reporting catheter infections in percentages of infected catheters ignores the duration of catheterization. Therefore, it is preferable to report CRBSI in terms of numbers of CRBSI per 1000 days of catheter use. Decker and Edwards reviewed 21 studies, including pediatric patients [8]. These studies collectively report 260,578 catheter days with 455 septic episodes, representing an overall rate of 1.7 CRBSI per 1000 days of catheter use. Clarke and Raffin combined data from multiple studies and calculated a rate of 1.37 infections per 1000 days of long-term CVC use [9].

Peripheral intravenous catheters are associated with higher infection rates than long-term CVCs. In one study, a rate of 27.7 infections for peripheral intravenous catheters per 1000 catheter days was observed [10]. Also, the use of short-term CVCs was associated with 3.35 infections per 1000 catheter days as reported in a review of three studies [11–13].

Given the above figures, at least 400,000 episodes of CRBSI are expected to occur annually [14]. Therefore, it becomes obvious that CRBSI cause morbidity and mortality which can clearly prolong hospitalization, leading to an added financial burden. A study published in 1994 estimated the cost of treating a single episode of CRBSI in critically ill patients to be $28,690 (1994 dollars) with an additional 6.5 days in the intensive care unit (ICU) [15].

In spite of the magnitude of the problem, CRBSI are preventable in most cases. It is essential to comprehend the possible risk factors that
TABLE 1. Risk factors for catheter-related bloodstream infection

- Prolonged catheterization
- Catheter dressings
- Catheter material
- Number of catheter lumens
- Location of catheter
- Improper aseptic techniques

TABLE 2. Preventive measures proven to decrease CRBSI

Aseptic measures
- Expert infusion therapy team
- Use of maximal sterile barrier precautions
- Use of topical disinfectants

New technologies
- Flush solutions: anticoagulant/antimicrobial
- Silver impregnated cuffs
- Aseptic hub mode
- Coated catheters: antiseptics and antimicrobials

attribute to the occurrence of CRBSI. Also, a thorough and comprehensive understanding of the different preventive techniques is essential to its application and, hence, to harvesting the coveted lower catheter-related infection rates. We will discuss the risk factors (Table 1) and preventive measures (Table 2) that have been shown to protect against CRBSI.

Risk Factors Associated with CRBSI

Prolonged catheterization has been shown to be a risk factor for infection. Catheters remaining in place for longer than 72 hours were shown to be at a significantly higher risk for infection [16, 17].

It has been suggested that catheter material may play a role in the process of thrombogenesis and adherence of organisms to the catheter surface and, hence, has a role in the pathogenesis of CRBSI. In a study by Linder et al., polyvinylchloride catheters were shown to be more thrombogenic than soft silicone and polyurethane catheters [18]. Staphylococci and fungi were shown to adhere better to polyvinylchloride surfaces than to Teflon surfaces [19, 20]. Several studies have also examined the issue of comparing different CVC dressings and the role they play in CRBSI. Conly et al. compared transparent and dry gauze dressings in a prospective randomized trial. The authors showed that transparent dressings were associated with significantly increased rates of insertion site colonization (P = 0.009), local catheter-related infection (P = 0.002) and systemic catheter-related bacteremia (P = 0.015) than dry gauze dressings [21]. These findings were supported by a study that presented the outcome of meta-analysis of many randomized controlled trials comparing transparent polyurethane film and gauze dressings for hospitalized patients with central and peripheral venous catheters [22]. It was shown that the risk for catheter-related infections was increased with the use of occlusive transparent polyurethane film compared with gauze dressings. This could be due to the fact that occlusive transparent polyurethane films encourage a warm, moist environment at the catheter insertion site which is optimal for increasing the microbial burden and, hence, the increased risk of catheter colonization and septicemia. This finding may not be valid for the nonocclusive transparent dressings.

Some controversial issues that have been suggested to have a role in the risk of CRBSI include the number of catheter lumens and the site of catheter insertion. Retrospective studies have found that triple lumen CVCs were associated with higher risk of CRBSI than were single lumen CVCs [23–26]. On the other hand, some prospective randomized trials did not find significant differences in the infection rates between them [27–29]. While CVCs placed in internal jugular vein were found in one study more likely to become infected than those placed in subclavian veins [30], other researchers have presented contradictory data [31]. Frequent