Knowledge about the three different types of IV connectors (negative, positive, and neutral) is imperative to cancer care as specific and distinct interventions can help prevent occlusions and catheter-related bloodstream infections that can lead to increased morbidity with infections and loss of treatment time and mortality. Nurses have responsibilities associated with nursing research, education, and evidence-based practice that should support the outcomes of best patient care when using IV connectors.

Most patients with cancer have IV lines (including some with connectors) associated with cancer treatments. Immunosuppression in patients with cancer increases their risk for infection. Nursing knowledge of IV connectors is necessary to avoid infection and decrease the risk of thrombus formation. IV connectors are devices that connect a fluid source to an IV catheter hub and have a terminal access called a septum. Many clinical names have been used for these products; some common names are hep-locks, male adaptors, Luer-locks, split-septums, and connectors. A gap exists in the scientific literature regarding the care and maintenance of these connectors. Most literature is manufacturer developed or driven.

This article will disseminate nursing knowledge about types of IV connectors, occlusions, and catheter-related bloodstream infections (CRBSIs). The knowledge may increase adherence through ease of use regarding care and maintenance of IV connectors and reduce infections and occlusions, which positively impacts patient outcomes.

### Literature Review

Three types of IV connectors exist: negative, positive, and neutral (see Figure 1 and Table 1). Several issues can develop based on connectors, including total or partial occlusion and bloodstream infections. The issues are important to patients and clinicians because tragic patient care errors, such as tubing misconnections, have occurred (Moore, 2003; Simmons, Phillips, Grissinger, & Becker, 2008). With knowledge of the issues, different device types, and associated interventions, oncology nurses can identify and assess for complications related to IV connectors.

### Occlusions

Occlusions are a known complication of central venous access devices in patients, and about 50% are directly related to thrombus formation (Rummel, Donnelly, & Fortenbaugh, 2001). Catheter-related thrombi may develop extraluminally (outside) and intraluminally (inside). Connector usage is related to intraluminal thrombus formation (Garland et al., 2008). Occlusion is more prevalent with a negative-pressure system (Casella & Jarvis, 2007b; Jacobs et al., 2004) with reflux occurring with disconnection. Split septum (Q-Syte™ and Interlink® B-D Interlink Access System) and Luer-activated (Clearlink®, V-Link®, CLC2000®, Clave®) are IV connectors that allow a negative backflow of blood (reflux) to occur with disconnection of a syringe or tubing from the connector.

Occlusion incidence is lower with a neutral connector (Caillouet, 2008). Catheter patency can be maintained with a combination of nursing care, maintenance, and appropriate flushing and clamping associated with connectors.

Flushing is the primary nursing practice designed to remove fibrin build-up within the intraluminal fluid pathway (Dougherty, 2000). Flushing, however, does not remove build-up in the connector deadspace (e.g., the area not within the direct fluid pathway of the connector). Holding pressure on the syringe plunger and closing the clamp prior to disconnection may prevent this reflux.
Another technique, the flushing and clamping method, can be performed by clamping the catheter or extension set while flushing before the syringe is completely empty. With the rise of occlusions during the 1990s, positive-pressure or positive-displacement connectors were developed. The positive connectors have a positive push with disconnection. To achieve this positive displacement, an equal volume of reflux occurs with connection. With this connector classification, the nurse should not clamp before disconnection. Clamping before removing the syringe from the injection port negates the final positive push. A lower occlusion rate with positive connectors was substantiated compared to standard devices in a research study in children (Schilling, Doellman, Hutchinson, & Jacobs, 2006). On the other hand, research significantly links this connector classification to an increase in bloodstream infections (Casey et al., 2003; Maragakis et al., 2007).

Knowing whether a negative, neutral, or positive-pressure system connector is being used is important to patient care outcomes. Occluded catheters can cause an increase in the use of thrombolytics, an increase in cost for patients and the institution, and a delay in treatment, as well as a decrease in patient satisfaction. A new connector type category defined as neutral (i.e., Invison-Plus® and Neutral®) has made an impact with a decreased incidence of occlusion and CRBSI rates (Caillouet, 2008).

**Bloodstream Infections**

Patients with long-term vascular access devices and who are immunosuppressed, particularly patients with cancer, are at increased risk for acquiring CRBSIs by microbes that frequently gain access through an injection port (Menyhay & Maki, 2006). Most CRBSIs occur within 60 days of insertion and are caused by hub contamination (Caillouet, 2008) or hub manipulation (Hadaway, 2006; Safdar & Maki, 2004). The cost of CRBSIs has been calculated to be about $33,000–$35,000 per episode, making it a relevant cost issue (Arnow, Quimosing, & Beach, 1993; Pittet, Tarara, & Wenzel, 1994; Rello et al., 2000). A few research studies have begun to explore the use of antiseptic caps (Menyhay & Maki), external catheter coatings (Bassetti, Hu, D’Agostino, & Sherertz, 2001; Raad et al., 1998), and disinfectable, needle-free connectors (Yébenes et al., 2004) to help reduce CRBSIs. Several studies reveal that specific connectors increase bloodstream infections (Field et al., 2007; Karchmer, Cook, Palavecino, Ohl, & Sherertz, 2005; Rosenthal, 2006; Rupp et al., 2007), including positive-pressure connectors (Marschall et al., 2008).

Fibrin is the building block for bacterial adhesion and biofilm (i.e., a polysaccharide secreted by microorganisms often referred to as “slime”) formation (Ryder, 2006). Fibrin has been identified in intraluminal fluid pathway contamination as a primary source of CRBSI in neonates (Garland et al., 2008), and it has been accepted that CRBSI is caused by the migration of organisms through the cutaneous insertion site down the extraluminal catheter track and also through the intraluminal fluid pathway. Once organisms gain access, infection occurs as a result of the bacteria’s ability to adhere to the fibrin on the catheter surface, colonize, and develop a biofilm. Studies have identified positive-pressure connectors as a primary CRBSI source (Maki, Kluger, & Crnich, 2006). When these positive-pressure connectors were replaced with negative connectors, CRBSI rates fell to the earlier baseline figure. Occlusion rates, however, continued.

### Nursing Interventions

Although oncology nurses predominantly use positive and negative connectors in the clinical area, they should care for them appropriately to decrease poor outcomes. The first intervention is to know what type of connector your hospital or practice uses. Second, establish protocols and education based on the following.

- Care of a negative connector involves holding pressure on the barrel of the syringe while clamping and, after the clamping is complete, removing the syringe from the septum.
- Care of a positive connector includes removing the syringe first before clamping.
- Care of a neutral connector does not require a clamping sequence, so the nurse should simply clamp when not in use for patient safety.

Additional interventions to control CRBSIs include the use of acceptable antiseptic solutions; chlorhexidine-impregnated dressings; antimicrobial-impregnated injection caps, locks, and catheters; and not routinely using positive-pressure connectors (Marschall et al., 2008). Nursing curricula should include distinct courses on IV and vascular access therapies because they are the primary components of everyday nursing practice. Casella and Jarvis (2007a) revealed that 64% of staff nurses say they are involved in at least five to six hours of IV therapy and maintenance per 12-hour shift.

<table>
<thead>
<tr>
<th>TYPE OF PRESSURE</th>
<th>EXAMPLES</th>
<th>DISCONNECT CARE</th>
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<tr>
<td><strong>Negative</strong></td>
<td>Bionector®, Clave®, ClearLink®, FloStar®, InterLink®, LifeShield®, MicroClave®, Q-Syte®, SafeLine®, SmartSite®, V-Link®</td>
<td>Flush and keep pressure on syringe. Close the clamp and remove syringe from injection port.</td>
</tr>
<tr>
<td><strong>Positive</strong></td>
<td>CLC2000®, Flowlink®, MaxPlus®, PosiFlow®, SmartSite Plus®, UltraSite®</td>
<td>Flush, remove syringe from injection port, and clamp.</td>
</tr>
<tr>
<td><strong>Neutral</strong></td>
<td>Invision-Plus®, Neutral®</td>
<td>Flush; clamping sequence not required. Clamp when not in use for patient safety.</td>
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</table>
Summary

Negative, neutral, and positive IV connectors require knowledge specific to the connector type as it influences maintenance. Research is needed regarding IV connectors and nursing care, specifically comparative effectiveness of technologies, dressing changes, flushing protocols in care, maintenance, and quality of nursing education. Education on connectors may improve bedside and advanced practice nursing care. Nursing curricula may want to implement specific content on IV and vascular therapies. The prevention of the associated sequelae of occlusion and CRBSIs is imperative to implementing cancer treatment regimens on time, increasing quality of life, and decreasing associated morbidity and mortality.

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References


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**Do You Have an Interesting Topic to Share?**

Oncology Nursing 101 provides readers with a brief summary of oncology nursing basics. Length should be no more than 1,000–1,500 words, exclusive of tables, figures, insets, and references. If interested, contact Associate Editor Debra L. Winkeljohn, RN, MSN, AOCN®, CNS, at dwinkeljohn@comcast.net.