Central Line Associated Blood Stream Infections

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Objectives

• Overview of Central Line Associated Blood Stream Infections (CLABSI)
• Evidence of infection prevention
• Resources at the U of U
Background

• 15 million CVC days in the ICU/year

• Surveillance and Control of Pathogens of Epidemiologic Importance: SCOPE (49 hospitals)
  • 2001-43,000 CLABSI in US ICUs
  • 2009-18,000 CLABSI is US ICUs
  • 23,000 CLABSI in US wards
Pathogenesis

• Migration of skin organisms at the insertion site into the catheter tract colonizing the tip
• Direct contamination of the catheter or hub by contact with contaminated hands/fluids etc.
• Hematogenously seeded from another site of infection
• Infusate contamination
Risk Factors for Nosocomial BSI

- Chronic illness
- BMT
- Immunodeficiency, neutropenia
- Malnutrition
- TPN
- Previous BSI
- Extremes of age
- Loss of skin integrity (burns)
Extrinsic risk factors of CLABSI

- Duration of catheterization
- Type of catheter material
- Conditions of insertion
- Catheter-site care
- Skill of the catheter inserter
Biofilm

- Matrix of extracellular polymeric substance (DNA, protein, polysaccharides)
Organisms

- **SCOPE 1995-2002**
  - Coagulase-negative staphyloccoci — 31 percent
  - Staphylococcus aureus — 20 percent
  - Enterococci — 9 percent
  - Candida species — 9 percent
  - Escherichia coli — 6 percent
  - Klebsiella species — 5 percent
  - Pseudomonas species — 4 percent
  - Enterobacter species — 4 percent
  - Serratia species — 2 percent
  - Acinetobacter baumannii — 1 percent
CDC definition

- Recognized pathogen from one or more blood cultures. Pathogen not related to an infection at another site.

- OR

- Patient at least one
  - fever, chills, and/or hypotension and
  - positive laboratory cultures from two or more blood samples drawn on separate occasions which are not related to infection at another site and do not reflect contamination.
CLABSI Criteria

- One of the following must be met
  - Same organism from both the catheter tip and at least one percutaneous blood culture.
  - Same organism from at least two blood samples (one from a catheter hub and the other from a peripheral vein or second lumen) meeting criteria for quantitative blood cultures or differential time to positivity.
• Quantitative Culture-colony count from catheter $\geq 3$ fold the peripheral sample

• Differential time to positivity (DTP)-
  - catheter growth $< 2$ hrs before growth from peripheral sample.

• Sensitivity 85% and specificity 91%
Treatment

• ABX not needed when
  • Positive catheter tip culture in the absence of clinical signs of infection
  • Positive blood cultures obtained through a catheter with negative cultures through a peripheral vein.
  • Phlebitis in the absence of infection
Remove If

- Severe sepsis
- Hemodynamic instability
- Endocarditis or evidence of metastatic infection
- Erythema or exudate due to suppurative thrombophlebitis
- Persistent bacteremia after 72 hours of antimicrobial therapy to which the organism is susceptible
Empiric ABX

- GPC
  - Vanc
  - Dapto
  - Linezolid???

- GNR
  - Carbapenem
  - 4th generation cephalosporin
  - pip/tazo
Fungemia Risk Factors

- Total parenteral nutrition
- Prolonged use of broad-spectrum antibiotics
- Hematologic malignancy
- Bone marrow or solid organ transplant
- Femoral catheterization
- Colonization due to Candida species at multiple sites
Let’s Play....
Name that Grade 1 A recommendation!!!
• Which of the below is a grade 1A recommendation for preventing CLABSI?
  
  • A) Educate health care personnel on indications, insertion techniques and maintenance and periodically assess adherence to guidelines
  
  • B) Use ultrasound guidance to place central venous catheters (if this technology is available) to reduce the number of cannulation attempts and mechanical complications. Ultrasound guidance should only be used by those fully trained in its technique.
  
  • C) Perform hand hygiene procedures, either by washing hands with conventional soap and water or with alcohol-based hand rubs (ABHR).
Which of the below is a grade 1A recommendation for preventing CLABSI?

- A) **Educate health care personnel on indications, insertion techniques and maintenance and periodically assess adherence to guidelines**

- B) Use ultrasound guidance to place central venous catheters (if this technology is available) to reduce the number of cannulation attempts and mechanical complications. Ultrasound guidance should only be used by those fully trained in its technique. (1B)

- C) Perform hand hygiene procedures, either by washing hands with conventional soap and water or with alcohol-based hand rubs (ABHR). (1B)
Catheter-Associated Bloodstream Infections

Figure 1. Monthly rate per 1,000 catheter-days of catheter-associated bloodstream infection from January 2000 through December 2003. The mean catheter-associated bloodstream infection rate for the baseline period (2000 and 2001) and the time period following introduction of the education program (2002 and 2003) are shown (broken line).
- Estimated cost savings of $100K to $1.5 million
Figure. Effect of a procedure course on the risk for primary bloodstream infection (white bars) and catheter-related infection (striped bars) in six intensive care units and one step-down unit. The course was offered twice; participants were medical students and physicians completing their first postgraduate year. The difference between the total number of infections per 1000 patient-days before the first course (baseline) compared with that after the first course is statistically significant ($P = 0.01$).
• Estimated cost savings of $63,000-800,000
Which of the below is a grade 1A recommendation for preventing CLABSI?

- A) Use maximal sterile barrier precautions, including the use of a cap, mask, sterile gown, sterile gloves, and a sterile full body drape, for the insertion of CVCs
- B) Prepare clean skin with a >0.5% chlorhexidine preparation with alcohol. If there is a contraindication to chlorhexidine, tincture of iodine, an iodophor, or 70% alcohol can be used as alternatives
- C) Use a sutureless securement device to reduce the risk of infection for intravascular catheters
Which of the below is a grade 1A recommendation for preventing CLABSI?

- A) Use maximal sterile barrier precautions, including the use of a cap, mask, sterile gown, sterile gloves, and a sterile full body drape, for the insertion of CVCs (1B)

- B) Prepare clean skin with a >0.5% chlorhexidine preparation with alcohol. If there is a contraindication to chlorhexidine, tincture of iodine, an iodophor, or 70% alcohol can be used as alternatives

- C) Use a sutureless securement device to reduce the risk of infection for intravascular catheters (II)
<table>
<thead>
<tr>
<th>Microbiological Isolates</th>
<th>0.25% Chlorhexidine 0.025% Benzalkonium (n = 12 [6])</th>
<th>10% Povidone Iodine (n = 24 [12])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulase-negative <em>Staphylococci</em></td>
<td>3 (2)</td>
<td>13 (5)</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>2 (0)</td>
<td>1 (1)</td>
</tr>
<tr>
<td><em>Streptococcus</em> spp.</td>
<td>0</td>
<td>2 (2)</td>
</tr>
<tr>
<td><em>Enterococcus</em> spp.</td>
<td>0</td>
<td>1 (0)</td>
</tr>
<tr>
<td><em>Corynebacteriae</em> spp.</td>
<td>0</td>
<td>3 (2)</td>
</tr>
<tr>
<td><em>Proteus</em> spp.</td>
<td>5 (2)</td>
<td>1 (0)</td>
</tr>
<tr>
<td><em>Acinetobacter</em> spp.</td>
<td>0</td>
<td>1 (0)</td>
</tr>
<tr>
<td><em>Pseudomonas</em> spp.</td>
<td>2 (2)</td>
<td>2 (2)</td>
</tr>
</tbody>
</table>

Numbers in brackets and parentheses indicate the values for catheter-related sepsis.

*Figure 2. Analysis of catheter-related bloodstream infection in studies comparing chlorhexidine gluconate and povidone-iodine solutions for care of vascular catheter sites.

<table>
<thead>
<tr>
<th>Study (Reference), Year</th>
<th>Risk Ratio (95% CI)</th>
<th>Catheters, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maki et al. (7), 1991</td>
<td>0.18 (0.02–1.46)</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>Meffre et al. (10), 1995</td>
<td>0.97 (0.20–4.77)</td>
<td>1117</td>
</tr>
<tr>
<td>Minoz et al. (11), 1996</td>
<td>0.64 (0.15–2.81)</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>Knasinski and Maki, 2000*</td>
<td>0.36 (0.14–0.95)</td>
<td>849</td>
</tr>
<tr>
<td>Overall (95% CI)</td>
<td>0.49 (0.28–0.88)</td>
<td>3899</td>
</tr>
</tbody>
</table>
• Which of the below is a grade 1A recommendation for preventing CLABSI?

• A) Use a chlorhexidine/silver sulfadiazine or minocycline/rifampin - impregnated CVC in patients whose catheter is expected to remain in place >5 days if, after successful implementation of a comprehensive strategy to reduce rates of CLABSI, the CLABSI rate is not decreasing.

• B) 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.

• C) Do not administer systemic antimicrobial prophylaxis routinely before insertion or during use of an intravascular catheter to prevent catheter colonization or CRBSI.
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- B) 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 (II).

- C) Do not administer systemic antimicrobial prophylaxis routinely before insertion or during use of an intravascular catheter to prevent catheter colonization or CRBSI (IB).
No evidence of resistant bacteria
• Minocyclin/Rifampin-0.3/1000days
• Chlorhexidine/Silver-4.1/1000days
• Controversy of later generation chlorhexidine/silver catheters
• The comprehensive strategy should include at least the following three components: educating persons who insert and maintain catheters, use of maximal sterile barrier precautions, and a >0.5% chlorhexidine preparation with alcohol for skin antisepsis during CVC insertion.
Which of the below is a grade 1A recommendation for preventing CLABSI?

- A) When adherence to aseptic technique cannot be ensured (i.e. catheters inserted during a medical emergency), replace the catheter as soon as possible, i.e., within 48 hours
- B) Use a CVC with the minimum number of ports or lumens essential for the management of the patient
- C) Avoid using the femoral vein for central venous access in adult patients
Which of the below is a grade 1A recommendation for preventing CLABSI?

- A) When adherence to aseptic technique cannot be ensured (i.e. catheters inserted during a medical emergency), replace the catheter as soon as possible, i.e, within 48 hours (IB)

- B) Use a CVC with the minimum number of ports or lumens essential for the management of the patient (IB)

- C) Avoid using the femoral vein for central venous access in adult patients
Lorent et al. Crit Care, 2005

<table>
<thead>
<tr>
<th>Site</th>
<th>Number of CVCs</th>
<th>Days of CVC</th>
<th>Number of CRLs</th>
<th>ID of CRLs</th>
<th>% CVC with CRLI</th>
<th>Number of CRBSIs</th>
<th>ID of CRBSIs</th>
<th>% CVC with CRBSIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subclavian</td>
<td>917</td>
<td>8,239</td>
<td>13</td>
<td>1.57</td>
<td>1.42%</td>
<td>8</td>
<td>0.97</td>
<td>0.87%</td>
</tr>
<tr>
<td>Jugular</td>
<td>1,390</td>
<td>8,361</td>
<td>64</td>
<td>7.65</td>
<td>4.60%</td>
<td>25</td>
<td>2.99</td>
<td>1.80%</td>
</tr>
<tr>
<td>Femoral</td>
<td>288</td>
<td>2,399</td>
<td>38</td>
<td>15.83</td>
<td>13.19%</td>
<td>20</td>
<td>8.34</td>
<td>6.94%</td>
</tr>
<tr>
<td>Total</td>
<td>2,595</td>
<td>18,999</td>
<td>115</td>
<td>6.05</td>
<td>4.43%</td>
<td>53</td>
<td>2.79</td>
<td>2.04%</td>
</tr>
</tbody>
</table>

CRBSI, catheter-related bloodstream infection; CRLI, catheter-related local infection; CVC, central venous catheter; ID, incidence density defined as number of infections per 1,000 catheter-days.
Which of the below is a grade 1A recommendation for preventing CLABSI?

A) Promptly remove any intravascular catheter that is no longer essential.

B) Do not routinely use anticoagulant therapy to reduce the risk of catheter-related infection in general patient populations.

C) Do not remove CVCs or PICCs on the basis of fever alone. Use clinical judgment regarding the appropriateness of removing the catheter if infection is evidenced elsewhere or if a noninfectious cause of fever is suspected.
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- **A) Promptly remove any intravascular catheter that is no longer essential**

- B) Do not routinely use anticoagulant therapy to reduce the risk of catheter-related infection in general patient populations (II)

- C) Do not remove CVCs or PICCs on the basis of fever alone. Use clinical judgment regarding the appropriateness of removing the catheter if infection is evidenced elsewhere or if a noninfectious cause of fever is suspected. (II)
Enacted a central line bundle in 108 ICUs
- Hand washing
- Full Barrier Precautions
- Chlorhexidine skin cleansing
- Avoiding the femoral artery
- Remove unnecessary catheters
### Table 3. Rates of Catheter-Related Bloodstream Infection from Baseline (before Implementation of the Study Intervention) to 18 Months of Follow-up.*

<table>
<thead>
<tr>
<th>Study Period</th>
<th>No. of ICUs</th>
<th>No. of Bloodstream Infections per 1000 Catheter-Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Overall</td>
</tr>
<tr>
<td>Baseline</td>
<td>55</td>
<td>2.7 (0.6–4.8)</td>
</tr>
<tr>
<td>During implementation</td>
<td>96</td>
<td>1.6 (0–4.4)†</td>
</tr>
<tr>
<td>After implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–3 mo</td>
<td>96</td>
<td>0 (0–3.0)‡</td>
</tr>
<tr>
<td>4–6 mo</td>
<td>96</td>
<td>0 (0–2.7)‡</td>
</tr>
<tr>
<td>7–9 mo</td>
<td>95</td>
<td>0 (0–2.1)‡</td>
</tr>
<tr>
<td>10–12 mo</td>
<td>90</td>
<td>0 (0–1.9)‡</td>
</tr>
<tr>
<td>13–15 mo</td>
<td>85</td>
<td>0 (0–1.6)‡</td>
</tr>
<tr>
<td>16–18 mo</td>
<td>70</td>
<td>0 (0–2.4)‡</td>
</tr>
</tbody>
</table>

* Because the ICUs implemented the study intervention at different times, the total number of ICUs contributing data for each period varies.

Of the 103 participating ICUs, 48 did not contribute baseline data. P values were calculated by the two-sample Wilcoxon rank-sum test.

† P ≤ 0.05 for the comparison with the baseline (preimplementation) period.

‡ P ≤ 0.002 for the comparison with the baseline (preimplementation) period.
Grade 1A recommendations

- Educate health care personnel on indications, insertion techniques and maintenance and periodically assess adherence to guidelines.

- Designate only trained personnel who demonstrate competence for the insertion and maintenance of peripheral and central intravascular catheters.

- Weigh the risks and benefits of placing a central venous device at a recommended site to reduce infectious complications against the risk for mechanical complications.

- Avoid the subclavian site in hemodialysis patients and patients with advanced kidney disease, to avoid subclavian vein stenosis.
• Prepare clean skin with a >0.5% chlorhexidine preparation with alcohol. If there is a contraindication to chlorhexidine, tincture of iodine, an iodophor, or 70% alcohol can be used as alternatives.

• Use a chlorhexidine/silver sulfadiazine or minocycline/rifampin - impregnated CVC in patients whose catheter is expected to remain in place >5 days if, after successful implementation of a comprehensive strategy to reduce rates of CLABSI, the CLABSI rate is not decreasing.

• The comprehensive strategy should include at least the following three components: educating persons who insert and maintain catheters, use of maximal sterile barrier precautions, and a >0.5% chlorhexidine preparation with alcohol for skin antisepsis during CVC insertion.
• Promptly remove any intravascular catheter that is no longer essential

• Sterile gloves should be worn for the insertion of arterial, central, and midline catheters

• Use either sterile gauze or sterile, transparent, semipermeable dressing to cover the catheter site

• Avoid the Femoral artery for insertion of a central venous catheter
Resources at the U

- Dr. Markewitz
- U of U Infection rate 2011
  - 1.3/1000 catheter days
Objectives

• Overview of Central Line Associated Blood Stream Infections (CLABSI)
• Evidence of infection prevention
• Resources at the U of U
References


- Warren, DK et al. The effect of an education program on the incidence of central venous catheter-associated bloodstream infection in a medical ICU. Chest. 2004;126;1612-1618