Preventing Catheter-related Bloodstream Infections: Is Zero Realistic?

Canada’s Forum on Patient Safety and Quality Improvement 2010

Improving Safety Across the Continuum

Toronto, Ontario
April 13, 2010

William R. Jarvis, M.D.
Jason and Jarvis Associates
www.jasonandjarvis.com
Disclosure

• I consult for:
  – Bard
  – Becton-Dickinson
  – J&J
  – Kimberly-Clark
  – APIC
  – CDC
Several Reasons Why YOU Should Want to Prevent Catheter-Related Bloodstream Infections
Impact of Primary BSI

Crude mortality
10% to 40%

Attributable mortality
2% to 15%

Prolongation of hospitalization
5 to 20 days

Attributable cost
$34,000 to $56,000

Healthcare-associated Infections in Canadian Adult Acute Care Hospitals

- **Study design**: Point prevalence survey, February 2002.
- **Results**: 5750 adults surveyed. 667 HAIs detected in 601 patients (prevalence: 10.5% of patients infected; 11.6% HAI prevalence). Urinary tract infections were most common (3.4%), followed by pneumonia (3%), surgical site infections (2/5%), and bloodstream infections (1.6%).
- **Conclusion**: HAIs are prevalent in adult patients, similar to other developed countries.

Healthcare-associated Infections in Canadian Acute Care Hospital Pediatric Populations

- **Study design**: Point prevalence survey, February 2002 at 25 hospitals across Canada.

- **Results**: 997 children surveyed. 91 HAIs detected in 80 patients (prevalence 91 per 1,000 patients). Bloodstream infections were the most common HAI (3% of patients; 34% of HAIs). The HAI prevalence was 8% and ranged from 0% in trauma/burn units to 19% in PICUs to 27% in transplant units. Multivariate analyses identified a central venous catheter (OR 2.54), mechanical ventilation (2.59, and receiving antimicrobials (OR 9.27) as independent risk factors for HAI.

- **Conclusion**: HAIs are prevalent in pediatric patients and CLA-BSIs are the most common HAI.

Study design: The Resources for Infection Control (RICH) project assessed infection control programs (ICPs) in Canadian acute care hospitals in 1995. In 2006, a similar RICH survey was mailed to ICPs in all acute care hospitals with >80 beds.

Results: Response rate: 1995: 72.3%; 2006: 60.1%. The number of infection control professionals (mean: 0.5 to 0.8 per 100 beds), surveillance intensity index score (mean: 61.7 to 68.1), and control intensity index score (mean: 60.8 to 64.1) increased from 1995 to 2006. MRSA (2.0 to 5.2 per 1,000 admissions) and CDAD (3.8 to 4.7) rates, and proportion of hospitals with VRE infections increased (34.5% to 61.0%).

Conclusions: Canadian ICPs continue to fall short of expert recommendations for human resources and surveillance and control activities. Rapid rise on infection control personnel has not translated into marked improvement ICP surveillance and control of MDRO control.

Central Line-associated Bloodstream Infection (CLA-BSIs) Surveillance, Canadian Pediatric Hospitals

- **Methods**: Telephone survey of infection control practitioners (ICPs) at 15 university-affiliated Canadian Pediatric hospitals.

- **Results**: Surveillance: 14 (93%) hospitals conduct surveillance for infections associated with CLAs (11 comprehensive; 3 selected patients; 3 include outpatients). One conducts surveillance for mechanical complications. **Numerator**: A positive blood culture was sufficient for CLA-BSI in eight centers; the rest use CDC definitions. **Denominators**: Four centers collect CLA days on all patients; four use per 100 discharges; four report absolute number of infections (2 use >1 denominator). **Surveillance methods**: chart and micro records; none used electronic records. **Standardized protocols**: All 15 either had or were developing hospital-wide protocols for CLA use.

- **Conclusions**: Insufficient personnel exist to meet recommended data collection. Inter-hospital comparisons are not possible because of variation in definitions, denominators, and patients surveyed.

<table>
<thead>
<tr>
<th>Patient Safety Indicator</th>
<th>Start Date of Public Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clostridium difficile (C. difficile)</td>
<td>Sept. 30, 2008</td>
</tr>
<tr>
<td>Vancomycin-resistant Enterococci (VRE)</td>
<td>Dec. 31, 2008</td>
</tr>
<tr>
<td>Hospital standardized mortality ratio (HSMR)</td>
<td>Dec. 31, 2008</td>
</tr>
<tr>
<td>Rates of ventilator-associated pneumonia</td>
<td>April 30, 2009</td>
</tr>
<tr>
<td>Rates of central line infections</td>
<td>April 30, 2009</td>
</tr>
<tr>
<td>Rates of surgical site infections</td>
<td>April 30, 2009</td>
</tr>
<tr>
<td>Hand hygiene compliance among health care workers</td>
<td>April 30, 2009</td>
</tr>
</tbody>
</table>
U.S. Deficit Reduction Act

As of October 1, 2008, Medicare will stop paying hospitals for treating the following conditions, if they are not present on admission:

- Catheter-associated urinary tract infections
- Pressure ulcers (decubitus ulcers)
- Vascular catheter-associated infections
- Mediastinitis after coronary artery bypass graft surgery
- Fractures, dislocations, or other hospital-acquired injuries
- Objects left in during surgery
- Air embolisms
- Blood incompatibilities
Pathophysiology of Catheter-Related Infection

All sources of infection are potential targets for prevention.

Critically ill patient: 2-4 vascular access devices

Infusates/drugs

hub/lines

Dressing

skin

catheter

hematogeneous
Pathogenesis of CR-BSI
Extraluminal biofilm is the major source of CRBSI within the first week of catheterization in short-term catheters. Extraluminal biofilm is the major source of tunnel infections in long-term catheters.

Intraluminal biofilm is the major source of CRBSI after 1 week in both short- and long-term catheters.

The Perfect Storm for CLA-BSI Prevention?

- **2006-2009:** State legislatures pass laws mandating reporting of healthcare-associated infections.

- **July 2008:** The Joint Commission (JC) released its National Patient Safety Goal (NPSG) #7 which is expanded in 2009 and now includes the following recommendation:
  - Prevent central line-associated bloodstream infections (CLA-BSIs) by implementing best practices or evidence-based guidelines.

- **October 1, 2008:** The Center for Medicare and Medicaid Services (CMS) implemented its new reimbursement guidelines that result in eliminating payment for selected healthcare-associated infections (HAIs), including CLA-BSIs, not present upon admission.
  - Major private insurance companies are following CMS’s lead.

- **October 8, 2009:**
  - Infection control, hospital, and infectious diseases organizations (i.e., Society for Healthcare Epidemiology of America (SHEA), Infectious Diseases Society of America (IDSA) in partnership with the Association for Professionals in Infection Control and Epidemiology (APIC), Joint Commission (JC), and American Hospital Association (AHA) release new recommendations for the prevention of HAIs, including CLA-BSIs.
Strategies to Prevent Central Line-Associated Bloodstream Infections (CLA-BSIs) in Acute Care Hospitals.


Strategies to Prevent Central Line–Associated Bloodstream Infections in Acute Care Hospitals

Teresa Marschall, MD; Edward A. Mercure, DO; Seji David Chusid, MD; Kathleen M. Arias, MS, CIC; Kelly Candidate, RN, MS, CICP; Darrell T. Anderson, MD, MPH; Robin Baron, MD; David S. Cohen, MD; MS; James E. Coffin, MD; MPH; Eric L. Dubois, MD; Victoria Fennelly, MD; Delia N. Friedland, MD; Frances A. Griffin, MPH; MPA; Peter Gross, MD; Keith S. Kave, MD; Michael Kowalski, MD; Elinor G. Lowenstein, MD; Lindsay Nicolle, MD; FOX A. Pappas, MD; Tiril M. Pedersen, MD; Basman Saini, MD; Cassandra D. Salgards, MD; MS; Robert A. Waldvogel, MD; Robert Wax, MD; Deborah Yolken, MD, MPH

P U R P O S E
Practically published guidelines are reliable that provide comprehensive recommendations for detecting and preventing healthcare-associated infections. The intent of this document is to highlight practical recommendations in a concise format designed to assist acute-care hospitals in implementing and prioritizing their central-line–associated bloodstream infection (CLA-BSI) prevention efforts. Refer to the Society for Healthcare Epidemiology of America's Infectious Disease Society of America's "Compendium of Strategies to Prevent Healthcare-Associated Infections." Executive Summary and Introduction and accompanying editorial for additional discussion.

S E C T I O N 1: RATIONALE AND STATEMENTS OF CONCERN
1. Patients at risk for CLA-BSIs in acute care facilities:
   a. Intensive care unit (ICU) population: The risk of CLA-BSIs in ICU patients is high. Reasons for this include frequent insertion of multiple catheters, the use of specific types of catheters that are almost exclusively inserted in ICU patients, and associated with substantial risk (eg, arterial catheters), and the fact that patients are frequently placed in emergency circumstances, repeatedly sedated each day, and often need for extended periods.12
   b. Hypo-ICU population: Although the primary focus of attention over the past 2 decades has been the ICU setting, recent data suggest that the greatest numbers of patients with central lines are in hospital units outside the ICU, where there is a substantial risk of CLA-BSI.13
   c. Outcomes associated with hospital-acquired CLA-BSI:
      i. Increased length of hospital stay10
      ii. Increased cost, the non-inflation-adjusted attributable cost of CLA-BSIs has been found to vary from $3,790 to $2,46,000 per episode.3,11
      iii. Independent risk factors for CLA-BSI (in 2 or more published studies)10
         a. Factors associated with increased risk:
            i. Prolonged hospitalization before catheterization
            ii. Prolonged duration of catheterization
            iii. Heavy microbial colonization at the insertion site
            iv. Major surgical intervention of the catheter hub
            v. Insertion site location


Accepted June 9, 2008; electronically published September 16, 2008

Copyright © 2008 by The Society for Healthcare Epidemiology of America. All rights reserved. 0899-823X/2008/2908-0030. DOI: 10.1086/590583
SHEA Recommended Basic and Special Approaches for the Prevention of CLA-BSIs

**Basic Practices**
- Catheter Checklist: B- II
- Hand Hygiene: B- II
- Insertion site-Femoral: A- I
- Cart Kit: B- II
- Maximal Barrier Precautions: A- I
- Chlorhexidine (CHG) Skin Prep: A- I

**Special Approaches**
- CHG Baths (ICU patients): B- II
- Impregnated Catheters: A- I
- BioPatch Disk: B- I
- Antimicrobial Locks: A- I

## Effect of Hand Hygiene on Resistant Organisms*

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Setting</th>
<th>Impact on organisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>Maki</td>
<td>adult ICU</td>
<td>decreased</td>
</tr>
<tr>
<td>1984</td>
<td>Massanari</td>
<td>adult ICU</td>
<td>decreased</td>
</tr>
<tr>
<td>1990</td>
<td>Simmons</td>
<td>adult ICU</td>
<td>no effect</td>
</tr>
<tr>
<td>1992</td>
<td>Doebbeling</td>
<td>adult ICU</td>
<td>decreased with one versus another hand hygiene product</td>
</tr>
<tr>
<td>1994</td>
<td>Webster</td>
<td>NICU</td>
<td>MRSA eliminated</td>
</tr>
<tr>
<td>1999</td>
<td>Pittet</td>
<td>hospital</td>
<td>MRSA decreased</td>
</tr>
</tbody>
</table>

ICU = intensive care unit; NICU = neonatal ICU
MRSA = methicillin-resistant *Staphylococcus aureus*

*All interventions included multifaceted intervention programs; Most quasi-experimental or observational, not randomized trials. No randomized trial of hand hygiene vs. no hand hygiene has been conducted.

Source: Pittet D: Emerg Infect Dis 2001;7:234-240
Effect of Maximal Barrier Precautions During Insertion on CVC Infections

Raad I. et al., Infect Control Hosp Epidemiol, 1994
Chlorhexidine Compared with Povidone-Iodine Solution for Vascular Catheter–Site Care: A Meta-Analysis

<table>
<thead>
<tr>
<th>Study (Reference), Year</th>
<th>Risk Ratio (95% CI)</th>
<th>Catheters, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mald et al. (7), 1991</td>
<td>0.18 (0.92–1.46)</td>
<td>441</td>
</tr>
<tr>
<td>Sheehan et al. (9), 1993</td>
<td>1.05 (0.07–16.61)</td>
<td>346</td>
</tr>
<tr>
<td>Maffre et al. (10), 1995</td>
<td>0.97 (0.20–4.77)</td>
<td>1117</td>
</tr>
<tr>
<td>Almaz et al. (11), 1996</td>
<td>0.64 (0.15–2.21)</td>
<td>315</td>
</tr>
<tr>
<td>Legras et al. (12), 1997</td>
<td>0.13 (0.01–2.45)</td>
<td>457</td>
</tr>
<tr>
<td>Humar et al. (14), 2000</td>
<td>0.75 (0.20–2.75)</td>
<td>374</td>
</tr>
<tr>
<td>Knaus and Mald, 2000°</td>
<td>0.36 (0.14–0.95)</td>
<td>249</td>
</tr>
<tr>
<td>Overall (95% CI)</td>
<td>0.49 (0.28–0.88)</td>
<td>3899</td>
</tr>
</tbody>
</table>

Evidence-Based Measures to Decrease the Risk of Infection During Maintenance of the Intravascular Catheter

- Minimize catheter site skin bioburden.
- Device selection
- Aseptic manipulation of catheter connectors—**Scrub the hub**!
- (Antibiotic/antiseptic lock)
- (Impregnated-catheters)
Microbiology of the Skin

- 80% of the resident bacteria exist within the epidermis
- 20% are found in biofilms within hair follicles and sebaceous glands
- Complete re-colonization can occur within 18 hours of antiseptic application


Posted 08/18/2005.
Skin Microbial Density
Catheter Entry Site Matters

• Skin surface microbial density varies at different body sites and between genders

• Normal microbial colony counts at the antecubital space are 10 to 20 CFU per cm²

Photo contributed by Marcia Ryder PhD MS RN

Ryder M. Evidence-based practice in the management of vascular access devices for home parenteral nutrition therapy. JPEN. 2006;30(1):S82-93.
Skin Microbial Density
Catheter Entry Site Matters

• Skin surface microbial density is highest on the skin at the femoral, jugular, and subclavian sites

• Normal microbial colony counts at the subclavicular space are $10^3 - 10^4$ CFU per cm$^2$

Ryder M. Evidence-based practice in the management of vascular access devices for home parenteral nutrition therapy. *JPEN*. 2006;30(1):S82-93
Photo contributed by Marcia Ryder, PhD, MS, RN
Randomized Controlled Trial Evaluating a Chlorhexidine-Impregnated Patch (BIOPATCH) and Conventional Dressing

<table>
<thead>
<tr>
<th>Intervention</th>
<th>% local infections (N=1,401 lines)</th>
<th>% CR-BSIs (N=589 subjects)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOPATCH Dressing</td>
<td>16.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Control</td>
<td>29.3</td>
<td>6.1</td>
</tr>
</tbody>
</table>

• Comparative efficacy findings:
  – 44% reduction in the incidence of local infection
  – 60% reduction in the incidence of CR-BSIs
  – Statistically significant reduction in skin colonization

Maki D et al. ICAAC, Toronto, Canada, 2000
Chlorhexidine-Impregnated Sponges and Less Frequent Dressing Changes for Prevention of Catheter-Related Infections in Critically Ill Adults: A Randomized Controlled Trial

Context Use of a chlorhexidine gluconate-impregnated sponge (CHGIS) in intravascular catheter dressings may reduce catheter-related infections (CRIs). Changing catheter dressing every 3 days may be more frequent than necessary.

Objective To assess superiority of CHGIS dressings regarding the rate of major CRIs (clinical sepsis with or without bloodstream infection) and noninfectivity (less than 3% colonization-rate increase) of 7-day vs 3-day dressing changes.

Design, Setting, and Patients Assessor-blind, 2 × 2 factorial, randomized controlled trial conducted from December 2006 through June 2008 and recruiting patients from 7 intensive care units in 3 university and 2 general hospitals in France. Patients were adults (>18 years) expected to require an arterial, central-vein catheter, or both inserted for 48 hours or longer.

Interventions Use of CHGIS vs standard dressings (control). Scheduled change of unsoaked adherent dressings every 3 vs every 7 days, with immediate change of any soiled or leaking dressings.

Main Outcome Measures Major CRIs for comparison of CHGIS vs control dressings; colonization rate for comparison of 3- vs 7-day dressing changes.

Results Of 2096 eligible patients, 1636 (3778 catheters, 28931 catheter-days) could be evaluated. The median duration of catheter insertion was 6 (interquartile range [IQR], 4-10) days. There was no interaction between the interventions. Use of CHGIS dressings decreased the rates of major CRIs (10.4% vs 15.3% [IQR]; 0.6 per 1000 catheter-days vs 1/980; hazard ratio [HR], 0.39 [95% confidence interval [CI], 0.17-0.83]; P = .03) and catheter-related bloodstream infections (5.3% vs 6.9% catheter-days; HR, 0.40 [95% CI, 0.20-0.77]). Use of CHGIS dressings was not associated with greater resistance of bacteria in skin samples at catheter removal. Severe CHGIS-associated contact dermatitis occurred in 8 patients (3.3 per 1000 catheter-days). Use of CHGIS dressings prevented 1 major CRI per 117 catheters. Catheter colonization rates were 142 of 1657 catheters (8.5%); in the 3-day group (64 per 1000 catheter-days) and 16 of 1828 catheters (0.9%). In the 7-day group (11.0 per 1000 catheter-days), there was an absolute difference of 0.8% (95% CI, 1.78% to 2.15%; HR, 0.93 [95% CI, 0.77-1.18]), indicating noninferiority of 7-day changes. The median number of dressing changes per catheter was 4 (IQR, 3-6) in the 3-day group and 3 (IQR, 2-5) in the 7-day group (P < .001).

Conclusions Use of CHGIS dressings with intravascular catheters in the intensive care unit reduced risk of infection even when background infection rates were low. Reducing the frequency of changing unsoaked adherent dressings from every 3 days to every 7 days modestly reduces the total number of dressing changes and appears safe.

Trial Registration clinicaltrials.gov Identifier: NCT00417235

JAMA. 2009;201(12):1235-1241

Author Affiliations and the Members of the Dressing Study Group are listed at the end of this article.

Corresponding Author Jean-François Timsit, MD, PhD, INSERM U821, University Joseph Fourier, Albert Bonnot Institute, 20076, Grenoble Cedex, France (jean-francois.timsit@univ-grenoble1.fr).

Caring for the Critically Ill Patient Section Editor: Dennis C. Angtuco, MD, MPH, Contributing Editor, JAMA (lang dado@ajmc.com).

See also p. 1285 and Patient Page.
Does Vancomycin Lock or Flush Reduce CVC-BSIs?

- **Study design**: Meta-analysis of prospective randomized studies, 1966-2006.
- **Results**: Seven studies with 463 patients; cancer (n=5), NICU (n=1), cancer/TPN (n=1).
  - Summary risk ratio for vancomycin-heparin lock or flush = 0.49 (95% CI: 0.26-0.95, P=0.03).
  - Summary risk ratio for vancomycin-heparin lock: 0.34 (95% CI: 0.12-0.98, P=0.04)
- **Conclusion**: Use of vancomycin lock in high-risk patients with long-term IVDs reduces the risk of BSI.

Sadfar N et al. CID 2006;43:474-84
Meta-analysis of CA-BSI Rates with Antiseptic Catheters

Summary

George Trazzera Ramsay Pemberton Ciresi Collin Heard Bach Hannan Maki Tennenberg

OR 0.56, 95% CI (0.37-0.84)

(Veenstra, Saint, Saha, et al. JAMA 1999)
## Prevention: Impact of Coated Catheters

### Meta-analysis of published studies

<table>
<thead>
<tr>
<th>Nº of studies</th>
<th>0.03</th>
<th>0.1</th>
<th>0.3</th>
<th>1.0</th>
<th>RR (95% CI)</th>
<th>NNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 colonization</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>0.60 (0.49-0.74)</td>
<td>8</td>
</tr>
<tr>
<td>16 bloodstream infections</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td>0.64 (0.46-0.88)</td>
<td>55</td>
</tr>
<tr>
<td>6 &gt;1 week</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.35 (0.16-0.67)</td>
<td>28</td>
</tr>
<tr>
<td>9 &lt;1 week</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.82 (0.56-1.21)</td>
<td>122</td>
</tr>
</tbody>
</table>

*Walder, Pittet, Tramer CCM 02*
Does the BioPatch Enhance CVC-BSI Prevention in Patients with Impregnated Catheters?

- **Study design:** Prospective, randomized, open, controlled study in cancer chemotherapy patients requiring central venous catheters (CVC) for >5 days between January 2004 and January 2006. All patients had a chlorhexidine and silver sulfadiazine-impregnated triple lumen CVC. Randomized to CHG-sponge vs. standard dressing. Independent observation of site.

- **Results:** 601 patients with 9,731 CVC-days. Mean CVC duration: 16.6 days (treatment) vs. 15.8 days (control). Mean neutropenia: 7.5 days (treatment) vs. 6.9 days (control). CVC-related infections: 34/301 (11.3%) in control vs. 19/300 (6.3%) in CHG-sponge group (p=0.016, RR=0.54). CVC-related infections significantly reduced at internal jugular vein-inserted CVCs (P=0.018).

- **Summary:** The use of the CHG-sponge (BioPatch) reduced CVC-related infections even when CHG-silver impregnated catheters were used.

Device Selection
Split Septum Needleless Devices

Split septum surface

- Interlink
  - Blunt cannula insertion
  - Accepts both Luer Lock and Luer Slip Connections
  - High Flow Rates
  - Accepts Needle in Emergency

- Q-Syte
Mechanical Valves

For illustrative purposes only. Does not imply association with increased BSIs.
Increased BSI Rate Temporally Associated With Switching From A Split Septum to Mechanical Valve Needleless Device in a Long-Term Acute Care Hospital

• **Study location**: 40 bed long-term acute care hospital.
• **Split septum (SS) period**: January 2002-December 2003 (Interlink).
• **Mechanical valve (MV) period**: January 2004-October 2005 (SmartSite).

<table>
<thead>
<tr>
<th></th>
<th>SS Period</th>
<th>MV Period</th>
<th>RR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSI Rate*</td>
<td>1.79</td>
<td>5.41</td>
<td>3.02</td>
<td>2.62-3.39</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>GNB-BSIs</td>
<td>8%</td>
<td>39.5%</td>
<td>4.93</td>
<td>1.27-19.19</td>
<td>.0006</td>
</tr>
</tbody>
</table>

*BSI rate per 1,000 catheter days; BSI rate has decreased since returning to a split septum needleless device.

Increase in BSIs Temporally Associated with Switching From A Split Septum to a Positive Displacement Needleless Valve Device

- **Study location**: Academic medical center
- **Split septum (SS) period**: January 2003-February 2005 (Interlink/Q-Syte)
- **Positive displacement needleless valve (PDV) period**: March-August 2005 (SmartSite Plus)

<table>
<thead>
<tr>
<th>Unit</th>
<th>BSI SS Period</th>
<th>Rate PDV Period</th>
<th>P-value</th>
<th>Post-PDV SS Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Care/Transplant</td>
<td>3.87</td>
<td>10.43</td>
<td>&lt;.0001</td>
<td>7.62</td>
</tr>
<tr>
<td>9 other inpatient</td>
<td>3.47</td>
<td>7.51</td>
<td>&lt;.0001</td>
<td>2.36</td>
</tr>
<tr>
<td>Cooperative care (OPD TX)</td>
<td>5.80</td>
<td>15.18</td>
<td>.0005</td>
<td>4.30</td>
</tr>
</tbody>
</table>

*BSI Rate per 1,000 CVC-days  
Rupp M et al. CID 2007;44:1408-14
Increased CVC-BSIs on an Oncology Unit Associated with Mechanical Valve Needleless Connectors

• Setting: Hematology Oncology Unit at Geelong Hospital, a 400 bed hospital in SW Victoria, Australia. All patients with Hickman Catheters from July 2004-June 2005. Use of Clave and CLC-2000 (ICU Medical) from November 2004-March 2005.

• Results: 98 patients. CVC-BSI rate: increased from 2.6 (split septum) to 5.8 (mechanical valve) per 1,000 CVC-days (IRR 2.2, 95%CI 1.0-4.9, p<0.031). Post-MV SS use: CVC-BSI rate = 2.3 per 1,000 CVC-days.

Increased CVC-BSIs Temporally Associated with a Change From a Mechanical Valve to a Positive Pressure Mechanical Valve

- Johns Hopkins Hospital (JHH) used a mechanical valve without positive pressure (CLAVE, ICU Medical) for 10 years institution-wide.
- To reduce the use of heparin flushes in CVCs, JHH changed to the use of a positive pressure mechanical valve, SmartSite (Alaris). This new device was implemented in all units from April to December 2004.
- Active catheter-related bloodstream infection (CR-BSI) surveillance was conducted in all ICUs.
- An aggressive, multi-faceted program to lower CR-BSI was conducted in all ICUs.
- No changes in IV policies. Both mechanical valves and IV administration sets were changed every 96 hours. 70% alcohol was used for device disinfection. With their initial mechanical valve, the line was clamped before syringe disconnection. Whereas, the positive pressure mechanical valve was clamped after the syringe was disconnected.

Comparison of BSI Rates During Mechanical Valve (MV) and Positive Pressure Mechanical Valve (PPMV) Periods, JHH

<table>
<thead>
<tr>
<th>Location</th>
<th>BSI MV Period</th>
<th>Rate* PPMV Period</th>
<th>IRR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All ICUs</td>
<td>1.50</td>
<td>2.40</td>
<td>1.6</td>
<td>1.04-2.48</td>
<td>.05</td>
</tr>
<tr>
<td>Children’s Center</td>
<td>1.55</td>
<td>2.79</td>
<td>1.79</td>
<td>1.1-2.9</td>
<td>.01</td>
</tr>
<tr>
<td>--PICU</td>
<td>5.4</td>
<td>17.3</td>
<td>3.22</td>
<td>1.1-9.6</td>
<td>.02</td>
</tr>
<tr>
<td>--NICU</td>
<td>0.51</td>
<td>1.34</td>
<td>2.63</td>
<td>0.52-12.2</td>
<td>.17</td>
</tr>
<tr>
<td>--Ped Onc</td>
<td>2.61</td>
<td>4.71</td>
<td>1.81</td>
<td>0.64-4.9</td>
<td>.21</td>
</tr>
</tbody>
</table>

*Rate per 1,000 catheter-days; PPMV=Positive Pressure MV

Gram-negative bloodstream infections in hematopoietic stem cell transplant patients: The roles of needleless device use, bathing practices, and catheter care

**Study design:** Between August 1 and October 30, 1998 (outbreak period), an increased incidence of central venous catheter (CVC)-associated gram-negative bacterial bloodstream infection (GN-BSI) was detected in hematopoietic stem cell transplantation (HSCT) candidates and recipients in an outpatient HSCT unit in Seattle, WA. The Clave needleless connector was introduced in July 20, 1998. An epidemiologic study was performed to identify risk factors for GN-BSI.

Toscano C. et al. AJIC 2009;37:327-34.
Gram-negative bloodstream infections in hematopoietic stem cell transplant patients: The roles of needleless device use, bathing practices, and catheter care

• **Results**: CVC-associated GN-BSI rate was higher during the outbreak than pre-outbreak period (2.1 vs. 0.7 per 1000 CVC-days; RR 3.17; 95%CI 1.81 to 5.56; P=.01). All 31 case-patients identified had Clave needleless connectors. Independent risk factors for CVC-associated GN-BSI were self-administered IV infusion (OR 6.2; P=.02), lower frequency of needleless device changes (OR 15.2; P=.03), and more frequent baths (OR 1.4; P=.05). Interventions included increased frequency of needleless device change, recommending showers rather than baths, and use of CVC protection during howering/bathing. After these interventions, the CVC-associated GN-BSI rate declined to below the pre-outbreak period rate (2.1/1000 vs. 0.3/1000 CVC-days; P=.01).

• **Conclusions**: This study demonstrated an increased risk of CVC-associated GN-BSIs related to the Clave needleless connector and self-IV infusion, bathing habits, and frequency of needleless device change. Infection control practices associated with the use of needleless devices may expose susceptible patients to increased risk for BSI.

Toscano C. et al. AJIC 2009;37:327-34.
Health Care–Associated Bloodstream Infections Associated with Negative- or Positive-Pressure or Displacement Mechanical Valve Needleless Connectors

William R. Jarvis,1 Cathryn Murphy,1 Keri K. Hall,2 Pamela J. Fogle,3 Tohi B. Karchmer,4 Glenys Harrington,7 Cassandra Salgado,6 Eve T. Giannetta,1 Carol Camerons,1 and Robert J. Shorr2

1Vanderbilt University, Nashville, TN; 2University of Virginia; 3Bronx-Lebanon Hospital Center, New York; 4The Ohio State University, Columbus; 5Vanderbilt University School of Medicine, Nashville, TN; 6University of Virginia Medical Center, Charlottesville, VA; 7University of Virginia Health System, Charlottesville, VA

Background. Health care–associated, central venous catheter–related bloodstream infections (HA-BSIs) are a major cause of morbidity and mortality. Needleless connectors (NCs) are an important component of the intravascular system. NCs initially were introduced to reduce health care worker needlestick injuries, yet some of these NCs may increase HA-BSI risk.

Methods. We compared HA-BSI rates on wards or intensive care units (ICUs) at 5 hospitals that had converted from split septum (SS) connectors or needles to mechanical valve needleless connectors (MV-NCs). The hospitals (16 ICUs, 1 entire hospital, and 1 oncology unit; 3 hospitals were located in the United States, and 2 were located in Australia) had conducted HA-BSI surveillance using Centers for Disease Control and Prevention definitions during use of both NCs. HA-BSI rates and prevention strategies were compared during the pre-MV period, MV period, and post-MV period.

Results. The HA-BSI rate increased in all ICUs and wards when SS-NCs were replaced by MV-NCs. In the 16 ICUs, the HA-BSI rate increased significantly when SS-NCs or needles were replaced by MV-NCs: 6.15 vs 9.49 BSIs per 1000 central venous catheter (CVC)-days; relative risk, 1.54; 95% confidence interval, 1.37–1.74; P<0.001. The 14 ICUs that switched back to SS-NCs had significant reductions in their BSI rates (9.49 vs 7.77 BSIs per 1000 CVC-days; relative risk, 1.65; 95% confidence interval, 1.38–1.96; P<0.001). BSI infection prevention strategies were similar in the pre-MV and MV periods.

Conclusions. We found strong evidence that MV-NCs were associated with increased HA-BSI rates, despite similar BSI surveillance, definitions, and prevention strategies. Hospital personnel should monitor their HA-BSI rates and, if they are elevated, examine the role of newer technologies, such as MV-NCs.

Each year in the United States, >150 million intravascular (IV) catheters are used. IV catheters are the major risk factor for health care–associated catheter–related bloodstream infections (HA-BSIs). HA-BSIs result in substantial morbidity and mortality and cost $34,000–$56,000 per episode [1–3]. The Centers for Disease Control and Prevention (CDC) estimates that, in US intensive care unit (ICU) patients, >60,000 HA-BSIs occur, costing up to $2.5 billion annually [1, 4, 5]. In October 2008, the Center for Medicare and Medicaid Services (CMS) and major US health insurance carriers discontinued increased payment for HA-BSIs, so HA-BSI prevention is even more critical for facility financial viability.

Needles used with IV catheters are a source of health care worker (HCW) needlestick injuries (NSIs). In 1992, the US Occupational Safety and Health Administration recommended that health care facilities use safer IV devices to protect HCWs. The first generation of these devices introduced were needle devices with...
<table>
<thead>
<tr>
<th>Hospital</th>
<th>IV team</th>
<th>Antibiotic/antiseptic impregnated catheters</th>
<th>CHG patch (e.g., BioPatch)</th>
<th>Catheter securement device (e.g., Statlock)</th>
<th>Vancomycin prophylaxis</th>
<th>Use of stopcocks in IV line</th>
<th>Blood draws through NC</th>
<th>NC disinfectant</th>
<th>SS period: use of maximum barrier precautions</th>
<th>SS period skin antiseptic for CVC placement</th>
<th>MV period: use of maximum barrier precautions</th>
<th>MV period: skin antiseptic for CVC placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Yes*</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>ETOH</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>CHG/ETOH</td>
</tr>
<tr>
<td>B</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>ETOH</td>
<td>No</td>
<td>ETOH/PI</td>
<td>Yes</td>
<td>CHG</td>
</tr>
<tr>
<td>C</td>
<td>No</td>
<td>No/yesb</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>ETOH</td>
<td>Yes</td>
<td>CHG/ETOH</td>
<td>Yes</td>
<td>CHG/ETOH</td>
</tr>
<tr>
<td>D</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>ETOH</td>
<td>Yes</td>
<td>CHG/ETOH</td>
<td>Yes</td>
<td>CHG/ETOH</td>
</tr>
<tr>
<td>E</td>
<td>No</td>
<td>SS period, no; MV period, yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>ETOH</td>
<td>Yes&lt;sup&gt;c&lt;/sup&gt;</td>
<td>CHG/ETOH</td>
<td>Yes</td>
<td>CHG/ETOH</td>
</tr>
</tbody>
</table>

**NOTE.** CHG, chlorhexidine gluconate; ETOH, alcohol; IV, intravenous; MV, mechanical valve; NC, needleless connector; PI, povidone iodine; SS, split septum.

* On wards but not in the intensive care unit; for peripheral catheters, but not central venous catheters.

<sup>b</sup> Some antiseptic-impregnated catheters used on the basis of patient risk.

<sup>c</sup> Yes, except uses drape covering half the body.
<table>
<thead>
<tr>
<th>Hospital</th>
<th>Country</th>
<th>SS/needle used</th>
<th>Duration SS use, months</th>
<th>MV used</th>
<th>Duration of MV use, months</th>
<th>Post-MV device used</th>
<th>Duration post-MV period, months</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>United States</td>
<td>Interlink</td>
<td>18</td>
<td>UltraSite</td>
<td>39</td>
<td>Q-Syte</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>United States</td>
<td>Interlink</td>
<td>24</td>
<td>Clearlink</td>
<td>21</td>
<td>Interlink</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>United States</td>
<td>Interlink</td>
<td>18</td>
<td>Clearlink</td>
<td>11</td>
<td>Interlink</td>
<td>18</td>
</tr>
<tr>
<td>D</td>
<td>Australia</td>
<td>Interlink</td>
<td>12</td>
<td>SmartSite</td>
<td>12</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>E</td>
<td>Australia</td>
<td>Needles</td>
<td>6</td>
<td>SmartSite</td>
<td>11</td>
<td>Not available</td>
<td>Not available</td>
</tr>
</tbody>
</table>
### Table 3. Participating Hospital Bloodstream Infection (BSI) Rates during Split Septum (SS) and Mechanical Valve (MV) Needleless Device Use Period.

<table>
<thead>
<tr>
<th>Hospital, unit/ward</th>
<th>SS BSI rate (^a)</th>
<th>MV BSI rate</th>
<th>Relative risk (95% CI)</th>
<th>(P)</th>
<th>Post-MV-BSI rate</th>
<th>Relative risk (95% CI)</th>
<th>(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Adult ICUs (n = 4)</td>
<td>8.47</td>
<td>9.84</td>
<td>1.16 (0.94–1.44)</td>
<td>.16</td>
<td>6.10</td>
<td>1.61 (1.18–2.22)</td>
<td>.003</td>
</tr>
<tr>
<td>B: Adult ICUs (n = 6)</td>
<td>3.09</td>
<td>8.82</td>
<td>2.85 (2.15–3.65)</td>
<td>&lt;.001</td>
<td>5.29</td>
<td>1.67 (1.12–2.48)</td>
<td>.008</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult wards</td>
<td>2.48</td>
<td>3.41</td>
<td>1.38 (0.98–1.93)</td>
<td>.05</td>
<td>2.29</td>
<td>1.49 (1.04–2.11)</td>
<td>.02</td>
</tr>
<tr>
<td>Adult ICUs (n = 4)</td>
<td>3.15</td>
<td>3.47</td>
<td>1.10 (0.67–1.46)</td>
<td>.67</td>
<td>2.89</td>
<td>1.20 (0.74–1.95)</td>
<td>.43</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult ICU</td>
<td>0</td>
<td>4.30</td>
<td>NC (0.03–993)</td>
<td>.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult oncology ward</td>
<td>2.70</td>
<td>6.20</td>
<td>2.30 (2.09–2.71)</td>
<td>.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E: Adult ICU</td>
<td>6.80</td>
<td>11.8</td>
<td>1.79 (1.24–2.56)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A–E: Adult ICUs (n = 16)</td>
<td>6.15</td>
<td>9.49</td>
<td>1.54 (1.37–1.74)</td>
<td>&lt;.001</td>
<td>5.77(^b)</td>
<td>1.65 (1.38–1.96)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

**NOTE**  CI, confidence interval; ICU, intensive care unit; NC, not calculated.

\(^a\) Rates are based on health care–associated BSIs per 1000 central venous catheter–days for all except hospital C, which used 1000 patient-days for the adult ward health care–associated BSI rate that includes the entire hospital.

\(^b\) Includes 3 hospitals with 14 adult ICUs. Post-MV rate includes the health care–associated BSI rate only in facilities changing from MV needleless connectors to SS needleless connectors.
How May the Mechanical Valves Lead to BSIs?

- **Location**: Wake Forest University School of Medicine.
- **Study Design**: Quantitative cultures of blood from ICU patients drawn through MV ND from December 12, 2004 to January 21, 2005 (initial syringe pull back of morning blood draw).
- **Results**:
  - 226 “discard” obtained from 83 patients.
  - 39/226 (17%; range 8% to 50%, by unit) culture positive.
  - Colony forming units (CFU/ml): median=0.3, range 0.1->100.
  - Pathogens: 25 CNS, 5 yeast, 2 S. aureus, 2 each Serratia or Enterococcus spp., 1 each S. maltophilia or Acinetobacter spp.; 31% would be considered pathogens in a blood culture.
  - 31% of nurses did not disinfect the MV before accessing system.

Karchmer TB et al. SHEA 2005, Abstract #307
Disinfection of Needleless Catheter Connectors

- **Study design**: In vitro study.
  - 3 luer-activated valved connectors (Clearlink [Baxter Healthcare], PosiFlow [Becton-Dickinson], and Micro CLAVE [ICU Medical]) were studied.
  - 36 connectors from each tested concurrently.
  - One device as control, the rest inoculated by immersing the membranous surface in a suspension of *E. faecalis* containing >10^8 colony forming units (CFUs) per ml. Septum allowed to dry for 24 hours (final inoculum 10^5 CFU/ml).
  - Accessed by sterile syringe containing 3ml of sterile tryptocase soy broth and flushed with broth.

Menyhay and Maki  ICHE 2006;27:23-27
<table>
<thead>
<tr>
<th>Variable</th>
<th>No Disinfection</th>
<th>Disinfection With 70% Alcohol</th>
<th>Disinfection With Antiseptic-Barrier Cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of connectors showing microbial transmission across the membrane/total no. of connectors studied (%)</td>
<td>15/15 (100)</td>
<td>20/30 (67)</td>
<td>1/60 (1.6)</td>
</tr>
<tr>
<td>Approximate no. of colony-forming units traversing the membrane</td>
<td>4,500-28,000</td>
<td>442-25,000</td>
<td>0-350</td>
</tr>
</tbody>
</table>

\(^a\) \(P<.001\).
Disinfection of Mechanical Valves

• **Study design**: 300 MVs (4 types from 3 manufacturers) were tested. Each septum inoculated with $10^5$ CFUs/ml of *S. epidermidis*, *S. aureus*, *P. aeruginosa*, and/or *C. albicans*. Membranous septum disinfected for 15 seconds with friction, using 70% alcohol or 3.15% chlorhexidine/70% alcohol (Chlorascrub™). 0.9% non-bacteriostatic saline flush solutions were collected downstream and quantitatively cultured.

• **Results**: Disinfection of the membranous septum for **15 seconds with friction**, using either 70% alcohol alone or 3.15% chlorhexidine/70% alcohol (Chlorascrub™) was equally effective in preventing the transfer from the membranous septum downstream in the process of accessing the ports.

Guidelines for the Prevention of Intravascular Catheter-Related Infections

Prepared by
Naomi P. O’Grady, M.D.¹
Mary Alexander, R.N.²
Lillian A. Burns, M.T., M.P.H., C.I.C.³
E. Patchen Dellinger, M.D.⁴
Jeffery Garland, M.D.⁵
Stephen O. Heard, M.D.⁶
Pamela A. Lipsett, M.D.⁷
Henry Masur, M.D.¹
Leonard A. Mermel, D.O., Sc.M.⁸
Michele L. Pearson, M.D.⁹
Issam I. Raad, M.D.¹⁰
Adrienne Randolph, M.D., M.Sc.¹¹
Mark E. Rupp, M.D.¹²
Sajay Saint, M.D., M.P.H.¹³

¹National Institutes of Health, Bethesda, Maryland
²Infusion Nurses Society, Norwood, Massachusetts
³Greenwich Hospital, Greenwich, Connecticut
⁴University of Washington, Seattle, Washington
⁵Wheaton Franciscan Healthcare-St. Joseph, Milwaukee, Wisconsin
⁶University of Massachusetts Medical School, Worcester, Massachusetts
⁷Johns Hopkins University School of Medicine, Baltimore, Maryland
⁸Warren Alpert Medical School of Brown University and Rhode Island Hospital, Providence, Rhode Island
⁹Centers for Disease Control and Prevention, Atlanta, Georgia
¹⁰MD Anderson Cancer Center, Houston, Texas
¹¹The Children’s Hospital, Boston, Massachusetts
¹²University of Nebraska Medical Center, Omaha, Nebraska
¹³Ann Arbor VA Medical Center and University of Michigan, Ann Arbor, Michigan

Guidelines for the Prevention of Intravascular Catheter-Related Infections

Date From Subject
12-03-2009 William Jarvis (12 KB, 1 page)
12-03-2009 William Jarvis (110 KB, 18 pages)
12-03-2009 Barbara List (36 KB, 1 page)
12-03-2009 Barbara List (47 KB, 2 pages)
12-03-2009 Barbara List (36 KB, 4 pages)
12-03-2009 Barbara List (110 KB, 1 page)
12-03-2009 Betty Defina (37 KB, 1 page)
12-03-2009 Laura Dosen (49 KB, 1 page)
12-03-2009 Greg Art (31 KB, 1 page)
12-03-2009 Greg Art (30 KB, 1 page)

1/29 page(s) comments per page

What’s New in the 2009 CDC Draft IV Guideline or (Some things YOU need to know, but didn’t want to read the 123 page document!)
Major areas of emphasis include:

1) Educating and training healthcare personnel who insert and maintain catheters;
2) Using maximal sterile barrier precautions during central venous catheter insertion;
3) Using a 2% chlorhexidine (CHG) preparation for skin antisepsis;
4) Avoiding routine replacement of central venous catheters as a strategy to prevent infection; and
5) Using antiseptic/antibiotic impregnated short-term central venous catheters and CHG-impregnated sponge dressings if the rate of infection is high despite adherence to the above strategies;
6) Emphasize performance improvement by implementing bundled strategies, documenting and reporting rates of compliance rates with all components of the bundle as benchmarks for quality assurance and performance improvement.

http://www.cdc.gov/ncpdcid/pdf/Draft_BSI_guideline_v15_2FR.pdf
Number of Recommendations By Category

- Category 1A: 31
- Category 1B: 31
- Category 1C: 4
- Category II: 28
- Unresolved Issues: 4
CDC IV Guideline Draft: What’s Added

1. Discard multidose vial if sterility is compromised. Category IA
2. Use the needle and syringe to access the multidose vial only once and to then discard both safely. This applies to each and every dose withdrawn from the vial. Category IA
3. Use hospital-specific or collaborative-based performance improvement initiatives in which multifaceted strategies are "bundled" together improve compliance with evidence-based recommended practices. Category 1B
4. Use ultrasound guidance to place central venous catheters to reduce the number of cannulation attempts and mechanical complications [if this technology is available]. Category 1B
5. Use a needleless system to access IV tubing. Category IC
6. When needleless systems are used, the split septum valve is preferred over the mechanical valve due to increased risk of infection. Category II
CDC IV Guideline Draft: What’s Added

1. All multidose vials should be dated when 1st used and thereafter not used beyond the manufacturer's stated expiration period. Category IC
2. Do not routinely use anticoagulant therapy to reduce the risk of catheter-related infection in general patient populations. Category II
3. Use a 2% chlorhexidine wash daily to reduce CRBSI. Category II
4. During axillary or femoral artery catheter insertion, maximal sterile barriers precautions should be used. Category II
5. Replace arterial catheters only when there is a clinical indication. Category II
6. Remove the arterial catheter as soon as it is no longer needed. Category II
CDC IV Guideline Draft: What’s Been Upgraded

1. Use a chlorhexidine-impregnated sponge dressing for temporary short-term catheters in patients >2 months of age, if the CRBSI rate is higher than the institutional goal, despite adherence to basic CRBSI prevention measures. (Changed from unresolved issue to Category 1B).

2. Use a chlorhexidine/silver sulfadiazine or minocycline/rifampin-impregnated CVC in adults whose catheter is expected to remain in place >5 days if, after successful implementation of a comprehensive strategy to reduce rates of CRBSI, the CRBSI rate remains above the goal set by the individual institution based on benchmark rates and local factors. (Changed from a Category 1B to a 1A).

3. Minimize contamination risk by wiping the access port with an appropriate antiseptic (chlorhexidine preferred) and accessing the port only with sterile devices. (Changed from ETOH to CHG and upgraded from Category 1B to 1A).

4. Replace dressings used on short-term CVC sites every 2 days for gauze dressings and at least every 7 days for transparent dressings, except in those pediatric patients in which the risk for dislodging the catheter may outweigh the benefit of changing the dressing. (Changed from 11 to 1B)
1. Replace dressings used on tunneled or implanted CVC sites no more than once per week, until the insertion site has healed. (Changed from Category II to 1B)

2. Use povidone iodine antiseptic ointment or bacitracin/neomycin/polymyxin B ointment at the hemodialysis catheter exit site after catheter insertion and at the end of each dialysis session only if this ointment does not interact with the material of the hemodialysis catheter per manufacturer's recommendation. (Changed from a Category II to 1B).

3. Use a sutureless securement device to reduce the risk of infection for PICCs. (Changed from unresolved issue to Category II)

4. Use prophylactic antimicrobial lock solution in patients with long term catheters who have a history of multiple CRBSI despite optimal maximal adherence to aseptic technique. (Changed from do not use to use; both Category II)
1. In adults, use an upper-extremity site for catheter insertion. Replace a catheter inserted in a lower extremity site to an upper extremity site as soon as possible (Changed from a Category 1A to 1B)

2. Use maximal sterile barrier precautions, including the use of a cap, mask, sterile gown, sterile gloves, and a large sterile full body drape, for the insertion of CVCs, PICCs, or guidewire exchange. (Changed from a Category 1A to a 1B)

3. Do not use topical antibiotic ointment or creams on insertion sites, except for dialysis catheters, because of their potential to promote fungal infections and antimicrobial resistance. (Changed from Category 1A to 1B)

4. Replace catheter site dressing if the dressing becomes damp, loosened, or visibly soiled. (Changed from a 1A to a 1B).

5. No recommendation can be made regarding the necessity for any dressing on well-healed exit sites of long-term cuffed and tunneled CVCs. (Changed from a Category II to unresolved issue).
Lost in Space: In the 2002 Guideline But Not the 2009 Draft—Category 1As

1. Do not routinely culture catheter tips.
2. Select the catheter, insertion technique, and insertion site with the lowest risk for complications (infectious and noninfectious) for the anticipated type and duration of IV therapy.
3. Do not routinely use arterial or venous cutdown procedures as a method to insert catheters.
4. Do not apply organic solvents (e.g., acetone and ether) to the skin before insertion of catheters or during dressing changes.
5. Clean injection ports with 70% alcohol or an iodophor before accessing the system.
6. Do not use filters routinely for infection-control purposes.
7. Designate trained personnel for the insertion and maintenance of intravascular catheters. Do not routinely apply prophylactic topical antimicrobial or antiseptic ointment or cream to the insertion site of peripheral venous catheters.
8. Conduct surveillance in ICUs and other patient populations to determine CRBSI rates, monitor trends in those rates, and assist in identifying lapses in infection control practices.
Interventions That Prove That Implementation of Evidence-Based CVC-BSI Prevention Measures Can Prevent Infections, Save Lives, and Save Money
Central Line Insertion Checklist - Adults

Operator: ___________________________ Date: ______________________
RN Assisting: ___________________________ Room/Location: ____________

Safety Pause:
☐ Correct Patient    ☐ Correct Procedure
☐ Correct Site      ☐ Verbal agreement from all members of the team.

In order to eliminate central line associated blood stream infections, we will be following the Central Line Insertion Procedure Checklist based on CDC Guidelines.

Prior to the Procedure:
1. **Hand Hygiene** done with Chlorhexidine Gluconate (CHG) 2% surgical hand scrub and water or waterless alcohol based gel before patient contact and before donning sterile gloves.
   YES
2. **Cleansing Site** with 2% CHG with sponge 1.5mL.
   YES
3. **Disinfect Site** with a back and forth friction scrub, utilizing 2% CHG wand 10.5mL for 30 seconds and allow to dry completely before catheter insertion.
   YES
4. **Maximum Barriers** Did the operator wear:
   YES   Cap/Bouffant
   YES   Mask
   YES   Sterile Gown
   YES   Sterile Gloves
   YES   Patient draped with full body sterile sheet.

During the procedure:
5. YES Operator(s) maintained the sterile field.
6. YES Personnel assisting wore a cap, mask and donned gloves appropriately.

After the procedure:
6. **Sterile dressing** applied immediately by the operator.
   YES

QUALITY IMPROVEMENT

THIS FORM IS NOT PART OF THE PATIENT’S PERMANENT RECORD.

Please return the form to your Nurse Manager. If a step has was not followed, please note and the Nurse Manager will follow up with the physician.
Developing a Physician Champion—Prevention Should Be The Focus of Clinicians, Not Just Infection Control Personnel.

<table>
<thead>
<tr>
<th>DOCTOR</th>
<th># of CL Insertions</th>
<th>Full Barrier Precautions</th>
<th>Hand Hygiene</th>
<th>Femoral Lines</th>
<th>Used Chloroprep</th>
<th>Used Betadine</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>21</td>
<td>16 (76%)</td>
<td>17 (81%)</td>
<td>6 (29%)</td>
<td>19 (91%)</td>
<td>6 (29%)</td>
</tr>
<tr>
<td>B</td>
<td>13</td>
<td>13 (100%)</td>
<td>13 (100%)</td>
<td>2 (15%)</td>
<td>9 (69%)</td>
<td>6 (46%)</td>
</tr>
<tr>
<td>C</td>
<td>8</td>
<td>3 (38%)</td>
<td>7 (88%)</td>
<td>0</td>
<td>7 (88%)</td>
<td>1 (22%)</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>6 (100%)</td>
<td>5 (83%)</td>
<td>0</td>
<td>4 (67%)</td>
<td>4 (67%)</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>4 (100%)</td>
<td>3 (75%)</td>
<td>0</td>
<td>3 (75%)</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>F</td>
<td>3</td>
<td>2 (67%)</td>
<td>3 (100%)</td>
<td>0</td>
<td>1 (33%)</td>
<td>2 (67%)</td>
</tr>
</tbody>
</table>
Keystone Project

- Michigan Hospital Association
- 127 intensive care units (ICUs) in Michigan and five other states.
- **68 ICUs totally eliminated CVC-BSIs.**
- For 6 months, they eliminated VAP.
- Estimates that they saved >1,578 lives, reduced 81,000 hospital days, and saved $165 million.
- Hospitals in Rhode Island, New Jersey and Maryland are replicating the Keystone Project locally and others will follow.

Pronovost P. et al NEJM 2006;355:2725-32
Keystone Project

- **Study design**: Intervention cohort study in 108 Michigan Intensive care units (ICUs) over 18 months. Comparison of CVC-BSI rates before, during, and after intervention.

- **Results**: 103 ICUs. 1,981 months of ICU data and 375,757 catheter-days.

<table>
<thead>
<tr>
<th>Baseline</th>
<th>3 Months</th>
<th>IRR</th>
<th>16-18 Months</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7</td>
<td>0</td>
<td>0.62</td>
<td>1.4</td>
<td>0.34</td>
</tr>
</tbody>
</table>

**Conclusion**: An evidence-based intervention resulted in a large and sustainable decrease (up to 66%) in CVC-BSI rates that was maintained for 18 months.

Pronovost P. et al NEJM 2006;355:2725-32
**Table 2| Catheter related bloodstream infection rates from baseline until 36 months after quality improvement intervention**

<table>
<thead>
<tr>
<th>Study period</th>
<th>No of ICUs</th>
<th>Median (IQR) No of infections</th>
<th>Median (IQR) catheter days</th>
<th>Infection rate</th>
<th>Incidence rate ratio* (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>55</td>
<td>2 (1-3)</td>
<td>551 (220-1091)</td>
<td>2.7 (0.6-4.8)</td>
<td>7.7 (28.9)</td>
</tr>
<tr>
<td>During implementation</td>
<td>96</td>
<td>1 (0-2)</td>
<td>447 (237-710)</td>
<td>1.6 (0-4.4)</td>
<td>2.8 (4.0)</td>
</tr>
<tr>
<td>After implementation—initial evaluation period:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-3 months</td>
<td>95</td>
<td>0 (0-2)</td>
<td>436 (246-771)</td>
<td>0 (0-3.0)</td>
<td>2.3 (4.0)</td>
</tr>
<tr>
<td>4-6 months</td>
<td>95</td>
<td>0 (0-1)</td>
<td>460 (228-743)</td>
<td>0 (0-2.7)</td>
<td>1.8 (3.2)</td>
</tr>
<tr>
<td>7-9 months</td>
<td>96</td>
<td>0 (0-1)</td>
<td>467 (252-725)</td>
<td>0 (0-2.0)</td>
<td>1.4 (2.8)</td>
</tr>
<tr>
<td>10-12 months</td>
<td>95</td>
<td>0 (0-1)</td>
<td>431 (249-743)</td>
<td>0 (0-2.1)</td>
<td>1.2 (1.9)</td>
</tr>
<tr>
<td>13-15 months</td>
<td>95</td>
<td>0 (0-1)</td>
<td>404 (158-695)</td>
<td>0 (0-1.9)</td>
<td>1.5 (4.0)</td>
</tr>
<tr>
<td>16-18 months</td>
<td>95</td>
<td>0 (0-1)</td>
<td>367 (177-682)</td>
<td>0 (0-2.4)</td>
<td>1.3 (2.4)</td>
</tr>
<tr>
<td>After implementation—sustainability period:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19-21 months</td>
<td>89</td>
<td>0 (0-1)</td>
<td>399 (230-680)</td>
<td>0 (0-1.4)</td>
<td>1.8 (5.2)</td>
</tr>
<tr>
<td>22-24 months</td>
<td>89</td>
<td>0 (0-1)</td>
<td>450 (254-817)</td>
<td>0 (0-1.6)</td>
<td>1.4 (3.5)</td>
</tr>
<tr>
<td>25-27 months</td>
<td>88</td>
<td>0 (0-1)</td>
<td>481 (266-769)</td>
<td>0 (0-2.1)</td>
<td>1.6 (3.9)</td>
</tr>
<tr>
<td>28-30 months</td>
<td>90</td>
<td>0 (0-1)</td>
<td>479 (253-846)</td>
<td>0 (0-1.6)</td>
<td>1.3 (3.7)</td>
</tr>
<tr>
<td>31-33 months</td>
<td>88</td>
<td>0 (0-1)</td>
<td>495 (265-779)</td>
<td>0 (0-1.1)</td>
<td>0.9 (1.9)</td>
</tr>
<tr>
<td>34-36 months</td>
<td>85</td>
<td>0 (0-1)</td>
<td>456 (235-787)</td>
<td>0 (0-1.2)</td>
<td>1.1 (2.7)</td>
</tr>
</tbody>
</table>

ICU=intensive care units; IQR=interquartile range.

*Calculated with use of generalised linear latent and mixed model, with robust variance estimation and random effects to account for clustering of catheter related bloodstream infections within ICUs over time and clustering of hospitals within geographical regions; rates of catheter related bloodstream infections during implementation, initial evaluation, and sustainability periods compared with baseline (pre-implementation) values, adjusted for hospital’s teaching status and number of beds.
Children’s Hospital Corporation of America (CHCA) CVC-BSI rate reduction for PICU Collaborative Participants over time

Jefferies H et al. Accepted ICHE 2009
National Association of Children’s Hospitals and Related Institutions (NACHRI’s) PICU Intervention

Post-Intervention CA-BSI Rates

Data entered as of 9/27/2007
Pre- and Post-Collaborative CA-BSI Rate per 1000 Line Days - Ordered by Unit ID
(Post-Collaborative Jan-Aug 2007)
The Majority of CLA-BSIs Occur Outside of the ICU

A significant opportunity exists to reduce CLA-BSI incidence in non-ICU settings.

## Impact Of Dedicated IV Device-Care Teams

<table>
<thead>
<tr>
<th>Study</th>
<th>No. Patients</th>
<th>IV-Related Sepsis</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concurrent but non-randomized:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nehe, JAMA (1980)</td>
<td>391</td>
<td>26.2%</td>
<td></td>
</tr>
<tr>
<td>Nehe, Ward Care</td>
<td>284</td>
<td>1.3%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Tomford et al., Arch Int Med (1984)</td>
<td>427</td>
<td>2.1%</td>
<td></td>
</tr>
<tr>
<td>Edlin et al., Arch Int Med (1998)</td>
<td>463</td>
<td>1.5%</td>
<td>&lt;.05</td>
</tr>
<tr>
<td><strong>Randomized:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomford et al., Arch Int Med (1984)</td>
<td>433</td>
<td>0.2%</td>
<td>.02</td>
</tr>
<tr>
<td>Edlin et al., Arch Int Med (1998)</td>
<td>412</td>
<td>0%</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>
Conclusions

• CVC-Related BSIs are a major cause of patient morbidity and mortality.

• Prevention of CVC-Related BSIs requires a multi-factorial approach, including:
  • Implementing new prevention evidence.
  • Implementation of insertion and maintenance bundles.
  • Educating staff; Insuring adequate and properly trained staff
  • Insuring that policy = practice (clinician accountability)
  • Monitoring CVC insertion and maintenance processes (checklists) and CVC-related BSI rates (outcomes).

• A comprehensive CVC-related BSI prevention program can dramatically reduce infection rates and improve patient safety.

• A rate of ZERO CVC-BSIs in ICU patients is a reality and should be our goal. If “Prevention is Primary”, then action is essential!
Thank You!