Catheter-Related Bloodstream Infections
—Risk Factors, Monitoring, and Intervention in the Home Care Setting

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PHARMACIST AND PHARMACY TECHNICIAN
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Dietitian Learning Codes:
5440 Enteral and parenteral nutrition support
5380 Wound care
5030 Home care

This continuing education article is intended for pharmacists, pharmacy technicians, nurses, dietitians, and other alternate-site infusion professionals.

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EDUCATIONAL LEARNING OBJECTIVES:
1. Describe the human and financial costs associated with catheter-related bloodstream infections (CRBSIs) in the hospital and home settings.
2. List the key risk factors that can contribute to the development of CRBSIs.
3. Discuss strategies for reducing CRBSIs in the home care setting.
A patent, complication-free intravenous catheter is critical to the successful administration of home infusion therapy. Poor management of vascular access devices (VADs) leads to complications that add to the cost of care through catheter replacement, increased morbidity and mortality, and extended hospital stays or rehospitalizations. This article will review strategies for the prevention of a key VAD complication: catheter-related bloodstream infection (CRBSI) in the home care setting.

CRBSI is the most prevalent VAD complication in both the home and hospital settings. Home infusion CRBSI rates have been reported to range between 0.24 and 0.99 per 1,000 catheter days and hospital CRBSI rates to range from 0.5 to 2.7 per 1,000 catheter days. The Centers for Disease Control and Prevention (CDC) recently published data reporting a catheter-related infection rate of 0.59/1,000 catheter days in the hospital setting. This represents a 41% reduction in CRBSIs since 2008, which surpassed the 32% reduction reported in 2010. While efforts to eliminate CRBSIs are clearly having a positive impact, much room for improvement remains. CRBSIs are a high-profile complication with significant impact on costs and morbidity and mortality. According to the CDC, each year CRBSIs contribute to approximately $45 billion in hospital costs and 100,000 deaths.

Various factors impact the CRBSI incidence in both the hospital and home setting. Patient acuity is typically higher in a hospital setting, and catheter access more frequent, both factors are thought to play a prominent role in the incidence of CRBSI. The hospital setting provides exposure to many more infectious agents than the average home—and many more caregivers who can possibly transfer pathogens to patients from contaminated surfaces or other colonized or infected patients. Additionally, higher patient acuity in the hospital setting often necessitates multi-lumen catheter placement, a significant risk factor in the development of CRBSI.

Tokars et al., identified five prominent risk factors as playing a role in the possible development of a CRBSI (see Exhibit 1). Patients without any of these risk factors had an expected CRBSI rate of 0.16 per 1,000 catheter days. Those patients with three or more of these risk factors had an expected CRBSI rate of 6.77 per 1,000 catheter days.2

Surprisingly, length of catheter dwell time appears not to be a significant risk factor for CRBSI development.2 Catheter dwell time is typically longer in the home infusion setting where patients may maintain a single catheter for years, often successfully avoiding complications including infection.

Highlighting the increased risk associated with parenteral nutrition (PN) infusion, a literature review specific to home PN infusion reported a median of 1.31 CRBSIs per 1,000 catheter days (range 0.38-4.58).7 This systematic review of 39 studies demonstrated signifi-
significant variability in terminology, definitions, and description of risk factors, making direct study comparisons a challenge. The authors, however, did find that the majority of catheter infections were caused by human skin flora; thus hand hygiene and clinician/caregiver training remain critical to reducing CRBSI.

**Etiology of CRBSI**

There are four potential causes of catheter infection:
- Bacterial migration from the patient’s skin (extraluminal)
- Bacterial migration from the catheter hub (intraluminal)
- Contaminated infusate
- Hematogenous seeding from another contaminated site in the patient’s body

The most common means of introducing an intraluminal pathogen is via bacterial migration resulting from ineffective injection cap antisepsis. It has been reported that a 15-second injection cap scrub before catheter access is more effective than a 10-second injection cap scrub, and most importantly, no less effective than a 30-second scrub, regardless of injection cap type. In the home, patient and caregiver education, with return demonstration, reinforces appropriate scrubbing technique and duration to minimize this preventable source of CRBSI.

**Exhibit 1**

**Key Risk Factors for CRBSI Development**

- Bone marrow transplant within two months
- Previous CRBSI
- Parenteral nutrition (PN) infusion
- Infusion in an outpatient care setting other than home
- The presence of a multi-lumen catheter

Ultimately, bacterial ingress leads to intraluminal colonization. This colonization can be further complicated by biofilm development. Biofilm is made up of microorganisms that form a colony, secreting slime to aid in their adherence to foreign objects in the body, such as a VAD. This persistent aggregate of microorganisms is believed to be present on the external surface of all non-coated or impregnated catheters within hours of their insertion. While biofilm is the body’s means of protecting itself against a foreign object, it can also increase the risk of a CRBSI. Anti-infective therapy, antibiotic locks, ethanol locks, and impregnated catheters represent strategies used to prevent these infections from developing.

**Strategies to Decrease CRBSI Risk**

Many strategies exist for today’s home infusion patients and their caregivers for preventing the development of a CRBSI (see Exhibit 2). Injection cap antisepsis effectively reduces or, in some cases, eliminates bacterial ingress into the intraluminal space. In addition to a 15-second antiseptic scrub, the use of novel disinfection caps that provide catheters with sustained contact with antiseptic between accesses has been shown to be effective. These products luer-lock onto the injection cap and apply alcohol to the top of the injection cap. They also provide a physical barrier to bacterial contamination and typically remain in place until the next catheter access.

In one case study, a home infusion provider instituted the use of disinfection caps between catheter accesses.

**Exhibit 2**

**Strategies for Decreasing Risk of CRBSIs in the Home Care Setting**

- Injection cap antisepsis
- Antibiotic and ethanol lock therapy
- Impregnated catheters

“Many strategies exist for today’s home infusion patients and their caregivers for preventing the development of a CRBSI”
“Available studies on the risk factors associated with CRBSI in the home infusion setting demonstrate that the origin of a CRBSI is often multi-factorial”

Extraluminal infections typically occur within a week after catheter insertion, and are most often caused by skin bacteria that enter the bloodstream at the time of insertion.

Intraluminal infections typically appear a week or more after catheter insertion, and are generally related to contamination via the catheter hub and catheter manipulation.

The intervention was prompted by a patient census that included several infection risk factors, such as PN patients with multi-lumen catheters. The provider compared its CRBSI rates for six months prior to the institution of the disinfection cap to those collected during the first six months of disinfection cap use. The results showed a PN catheter infection rate that was reduced by 1.05/1,000 catheter days. In addition, none of the patients who reported full compliance with the disinfection cap protocol developed a CRBSI during the study period.

Antibiotic lock therapy and ethanol lock therapy have also been shown to prevent or reduce catheter infections. Antibiotic lock therapy (ABL) may be used to salvage colonized long-term catheters. It is not recommended, however, for routine prophylaxis due to concerns regarding the potential development of resistant microorganisms associated with its use. ABL involves filling the intravascular catheter with pharmacologic concentrations of an antibiotic agent and leaving it to dwell for a prescribed period of time. The lock solution is then aspirated from the catheter or flushed through, as per the physician orders. Common antibiotic agents used for ABL therapy include vancomycin, ceftazidime, cefazolin, ciprofloxin, gentamicin, and ampicillin.

Considerations related to ABL therapy include:

- Identifying the organism to be treated and the organism’s sensitivity (culture and sensitivity testing).
- Quantifying the antibiotic minimum inhibitory concentration (MIC).
- Determining the appropriate diluent for the antibiotic.
- Verifying the stability of the ABL solution and the ordered concentration.
- Determining heparin compatibility with the ABL solution, and flushing the catheter with 0.9% sodium chloride if the ABL solution is not compatible with heparin.

Ethanol lock therapy (ELT) involves filling the intravascular catheter with medical-grade ethanol and leaving it to dwell for a prescribed period of time. The lock solution is then aspirated from the catheter or flushed through, in accordance with physician orders. Ethanol is bactericidal and sterilizes the intraluminal space of the intravascular catheter. ELT may be prepared in concentrations of 20% - 80%, and in limited studies has been associated with the eradication of some biofilms. Considerations related to ELT include:

- Only medical-grade sterile ethyl alcohol should be used.
- Ethanol is not compatible with heparin; therefore, the intravascular catheter should be flushed with 0.9% sodium chloride between ELT and heparin instillation.
- Ethanol may cause degradation of some polyurethane catheters. Check with the manufacturer of the intravascular catheter to determine whether the device may be damaged by the presence of ethanol for extended periods of time.

Central venous catheters are available impregnated or coated with a variety of potentially infection-reducing substances, such as certain antibiotics, chlorhexidine gluconate (CHG), or silver sulfadiazine. A number of studies have reported on the efficacy of silver and CHG-impregnated catheters in reducing catheter colonization as well as CRBSI. Antibiotic-coated catheters have shown some promise clinically, but concerns over the development of antibiotic resistance have limited their widespread use.

Available studies on the risk factors associated with CRBSI in the home infusion setting demonstrate that the origin of a CRBSI is often multi-factorial. Risk factors described in these studies were associated with the degree and effectiveness of patient/caregiver education, the type of venous access device in place, the frequency of access, the administration of PN therapy, hand hygiene compliance, and clinical follow-up. Thus, all factors must be addressed when developing a comprehensive patient plan of care in order to help ensure a positive impact on catheter infection outcomes.
illustrated above, recognizing these risk factors, incorporating evidence-based practices in VAD care, and monitoring outcomes supports both the infusion provider’s internal accountability and commitment to patient care excellence—an essential component of every provider’s service.

REFERENCES