Central Venous Catheter Site Care for Blood and Marrow Transplant Recipients

Laura Zitella, RN, MS, NP, AOCN®

Central venous catheters (CVCs) are indispensable in blood and marrow transplant (BMT) recipients when administering IV fluids, medications, chemotherapy, parenteral nutrition, and blood products. The use of intravascular devices is complicated by local and systemic infections that increase morbidity and mortality. According to data from the National Nosocomial Infections Surveillance System Report (2001), the median rate of catheter-related bloodstream infections ranges from 2.4–7 episodes per 1,000 catheter days in the intensive care unit setting. BMT recipients are at even greater risk of infection because of the use of immunosuppressive agents, presence of neutropenia, protracted duration of CVC indwelling time, and disruption of skin integrity from high-dose chemotherapy regimens. In fact, one retrospective analysis of catheter-related infections reported a rate of 11.5 infections per 1,000 catheter days in BMT recipients compared to an overall rate of 3.3 infections per 1,000 catheter days (Keung et al., 1995).

Other studies have found that 16%–44% of BMT recipients with CVCs experience catheter-related infectious complications (Elshoov et al., 1998; Moosa, Julian, Rosenfeld, & Shadduck, 1991; Petersen et al., 1986; Uderzo et al., 1992; Ulz et al., 1990).

### Source of Catheter-Related Infections

The most common causative organisms of catheter-related infections are ubiquitous skin flora of hospitalized patients, including staphylococcus epidermidis, staphylococcus aureus, gram-negative bacilli, enterococci, and candida species (Baranowski, 1993; Conly, Grievest, & Peters, 1989; Elshoov et al., 1998; Maki, Goldman, & Rham, 1973). Molecular subtyping methods have confirmed a correlation between organisms isolated from catheter-related bacteremias and percutaneous skin flora in patients with short-term, nontunneled catheters (Conly, Stein, & Peters, 1990; Mermel, McCormick, Springman, & Maki, 1991). Additional studies have found that cutaneous colonization at the CVC site is highly predictive of catheter-related infection and sepsis (Banks, Yates, Cawdrey, Harries, & Kidner, 1970; Bernard, Stahl, & Chase, 1971; Maki, Ringer, & Alvarado, 1991; Maki, Stolz, Wheeler, & Mermel, 1997). Diligent catheter site care lowered the catheter-related infection rate to 0%–3.8%, compared to infection rates of 20%–28% with nondiligent site care (Ena, Cercenando, Martinez, & Bouza, 1992; Johnstone, 1982; Nelson, Kien, Mohr, Frank, & Davis, 1986; Ryan et al., 1974; Wagman, Kirkemo, & Johnston, 1984).

Although the pathogenesis of catheter-related infections in short-term, nontunneled CVCs (in situ < 10 days) is related to cutaneous colonization, the pathogenesis of catheter-related infections in long-term, nontunneled and tunneled catheters (in situ > 10 days) most often is attributed to hub colonization or intraluminal colonization (Crnich & Maki, 2002; Garland et al., 2001; Raad, Humphrey, Khan, Truest, & Bodey, 1993). Therefore, strategies to prevent cutaneous colonization may effectively prevent catheter-related infections in short-term catheters but may be less effective for long-term catheters because hub and, occasionally, intraluminal colonization become the more predominant sources of catheter-related infections.

### Transparent Versus Gauze Dressings

A great deal of research has been conducted to examine the practice of CVC care...
colony under traditional TDs. This lead to the development of a novel, highly permeable TD (HPTD) (OpSite IV3000, Smith & Nephew) with a high moisture vapor transmission rate. Based on laboratory measurements, the moisture vapor transmission rate of OpSite IV3000 ranges from three to eight times greater (3,000 g/m² per day versus 422–839 g/m² per day) than other TDs (Maki et al., 1994). However, all of the prospective randomized studies of HPTDs and TDs (i.e., OpSite or Tegaderm) suggest that this technologic advantage does not translate into an improved clinical outcome because no significant difference occurred in infection rates between the two dressings (Little & Palmer, 1998; Maki et al., 1994, 1996; Reynolds, Tebbs, & Elliott, 1997). One retrospective analysis of 3,931 CVC insertions from 1990–1994 found decreased catheter-related infection rates (5.5% TD, 8.5% DSGD, and 3.3% HPTD) with HPTDs. The infection rate decreased by 25% using HPTDs and resulted in a cost savings of $69,814 per year and 178 fewer patient hospitalization days (Treston-Aurand et al., 1997).

## Frequency of Dressing Change

Several studies suggest that TDs may be used safely for as long as one week. Equivalent rates of skin colonization or catheter-related bloodstream infection were found with DSGD changes three times per week and OpSite (TD) dressing changes every two days or TD changes every two to seven days (Young et al., 1988). Other studies found no significant difference in cutaneous colonization between Tegaderm (TD) and DSGD changes every two days but reported a significant increase in cutaneous colonization with TD changes every five and seven days (Maki et al., 1996; Maki & Will, 1994). Catheter colonization increased significantly with TD changes every five days (Maki et al., 1996) but not in the earlier study with TD changes every two or seven days (Maki & Will). Both studies reported no significant difference in the rate of catheter-related bloodstream infection with DSGD changes every two days or TD changes every two, five, or seven days (Maki et al., 1996; Maki & Will). A smaller study (N = 39) compared Tegaderm dressing changes once and twice weekly in patients with hematologic malignancies and found a significant increase in catheter colonization with once-weekly dressing changes but no significant differences in cutaneous colonization or gram-positive septicemias (Engervall, Ringertz, Hagman, Skogman, & Bjorkholm, 1995). This study was limited by a small sample size and a vague operational definition of catheter-related bloodstream infection.

## Blood and Marrow Transplant Recipients

Four studies exclusively evaluated BMT recipients. A study of pediatric BMT recipients and children with cancer (N = 60) found no significant difference in skin colonization between TD and DSGD changes every Monday, Wednesday, and Friday (Freiberger et al., 1992). Brandt et al. (1996) found equivalent rates of local or systemic infection between DSGD changes every 24 hours and OpSite IV3000 dressing changes weekly in 101 adult autologous BMT recipients with long-term, tunneled catheters. Shivnan et al. (1991) reported no significant difference in infection rates of long-term, tunneled catheters with TD changes every four days or DSGD changes daily. However, a significantly higher rate of skin irritation existed in the DSGD group and a significantly higher rate of patient satisfaction existed in the TD group. Brandt et al. and Shivnan et al. determined that nursing time and costs were significantly lower with the use of TDs. Longer dressing-change intervals were associated with a significant reduction in costs based on a prospective, randomized trial of 399 BMT recipients (Rasero et al., 2000). No significant difference was found in the incidence of skin colonization when TDs were changed every five days versus every 10 days for tunneled CVCs and every two days versus every five days for nontunneled CVCs. The rate of catheter-related bloodstream infection was not reported.

## Antisepsis: Chlorhexidine or Povidone-Iodine?

In a landmark prospective, randomized study of 668 patients in a surgical intensive care unit, Maki et al. (1991) evaluated 10% povidone-iodine, 70% isopropyl alcohol, and 2% aqueous chlorhexidine skin disinfection prior to CVC insertion and for site maintenance every other day. The chlorhexidine treatment group had a significantly decreased incidence of local catheter-related infection and infusion-related bacteremia, but no significant difference was found in the rate of catheter-related bloodstream infection. These findings generated much interest in the use of chlorhexidine for catheter site care, but commercially available chlorhexidine products were not available at that time. Four...
### Table 1. Studies Examining Central Venous Catheter Site Care and Dressing Change Procedures

<table>
<thead>
<tr>
<th>Study</th>
<th>Research Design and Sample</th>
<th>Catheter Site Care</th>
<th>Results</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aly et al., 1988</td>
<td>Prospective, controlled trial: 50 healthy volunteers and 49 long-term inpatients</td>
<td>Volar forearm cleansed with 70% alcohol and povidone-iodine; each subject received OpSite™ (Smith &amp; Nephew, Largo, FL), Tegaderm™ (3M™ Health Care, St. Paul, MN), Uniflex™ (Smith &amp; Nephew), DSGD, Saran Wrap™ (S.C. Johnson &amp; Son, Inc., Racine, WI), and exposed control site on the volar forearm surface.</td>
<td>Measurement of the indigenous skin flora after three days showed that all of the dressings maintained normal flora at 10% the population of the uncovered site, but the Saran Wrap supported 100-fold more bacteria than the exposed control site.</td>
<td>No significant difference was found in quantitative measurement of skin flora or gram-negative bacteria under OpSite, Tegaderm, Uniflex, or DSGD. Saran Wrap dressing was ineffective in preventing growth of skin flora.</td>
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<td>Brandt et al., 1996</td>
<td>Prospective, randomized, controlled trial: 101 hospitalized autologous BMT recipients with Hickman CVCs</td>
<td>Two dressing protocols: DSGD changed every 24 hours (n = 53) and OpSite IV3000 HPTD changed every week (n = 48)</td>
<td>Definite CVC sepsis occurred in 10% of HPTD patients and 2% of DSGD patients. Suspected CVC sepsis occurred in 59% of DSGD patients and 41% of HPTD patients. Absolute neutrophil count less than 500 generally occurred during weeks two or three of the study, and the mean duration of neutropenia was 21.7 days.</td>
<td>No significant difference was found in the rate of definite or suspected CVC sepsis between patients with DSGD and HPTD.</td>
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<td>Chaiyakunapruk et al., 2002</td>
<td>Meta-analysis</td>
<td>Eight studies of 4,143 catheters (1,493 CVCs, 1,361 peripheral venous, 704 peripheral arterial, 395 pulmonary arterial, 75 peripherally inserted central catheters, 62 introducer sheaths, and 53 hemodialysis)</td>
<td>The summary risk ratio for CR-BSIs was 0.49 (95% CI, 0.28–0.88) using chlorhexidine gluconate rather than povidone-iodine for catheter site antisepsis. The summary risk ratio for CR-BSIs among CVCs using chlorhexidine for site antisepsis was 0.51 (95% CI, 0.27–0.97).</td>
<td>Catheter site antisepsis with chlorhexidine gluconate for CVCs significantly decreased the risk of CR-BSI by 49%.</td>
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<td>Conly et al., 1989</td>
<td>Prospective, randomized, controlled trial: 79 medical, surgical, or pediatric patients with 115 CVCs</td>
<td>Two dressing protocols: OpSite TD dressing (n = 58) or DSGD (n = 57). All dressings were changed every 48 hours, and catheter site antisepsis with 70% isopropyl alcohol was followed by 10% povidone-iodine.</td>
<td>Quantitative cultures of the catheter insertion site showed significantly greater colonization after 48 hours with TD (p &lt; 0.009). Local CVC infections occurred in 62% of TD patients and 24% of DSGD patients (p = 0.002). Catheter-related bacteremias occurred in 16.6% of TD patients and in none of the DSGD patients (p = 0.015). The mean duration of catheterization was 13.5 days (DSGD) and 17.9 days (TD).</td>
<td>The rates of insertion site colonization, local catheter-related infection, and CR-BSI were significantly increased with the use of TDs for CVC care.</td>
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<td>Dickerson et al., 1989</td>
<td>Prospective trial: 80 CVCs</td>
<td>Three dressing protocols: DSGD (n = 33), TD (n = 36), and combination of the two (n = 11). Catheter site antisepsis and frequency of dressing changes were not stated.</td>
<td>The rate of catheter-related infections was 8.3% in TDs and 3% in DSGDs (p = 0.34).</td>
<td>No significant difference was reported in the rate of infection between the two dressing groups.</td>
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<td>Engervall et al., 1995</td>
<td>Prospective, randomized, controlled trial: 32 patients with hematologic disorders with 39 catheters</td>
<td>Two dressing protocols: Tegaderm TD changed every week (n = 20) and TD changed twice a week (n = 19)</td>
<td>The once-a-week dressing-change group had more positive CVC-tip cultures (11 of 14) compared to the twice-a-week dressing-change group (2 of 9) (p &lt; 0.05).</td>
<td>A significant increase in catheter colonization existed in the once-a-week dressing-change group. No significant difference was found in cutaneous colonization, time to first exit site infection, or (Continued on next page)</td>
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</tbody>
</table>

BMT—blood and marrow transplant; CI—confidence interval; CR-BSI—catheter-related bloodstream infection; CVC—central venous catheter; DSGD—dry sterile gauze dressing; EA—ethyl alcohol; HPTD—highly permeable transparent dressing; ICU—intensive care unit; TD—transparent dressing
Four dressing or antisepsis protocols: (a) Betadine® (Purdue Pharma L.P., Stamford, CT) and Tegaderm, (b) Betadine and DSGD, (c) chlorhexidine gluconate and Tegaderm, and (d) chlorhexidine gluconate and DSGD. All dressings were changed every Monday, Wednesday, and Friday.

Not reported

A significant decrease was noted in the rate of catheter colonization in the Biopatch group, but no significant difference was found in the rate of catheter-related infection between the two groups. 15% of the neonates weighing less than 1,000 g developed contact dermatitis with Biopatch.

Four dressing or antisepsis protocols: (a) anti-sepsis with povidone-iodine and Bioclusive Transparent Dressing™ (Ethicon, Inc., Cornelia, GA) changed every three days (n = 370) and (b) 70% alcohol and the chlorhexidine-impregnated Biopatch™ (Johnson & Johnson Medical, Arlington, TX) and TD changed every week (n = 335)

CVC-tip colonization occurred in 15% of the Biopatch group and 24% of the povidone-iodine group. CR-BSIs occurred in 3.8% of the Biopatch group and 3.2% of the povidone-iodine group, and bloodstream infection without a source occurred in 15.2% of the Biopatch and 14.3% of the povidone-iodine group.

Use of TDs resulted in increased risk of catheter-tip infection (relative risk = 1.78; 95% CI, 1.38–2.3; p < 0.001). A trend toward increased risk of catheter-related sepsis existed (relative risk = 1.69; 95% CI, 0.97–2.95; p = 0.06) and bacteremias (relative risk = 1.63; 95%, CI 0.76–3.47; p = 0.2) with the use of TDs.

No significant difference existed in the incidence of cutaneous colonization between dressing groups. The sample size limits the power to detect differences.

The use of TDs on CVCs was associated significantly with an increased relative risk of catheter-tip infection. A trend existed toward elevated relative risk of catheter-related sepsis and bacteremias, but this result was not statistically significant.

No significant difference was found in the rate of local catheter infection, cutaneous colonization, or catheter-related bacteremia between the two antisepsis groups.

No significant difference was found in the rate of catheter-related sepsis between dressing groups.

(Continued on next page)
<table>
<thead>
<tr>
<th>Study</th>
<th>Research Design and Sample</th>
<th>Catheter Site Care</th>
<th>Results</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maki et al., 1991</td>
<td>Prospective, randomized, controlled trial: 668 CVCs (n = 176) and central arterial catheters (n = 492) in surgical ICU patients</td>
<td>Three catheter site antisepsis protocols: 10% povidone-iodine (n = 227), 70% alcohol (EA) (n = 227), and 2% aqueous chlorhexidine (n = 214). DSGDs were changed every 48 hours.</td>
<td>The rate of local CR-BSI was 2.3% chlorhexidine gluconate, 7.1% EA, and 9.3% povidone-iodine (p = 0.02). The rate of infusion-related bacteremias was 0.5% chlorhexidine gluconate, 2.6% EA, 3.1% povidone-iodine, (p = 0.04). The rate of catheter-related bacteremias was 0.5% chlorhexidine gluconate, 2.3% EA, and 2.6% povidone-iodine (p = not significant). The mean duration of catheterization was 5.3 days.</td>
<td>Chlorhexidine gluconate for catheter site antisepsis significantly decreased the risk of local catheter-related infection and infusion-related bacteremia. No significant difference existed in the rate of CR-BSI between antisepsis groups.</td>
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<tr>
<td>Maki et al., 1994</td>
<td>Prospective, randomized, controlled trial: 442 ICU patients with pulmonary artery catheters</td>
<td>Three dressing protocols: DSGD changed every two days (n = 130), Tegaderm TD changed every five days (n = 127), and OpSite IV3000 HPTD changed every five days (n = 185). Used 10% povidone-iodine for all catheter site antisepsis</td>
<td>Cutaneous colonization was significantly lower in DSGDs, intermediate in HPTDs, and highest in TDs (p &lt; 0.01). Catheter colonization occurred in 20% of DSGDs, 25% of TDs, and 21% of HPTDs. CR-BSI occurred in 1.6% of DSGDs, 0.8% of TDs, and 1.1% of HPTDs.</td>
<td>No significant difference was reported in the rate of catheter colonization or CR-BSI among the three dressing groups. Cutaneous colonization significantly increased with TDs and HPTDs as compared with DSGDs.</td>
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<tr>
<td>Maki et al., 1996</td>
<td>Prospective, randomized, controlled trial: 395 catheters</td>
<td>Two dressing protocols: DSGD changed every two days (n = 191) and Tegaderm HPTD changed every five days (n = 204)</td>
<td>Cutaneous colonization was significantly greater with TDs than DSGDs (p = 0.03). Catheter colonization occurred in 20% of DSGDs by roll tip method and 14% by sonication method and 31% of TDs by roll tip method and 23% by sonication method, CR-BSI occurred in 3.1% of DSGDs and 2.5% of TDs.</td>
<td>A significant increase was found in cutaneous colonization and catheter colonization using TDs versus DSGDs. However, no significant difference existed in the rate of CR-BSI between DSGDs and TDs.</td>
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<tr>
<td>Maki &amp; Mermel, 1997</td>
<td>Meta-analysis of seven prospective, randomized trials comparing TDs and DSGDs</td>
<td>Two dressing protocols: DSGDs and TDs</td>
<td>The pooled rate of CR-BSIs was 2.7% in DSGDs and 2.5% in TDs.</td>
<td>No significant difference was noted in the rate of CR-BSI between dressing groups.</td>
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<tr>
<td>Maki &amp; Will, 1984</td>
<td>Prospective, randomized, controlled trial: 356 central venous, arterial, and Hickman catheters</td>
<td>Three dressing protocols: DSGD changed every two days (n = 134), Tegaderm TD changed every two days (n = 122), and TD changed every seven days (n = 100)</td>
<td>No significant difference was found in cutaneous colonization between DSGDs and TDs. Cutaneous colonization significantly increased with TDs and HPTDs. However, no statistically significant differences were found in the rates of catheter colonization or CR-BSI among the three dressing groups.</td>
<td>A significant increase was noted in cutaneous colonization when TDs were changed every seven days, as opposed to every two days or when DSGDs were used. However, no statistically significant differences were found in the rates of catheter colonization or CR-BSI among the three dressing groups.</td>
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</tbody>
</table>

(Continued on next page)
TABLE 1. STUDIES EXAMINING CENTRAL VENOUS CATHETER SITE CARE AND DRESSING CHANGE PROCEDURES (CONTINUED)

<table>
<thead>
<tr>
<th>Study</th>
<th>Research Design and Sample</th>
<th>Catheter Site Care</th>
<th>Results</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mimoz et al., 1996</td>
<td>Prospective, randomized, controlled trial: 315 catheters (158 central venous and 157 central arterial)</td>
<td>Two antiseptics protocols: (a) 0.25% chlorhexidine gluconate, 0.025% benzalkonium chloride, and 4% benzyl alcohol (chlorhexidine) and (b) 10% povidone-iodine. DSGDs were changed every 48 hours.</td>
<td>The rate of catheter colonization was 12 per 1,000 catheter days in the chlorhexidine gluconate group versus 31 in the povidone-iodine group (p &lt; 0.01). The rate of catheter-related sepsis was six per 1,000 catheter days in the chlorhexidine gluconate group versus 16 in the povidone-iodine group (p = 0.05). The rate of bacteremic catheter-related sepsis was three per 1,000 catheter days in the chlorhexidine gluconate group and four in the povidone-iodine group (p = 0.4).</td>
<td>Chlorhexidine gluconate significantly reduced the rate of catheter colonization and catheter-related sepsis when compared with povidone-iodine. No significant difference existed in the rate of bacteremic catheter-related sepsis.</td>
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<tr>
<td>Pinheiro et al., 1997</td>
<td>Prospective, randomized, controlled trial: 160 ICU patients with CVCs</td>
<td>Two dressing protocols: DSGDs changed daily and Tegaderm TDs changed only when the film loosened</td>
<td>The rate of catheter-related infections was 10.8% in TDs and 21.6% in DSGDs (p = 0.086). Eighty-seven percent of the patients in the TD group never needed to change their dressings.</td>
<td>No significant difference was reported in the rate of catheter-related infections between the two dressing groups.</td>
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<tr>
<td>Powell et al., 1982</td>
<td>Prospective, randomized, controlled trial: 261 patients receiving parenteral nutrition</td>
<td>Two dressing protocols: (a) DSGD changed every Monday, Wednesday, and Friday (n = 138) and (b) OpSite TD changed every seven days (n = 123). Catheter site antisepsis with acetone-alcohol swab and two povidone-iodine swabs was followed by povidone-iodine ointment. In the TD group, the ointment was omitted because of interference with adherence of the dressing.</td>
<td>The maximum rate of infection was 8% in DSGDs and 13.8% in TDs. The rate of catheter colonization was 2.9% in DSGDs and 8.9% in TDs.</td>
<td>No significant difference was noted in the rate of catheter colonization or catheter-related sepsis between the dressing groups.</td>
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<tr>
<td>Rasero et al., 2000</td>
<td>Prospective, randomized, controlled trial: 399 BMT recipients with CVCs</td>
<td>Group A: Tegaderm TD changed every five days or TD changed every 10 days Group B: TD changed every two days or every five days</td>
<td>Cutaneous colonization rates: Group A: 12 of 79 TDs every five days and 13 of 81 TDs every 10 days Group B: 9 of 49 TDs every two days and 9 of 50 TDs every five days</td>
<td>No significant difference was reported in local CVC infections among dressing groups.</td>
</tr>
<tr>
<td>Reynolds et al., 1997</td>
<td>Prospective, randomized, controlled trial: 100 ICU patients</td>
<td>Two dressing protocols: Tegaderm TD and OpSite IV3000 HPTD</td>
<td>Not reported</td>
<td>No significant difference existed between the two dressing groups with respect to fluid accumulation, skin microbial colonization, local infection, or systemic infection.</td>
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<tr>
<td>Ricard et al., 1985</td>
<td>Prospective, randomized, controlled trial: 200 ICU patients with 708 catheters including central venous pressure, pulmonary artery, intra-arterial, and short IV catheters</td>
<td>Four dressing protocols: povidone-iodine ointment with DSGD (n = 50), OpSite film (n = 50), OpSite spray followed by OpSite film (n = 50), and Betadine and OpSite film (n = 50). All dressings were changed every 48 hours.</td>
<td>The rate of catheter contamination was 5 of 120 in group A, 2 of 130 in group B, 3 of 134 in group C, and 3 of 132 in group D.</td>
<td>No significant difference was found in the rate of catheter contamination among dressing groups. This study is limited in power because of sample size and heterogeneity of catheters. Generalizing these findings to current practice is difficult because the mean duration of catheterization was 48 hours.</td>
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</tbody>
</table>

BMT—blood and marrow transplant; CI—confidence interval; CR-BSI—catheter-related bloodstream infection; CVC—central venous catheter; DSGD—dry sterile gauze dressing; EA—ethyl alcohol; HPTD—highly permeable transparent dressing; ICU—intensive care unit; TD—transparent dressing

(Continued on next page)
Table 1. Studies Examining Central Venous Catheter Site Care and Dressing Change Procedures (Continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Research Design and Sample</th>
<th>Catheter Site Care</th>
<th>Results</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shivnan et al., 1991</td>
<td>Prospective, randomized, controlled trial: 98 BMT recipients</td>
<td>Two dressing protocols: DSGD changed daily (n = 47) and Tegaderm TD changed every four days (n = 51). Antisepsis with hydrogen peroxide was followed by povidone-iodine and antibiotic ointment. Exit site infections occurred in 2 of 51 TDs and 1 of 47 DSGDs. One case of catheter-related sepsis was reported, which occurred in the TD group.</td>
<td>No significant difference was noted in the rate of exit site infections, catheter-related sepsis, or positive blood cultures between the two dressing groups. A highly significant decrease was found in local skin irritation, nursing time, and dressing costs with TDs. Patient satisfaction was higher with TDs.</td>
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<td>Treston-Aurand et al., 1997</td>
<td>Retrospective trial: 3,931 CVCs</td>
<td>Three dressing protocols: TD (n = 880), DSG (n = 1,374), and OpSite IV3000 HPTD (n = 1,677). All dressings were changed every 48 hours. Catheter-related infection occurred in 3.3% of HPTDs, 5.5% of TDs, and 8.5% of DSGDs. The rate of catheter-related infection decreased by 25% using HPTDs. The estimated cost savings using HPTDs was $69,814 because of the decrease in infection rates. Average duration of catheterization was 6.5 days.</td>
<td>A significant decrease existed in the rate of catheter-related infection using HPTDs versus TDs or DSGDs. Significantly greater staff satisfaction with HPTDs (88%) versus DSGDs (28%) also was reported.</td>
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<tr>
<td>Wille et al., 1993</td>
<td>Prospective, randomized, controlled trial: 101 patients with long-term CVCs</td>
<td>Two dressing protocols: OpSite TD and OpSite IV3000 HPTD</td>
<td>One episode of catheter-related sepsis was found in the HPTD group, and three episodes were found in the TD group.</td>
<td>No significant difference was noted in rate of catheter-related sepsis between the two dressing groups.</td>
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<td>Young et al., 1988</td>
<td>Prospective trial: 168 patients receiving total parenteral nutrition via CVC. Subjects were allocated to study group based on nursing unit.</td>
<td>Four dressing protocols compared: OpSite TD changed every seven days (n = 31), TD changed every 10 days (n = 32), TD changed twice weekly (n = 69), and DSGD changed three times a week (n = 36). Catheter-related sepsis rates were 0 of 31 TDs changed every seven days, 1 of 32 TDs changed every 10 days, 2 of 69 TDs changed twice weekly, and 1 of 36 DSGDs changed three times weekly.</td>
<td>No significant difference was found in the rate of cutaneous colonization, catheter-related sepsis, or bacteremias related to any cause among the four dressing groups.</td>
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</tbody>
</table>

BMT—blood and marrow transplant; CI—confidence interval; CR-BSI—catheter-related bloodstream infection; CVC—central venous catheter; DSGD—dry sterile gauze dressing; EA—ethyl alcohol; HPTD—highly permeable transparent dressing; ICU—intensive care unit; TD—transparent dressing

Subsequent prospective, randomized studies using various chlorhexidine formulations or the chlorhexidine-impregnated sponge (Biopatch; antimicrobial dressing, Johnson & Johnson Medical, Arlington, TX) confirmed that chlorhexidine decreases catheter colonization (Garland et al., 2001; Maki, Naranj, Knasinski, & Kluger, 2000; Mimos et al., 1996; Sheehan, Leicht, O’Brien, Taylor, & Rennie, 1993). Mimos et al. also measured rates of catheter-related bloodstream infection and found a significant reduction in infection with the use of chlorhexidine. In contrast, Humar et al. (2000) found no significant difference in the rate of cutaneous colonization or catheter-related bloodstream infection with catheter site antisepsis using a 0.5% tincture of chlorhexidine or 10% povidone-iodine. However, in all of the trials, small sample sizes and the overall low incidence of catheter-related infections limited the ability to detect differences between the chlorhexidine and control groups. Furthermore, different preparations of chlorhexidine were used for antisepsis. A recent meta-analysis evaluated eight randomized, controlled studies comparing chlorhexidine and povidone-iodine solutions for catheter care (Chaiyakunapruk, Veenstra, Lipsky, & Saint, 2002). Among all types of catheters, chlorhexidine antisepsis reduced the risk of catheter-related bloodstream infection by approximately 50%. Of 4,143 catheters studied, 1,493 were CVCs, and catheter-related bloodstream infections were reduced by 49% in the cohort group of CVCs.

The data suggest that chlorhexidine gluconate is superior to povidone-iodine for central venous catheter care. Several explanations are available for the increased antimicrobial efficacy of chlorhexidine. First, the antimicrobial activity of chlorhexidine is rapid with a prolonged residual effect (i.e., at least six hours), whereas the antimicrobial activity of povidone-iodine occurs as it dries, which leaves no residual antimicrobial effect (Maki et al., 1991). Additionally, the antimicrobial activity of povidone-iodine is reduced markedly in the presence of blood, serum, or other protein-rich materials, whereas chlorhexidine is nearly unaffected (Lowbury & Lilly, 1974). A chlorhexidine swab now is commercially available, and the “Guidelines for the Prevention of Intravascular Catheter-Related Infection” recommended chlorhexidine gluconate as the preferred agent for central venous site care (Centers for Disease Control and Prevention, 2002).

Critical Analysis

The heterogeneity of the published studies with regard to patient population, tunneled versus nontunneled catheters, type of
dressing, frequency of dressing change, duration of catheter placement, and type of skin antisepsis limits the ability to determine optimal catheter care practice. In addition, the low incidence of catheter-related infections often limits the statistical power of analysis because large samples are necessary to determine statistically significant differences between experimental and control groups.

Several issues must be considered before implementing an evidence-based protocol for CVC care in BMT recipients. First, long-term, nontunneled or tunneled catheters are utilized for most patients undergoing BMT. Many of the studies evaluated short-term, nontunneled catheters that remained in place a median of 5–10 days. The epidemiology and pathogenesis of long-term catheter-related infections may differ from short-term catheter-related infections, which limits the applicability of these studies to the BMT recipient population. Second, the type of intravascular device included in an analysis limits the generalizability of the results to BMT recipients because pulmonary artery catheters or peripheral IV catheters are inherently different from CVCs. Pulmonary artery catheters typically remain in place for an average of three days (Mermel et al., 2001; Pearson, 1996), often are placed in the internal jugular vein (Pearson), and are heparin-bonded, which reduces not only catheter thrombosis but also microbial adherence to the catheter (Mermel et al., 2001; Mermel, Stolz, & Maki, 1993). Peripheral IV catheters remain in place for a maximum of three days and carry virtually no risk of systemic infection (Polderman & Girbes, 2002). Therefore, studies of peripheral IV catheters have been excluded from this discussion and consideration should be given to the differences between pulmonary artery catheters and CVCs and the consequential effect on outcomes. Third, catheter-related infections are difficult to diagnose using the available clinical and diagnostic techniques (Mermel et al., 2001). Lack of a precise method to diagnose catheter-related infection has led to the disparity of operational definitions of catheter-related infection. The validity of the method used to determine the incidence of catheter-related infection must be considered. Although catheter colonization is believed to be a harbinger for catheter-related bloodstream infection (Rijnders, Van Wijnegaarden, & Peetersmans, 2002), it is an indirect and imperfect measure; therefore, studies based on catheter colonization alone should be interpreted cautiously. Research efforts should be directed toward designing studies with similar measurement tools to improve the utility of the results and facilitate meta-analysis to increase the power of statistical evaluation.

**Current Practices**

The “Guidelines for the Prevention of Intravascular Catheter-Related Infections” (Centers for Disease Control and Prevention, 2002) are the most comprehensive guidelines for CVC care and represent a consensus of the Healthcare Infection Control Practices Advisory Committee and other professional organizations. The guidelines state that dressing type may be a matter of preference, but the recommended frequency of dressing changes is every two days for DSGDs and every seven days for TDs. The guidelines strongly recommend 2% chlorhexidine for skin antisepsis of all intravascular catheters (Centers for Disease Control and Prevention).

Because actual practice varies among institutions, an informal e-mail survey was sent to the members of the BMT Special Interest Group of the Oncology Nursing Society in January 2002 to determine the CVC care practices at BMT centers across the United States. Responses were received from 30 different centers representing all geographic areas of the country, including major academic centers and smaller, private hospitals. Survey results are reported in Table 2.

**Summary**

The broad range of variables confounding the outcomes of most clinical trials evaluating catheter care practices limits their generalizability to BMT recipients. Although considering the results from all available studies is helpful, the most useful trials are the studies of BMT recipients exclusively. The data presented in this article and the actual practices of BMT centers across the country suggest that TDs changed once a week are safe and effective CVC dressings for neutropenic and non-neutropenic BMT recipients. Chlorhexidine gluconate is the preferred antisepsis for the prevention of catheter-related infection. With the recent availability of a commercially prepared chlorhexidine swab (Chloraprep®, Medi-Flex, Overland Park, KS) and a new HPTD (Sorbaview™ Window Dressing, Tri-State Hospital Supply Corporation/
Centurion® Healthcare Products, Howell, MI), opportunities exist for the design of clinical trials to evaluate the role of skin antisepsis, dressing type, and dressing change frequency in the prevention of catheter-related infection in the BMT setting. Other infection control strategies to consider include the use of antimicrobial-coated catheters, strategies to reduce thrombus and biofilm formation, and antisep tic techniques to inhibit catheter hub colonization. Because large sample sizes are necessary to demonstrate significant differences between control and experimental groups, multicenter cooperation would be ideal to adequately answer these research questions.

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