Disclosures

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Acknowledgements:
David J. Weber, MD, MPH
Objectives

Understand the impact of bloodstream infections

Understand the incidence and causative pathogens of bloodstream infection

Understand the risk factors for healthcare-associated bloodstream infections

Understand how we define bloodstream infection, both clinically and epidemiologically

Understand the prevention and control of bloodstream infections
BSI: Impact on Healthcare Population

Approximately 72,000 primary bloodstream infections per year
- Accounts for ~10% of healthcare-associated infections (rank = 5)

Rate of BSIs varies by:
- Hospital size, unit, and service
- Population served (elderly/infants, acute/chronic)
- Use and type of intravascular access device
- Time-trends
- Endemic/Epidemic

Major risk = central venous catheter
- CLABSI associated with increased length of stay and increased cost ($3,700 to $39,000 per episode)

### Table 2. Distribution of 504 Health Care–Associated Infections.

<table>
<thead>
<tr>
<th>Type of Infection</th>
<th>Rank</th>
<th>No. of Infections</th>
<th>Percentage of All Health Care–Associated Infections (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia†</td>
<td>1 (tie)</td>
<td>110</td>
<td>21.8 (18.4–25.6)</td>
</tr>
<tr>
<td>Surgical-site infection</td>
<td>1 (tie)</td>
<td>110</td>
<td>21.8 (18.4–25.6)</td>
</tr>
<tr>
<td>Gastrointestinal infection</td>
<td>3</td>
<td>86</td>
<td>17.1 (14.0–20.5)</td>
</tr>
<tr>
<td>Urinary tract infection‡</td>
<td>4</td>
<td>65</td>
<td>12.9 (10.2–16.0)</td>
</tr>
<tr>
<td><strong>Primary bloodstream infection‡</strong></td>
<td>5</td>
<td>50</td>
<td>9.9 (7.5–12.8)</td>
</tr>
<tr>
<td>Eye, ear, nose, throat, or mouth infection</td>
<td>6</td>
<td>28</td>
<td>5.6 (3.8–7.8)</td>
</tr>
<tr>
<td>Lower respiratory tract infection</td>
<td>7</td>
<td>20</td>
<td>4.0 (2.5–6.0)</td>
</tr>
<tr>
<td>Skin and soft-tissue infection</td>
<td>8</td>
<td>16</td>
<td>3.2 (1.9–5.0)</td>
</tr>
<tr>
<td>Cardiovascular system infection</td>
<td>9</td>
<td>6</td>
<td>1.2 (0.5–2.5)</td>
</tr>
<tr>
<td>Bone and joint infection</td>
<td>10</td>
<td>5</td>
<td>1.0 (0.4–2.2)</td>
</tr>
<tr>
<td>Central nervous system infection</td>
<td>11</td>
<td>4</td>
<td>0.8 (0.3–1.9)</td>
</tr>
<tr>
<td>Reproductive tract infection</td>
<td>12</td>
<td>3</td>
<td>0.6 (0.2–1.6)</td>
</tr>
<tr>
<td>Systemic infection</td>
<td>13</td>
<td>1</td>
<td>0.2 (0.01–1.0)</td>
</tr>
</tbody>
</table>


- 50 Primary BSI
- 42 (82%) CLABSI
- 37 Secondary BSI
### Central Lines: Utilization

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All Patients (N = 11,282)</th>
<th>Patients without Health Care–Associated Infections (N = 10,830)</th>
<th>Patients with Health Care–Associated Infections (N = 452)</th>
<th>P Value^†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central catheter in place on survey date — no. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any</td>
<td>2,121 (18.8)</td>
<td>1,862 (17.2)</td>
<td>259 (57.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Femoral</td>
<td>54 (0.5)</td>
<td>44 (0.4)</td>
<td>10 (2.2)</td>
<td></td>
</tr>
<tr>
<td>Peripherally inserted</td>
<td>1,037 (9.2)</td>
<td>878 (8.1)</td>
<td>159 (35.2)</td>
<td></td>
</tr>
<tr>
<td>Other known type</td>
<td>1,057 (9.4)</td>
<td>958 (8.8)</td>
<td>99 (21.9)</td>
<td></td>
</tr>
<tr>
<td>Unknown type</td>
<td>32 (0.3)</td>
<td>29 (0.3)</td>
<td>3 (0.7)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>9,140 (81.0)</td>
<td>8,948 (82.6)</td>
<td>192 (42.5)</td>
<td></td>
</tr>
<tr>
<td>Missing data</td>
<td>21 (0.2)</td>
<td>20 (0.2)</td>
<td>1 (0.2)</td>
<td></td>
</tr>
</tbody>
</table>
# Central Line Utilization by Unit

**High:** ICUs (Medical and Surgical)

**Low:** Psych, L&D/Postpartum, Ortho

<table>
<thead>
<tr>
<th>Type of acute care hospital location</th>
<th>No. of locations</th>
<th>Central line days</th>
<th>Patient days</th>
<th>Pooled mean</th>
<th>10%</th>
<th>25%</th>
<th>50% (median)</th>
<th>75%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical/surgical: major teaching</td>
<td>358 (356)</td>
<td>800,019</td>
<td>1,482,658</td>
<td>0.54</td>
<td>0.28</td>
<td>0.39</td>
<td>0.53</td>
<td>0.65</td>
<td>0.71</td>
</tr>
<tr>
<td>Medical/surgical: all other, &lt;15 beds</td>
<td>1,647 (1,627)</td>
<td>1,260,781</td>
<td>3,453,458</td>
<td>0.37</td>
<td>0.11</td>
<td>0.19</td>
<td>0.34</td>
<td>0.50</td>
<td>0.62</td>
</tr>
<tr>
<td>Medical/surgical: all other, &gt;15 beds</td>
<td>807</td>
<td>2,132,226</td>
<td>4,291,341</td>
<td>0.49</td>
<td>0.30</td>
<td>0.40</td>
<td>0.51</td>
<td>0.60</td>
<td>0.69</td>
</tr>
<tr>
<td>Neurologic</td>
<td>59 (58)</td>
<td>80,894</td>
<td>171,989</td>
<td>0.47</td>
<td>0.22</td>
<td>0.32</td>
<td>0.46</td>
<td>0.55</td>
<td>0.67</td>
</tr>
<tr>
<td>Neurosurgical</td>
<td>181</td>
<td>317,745</td>
<td>731,728</td>
<td>0.43</td>
<td>0.24</td>
<td>0.34</td>
<td>0.43</td>
<td>0.54</td>
<td>0.60</td>
</tr>
<tr>
<td>Pediatric cardiothoracic</td>
<td>43</td>
<td>146,328</td>
<td>202,899</td>
<td>0.72</td>
<td>0.49</td>
<td>0.59</td>
<td>0.75</td>
<td>0.86</td>
<td>0.91</td>
</tr>
<tr>
<td>Pediatric medical</td>
<td>31 (29)</td>
<td>23,719</td>
<td>63,391</td>
<td>0.37</td>
<td>0.10</td>
<td>0.14</td>
<td>0.25</td>
<td>0.34</td>
<td>0.47</td>
</tr>
<tr>
<td>Pediatric medical/surgical</td>
<td>315 (307)</td>
<td>389,069</td>
<td>868,418</td>
<td>0.45</td>
<td>0.14</td>
<td>0.22</td>
<td>0.35</td>
<td>0.50</td>
<td>0.62</td>
</tr>
<tr>
<td>Pediatric surgical</td>
<td>6</td>
<td>3,105</td>
<td>9,609</td>
<td>0.32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prenatal</td>
<td>8</td>
<td>710</td>
<td>9,153</td>
<td>0.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Respiratory</td>
<td>6</td>
<td>9,842</td>
<td>26,288</td>
<td>0.37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical: major teaching</td>
<td>197</td>
<td>470,884</td>
<td>819,943</td>
<td>0.57</td>
<td>0.38</td>
<td>0.46</td>
<td>0.57</td>
<td>0.67</td>
<td>0.75</td>
</tr>
<tr>
<td>Surgical: all other</td>
<td>190 (188)</td>
<td>345,251</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical cardiothoracic</td>
<td>455 (454)</td>
<td>955,534</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trauma</td>
<td>147</td>
<td>329,688</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step-down units</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult step-down (postcritical care)</td>
<td>700 (699)</td>
<td>818,478</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step-down NICU (level II)</td>
<td>47 (44)</td>
<td>4,886</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pediatric step-down (postcritical care)</td>
<td>17</td>
<td>17,416</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed acuity units</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult mixed acuity</td>
<td>83 (82)</td>
<td>83,286</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed age mixed acuity</td>
<td>44</td>
<td>28,758</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pediatric mixed acuity</td>
<td>16</td>
<td>29,140</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inpatient wards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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Dudeck et al. AJIC 2015; 43: 206-221
Central Line Associated BSI (CLABSI) Rate by Unit

High: Burn, ICUs (Medical and Surgical), Trauma, Vent Unit

Low: Ortho, GYN, Psych

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Dudeck et al. AJIC 2015; 43: 206-221
Definitions: IMPORTANT!

CLINICAL DEFINITION ≠ SURVEILLANCE DEFINITION
What is BSI?

Bloodstream infection or Bacteremia:
Positive blood culture(s) +/- systemic signs of infection

Other terms:
- Septicemia: positive blood cultures + systemic signs of infection
- Sepsis and Septic Shock
- Pseudobacteremia or “contaminated” blood cultures: positive blood cultures resulting from contamination during the collection procedure or during laboratory processing
What is BSI?

**Primary BSI**: NO identifiable originating source on clinical exam and/or diagnostics

**Secondary BSI**: Identifiable, localized infection at a specific site on clinical exam and/or diagnostics

Ex: Group B Streptococcus BSI

### GBS BSI Source in Non-pregnant adults

<table>
<thead>
<tr>
<th>Source</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown (Primary)</td>
<td>30-40%</td>
</tr>
<tr>
<td>Skin and Soft Tissue</td>
<td>15-40%</td>
</tr>
<tr>
<td>Urinary Tract</td>
<td>5-15%</td>
</tr>
<tr>
<td>Upper Respiratory Tract</td>
<td>6-12%</td>
</tr>
<tr>
<td>Bone and Joint</td>
<td>2-15%</td>
</tr>
<tr>
<td>Cardiac/Endocarditis</td>
<td>2-9%</td>
</tr>
<tr>
<td>Central Nervous System</td>
<td>&lt;4%</td>
</tr>
</tbody>
</table>

Source: UpToDate.
How do pathogens enter the bloodstream?

Many potential points/mechanisms of entry.

Disruption of skin or mucosal barriers:
- Localized infection advances to become systemic (Secondary BSI)
- Skin disruption, scratches, bug bites
- IV drug abuse
- Invasive devices (central venous catheter)
- Invasive procedures (surgical, dental, scopes)

Transient bacteremias may happen all the time but are usually cleared by the liver/spleen

Host considerations
- Implants/prostheses
- Impaired immunity
**CLINICAL DEFINITION**

**Signs and symptoms**

Systemic: Fever, chills, rigors, fatigue $\rightarrow$ hypotension, shock

Respiratory: hyperventilation $\rightarrow$ respiratory failure

Neurologic: Confusion $\rightarrow$ seizure, coma

Secondary: Other localized infection symptoms

**Localized infection**  **Fever**  **Septic Shock + Organ Failure**
Recognize and Treat Sepsis

Patient with suspected infection

qSOFA ≥2? (see A)

No

Sepsis still suspected?

No

Monitor clinical condition; reevaluate for possible sepsis if clinically indicated

Yes

Assess for evidence of organ dysfunction

SOFA ≥2? (see B)

No

Monitor clinical condition; reevaluate for possible sepsis if clinically indicated

Yes

Sepsis

Despite adequate fluid resuscitation, 1. vasopressors required to maintain MAP ≥65 mm Hg AND 2. serum lactate level >2 mmol/L?

No

Septic shock

Yes

A qSOFA Variables
Respiratory rate
Mental status
Systolic blood pressure

B SOFA Variables
PaO₂/FiO₂ ratio
Glasgow Coma Scale score
Mean arterial pressure
Administration of vasopressors with type and dose rate of infusion
Serum creatinine or urine output
Bilirubin
Platelet count

JAMA. 2016;315(8):801-810
MORTALITY OF NOSOCOMIAL BSI, SCOPE, 1995-98

Clinical management: Go to the Source

1. Source control
   - Incision and Drainage for abscesses
   - Remove necrotic material
   - Remove foreign material
   - Contain bowel/bladder contents
   - Wash out joints

2. Antibiotics and/or antifungals
   - Initially IV
   - *May* be able to transition to oral depending on: clinical progress, culture clearance, primary source, and organism/susceptibilities

3. Supportive Care
   - Fluids, oxygen, ICU (pressors, vent)
<table>
<thead>
<tr>
<th>Infection</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheter colonization</td>
<td>Significant growth of $\geq$1 microorganism in a quantitative or semiquantitative culture of the catheter tip, subcutaneous catheter segment, or catheter hub</td>
</tr>
<tr>
<td>Phlebitis</td>
<td>Induration or erythema, warmth, and pain or tenderness along the tract of a catheterized or recently catheterized vein</td>
</tr>
<tr>
<td>Exit site infection</td>
<td>Microbiological: Exudate at catheter exit site yields a microorganism with or without concomitant bloodstream infection</td>
</tr>
<tr>
<td></td>
<td>Clinical: Erythema, induration, and/or tenderness within 2 cm of the catheter exit site; may be associated with other signs and symptoms of infection, such as fever or purulent drainage emerging from the exit site, with or without concomitant bloodstream infection.</td>
</tr>
<tr>
<td></td>
<td>Tunnel infection: Tenderness, erythema, and/or induration $&gt;2$ cm from the catheter exit site, along the subcutaneous tract of a tunneled catheter (e.g., Hickman or Broviac catheter), with or without concomitant bloodstream infection.</td>
</tr>
<tr>
<td>Pocket infection</td>
<td>Infected fluid in the subcutaneous pocket of a totally implanted intravascular device; often associated with tenderness, erythema, and/or induration over the pocket; spontaneous rupture and drainage, or necrosis of the overlying skin, with or without concomitant bloodstream infection.</td>
</tr>
<tr>
<td>Bloodstream infection</td>
<td>Infusate related: Concordant growth of a microorganism from infusate and cultures of percutaneously obtained blood cultures with no other identifiable source of infection</td>
</tr>
<tr>
<td></td>
<td>Catheter related: Bacteremia or fungemia in a patient who has an intravascular device and $&gt;1$ positive blood culture result obtained from the peripheral vein, clinical manifestations of infection (e.g., fever, chills, and/or hypotension), and no apparent source for bloodstream infection (with the exception of the catheter). One of the following should be present: a positive result of semiquantitative ($&gt;15$ cfu per catheter segment) or quantitative ($&gt;10^2$ cfu per catheter segment) catheter culture, whereby the same organism (species) is isolated from a catheter segment and a peripheral blood culture; simultaneous quantitative cultures of blood with a ratio of $&gt;3:1$ cfu/mL of blood (catheter vs. peripheral blood); differential time to positivity (growth in a culture of blood obtained through a catheter hub is detected by an automated blood culture system at least 2 h earlier than a culture of simultaneously drawn peripheral blood of equal volume). Note that this definition differs from the definition of central line–associated bloodstream infection used for infection-control surveillance activities.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of intravascular device</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral venous catheter</td>
<td>Usually inserted into the veins of the forearm or the hand; the most commonly used short-term intravascular device</td>
</tr>
<tr>
<td>Peripheral arterial catheter</td>
<td>For short-term use; commonly used to monitor hemodynamic status and to determine blood gas levels of critically ill patients; risk of bloodstream infection may approach that of CVCs</td>
</tr>
<tr>
<td>Midline catheter</td>
<td>Peripheral catheter (size, 7.6–20.3 cm) is inserted via the antecubital fossa into the proximal basilic or cephalic veins, but it does not enter central veins; it is associated with lower rates of infection, compared with CVCs</td>
</tr>
<tr>
<td>Short-term CVC</td>
<td>Most commonly used CVC; accounts for the majority of all catheter-related bloodstream infections</td>
</tr>
<tr>
<td>Pulmonary artery catheter</td>
<td>Inserted through a teflon introducer and typically remains in place for an average duration of only 3 days</td>
</tr>
<tr>
<td>Pressure-monitoring system</td>
<td>Used in conjunction with arterial catheter; associated with both epidemic and endemic nosocomial bloodstream infections</td>
</tr>
<tr>
<td>Peripherally inserted central catheter</td>
<td>Provides an alternative to subclavian or jugular vein catheterization; is inserted via the peripheral vein into the superior vena cava, usually by way of cephalic and basilic veins; similar risk of infection as CVCs in patients hospitalized in intensive care units</td>
</tr>
<tr>
<td>Long-term CVC</td>
<td>Surgically implanted CVC (e.g., Hickman, Broviac, or Groshong catheter) with the tunneled portion exiting the skin and a dacron cuff just inside the exit site; used to provide vascular access to patients who require prolonged chemotherapy, home-infusion therapy, or hemodialysis</td>
</tr>
<tr>
<td>Totally implantable device</td>
<td>A subcutaneous port or reservoir with self-sealing septum is tunneled beneath the skin and is accessed by a needle through intact skin; associated with low rates of infection</td>
</tr>
</tbody>
</table>
PERIPHERAL INSERTION OF CENTRAL VENOUS CATHETERS

Peripheral catheter in place in the superior vena cava

Method of catheter placement

Cephalic vein

Basilic vein

Median basilic vein
PATHOGENESIS Central Line Infection

Multifactorial and complex

Most catheter-related infections appear to result from migration of skin organisms at insertion site into the cutaneous tract with eventual colonization of the catheter tip.

Catheter hub also important contributor to intralumenal colonization (especially in long-term catheters).

Less common = hematogenous seeding of catheter tip from distant focus of infection or contaminated infusate.
POTENTIAL ROUTES OF INFECTION

Skin organisms
- Endogenous flora
- Extrinsic sources (e.g., health care worker, contaminated disinfectant)
- Invading wound

Contamination of catheter hub
- Extrinsic sources (e.g., health care worker)
- Endogenous flora (e.g., from the skin)

Contaminated infusate
- Fluid or medication
- Extrinsic sources
- Manufacturer

Contamination of device prior to insertion
- Usually extrinsic; rarely manufacturer

Fibrin sheath, thrombus

Hematogenous
- From distant infection
How does CLABSI happen?

How patients with central lines can get infected with germs

- Where medicines are injected can get dirty
- Skin where line is placed can be dirty
- Hand or glove touching the line can be dirty

TOP 10 PATHOGENS ASSOCIATED WITH CLABSIs: NHSN, 2009-2010

COMPLICATIONS OF CLABSIs

Local infection
- Tunnel infection, pocket infection

Sepsis

Remote site infection
- Osteomyelitis
- Meningitis

Endovascular infection
- Endocarditis
- Mycotic aneurysms
- Septic thrombophlebitis
Populations at Higher Risk for CLABSI

ICU patients
- High CL utilization (often multiple CL at once and specialized lines)
- Catheters placed in emergencies circumstances
- Need for repeated access daily
- Often need CL for extended time periods

Vulnerable populations
- Hemodialysis
- Peri-operative
- Hem/Onc
Risk Factors for CLABSI*

INCREASED RISK FACTORS:
- Prolonged hospitalization prior to catheterization
- Prolonged duration of catheterization
- Heavy microbial colonization at the insertion site
- Heavy microbial colonization of the catheter hub
- Site of catheter (adults): Femoral (worst), Internal jugular, compared to Subclavian (best)
- Host Immunity: Neutropenia, neonate prematurity
- Reduced Nurse:Patient Ratios (ICU)
- TPN
- Substandard catheter care (e.g. excessive manipulation)
- Blood products (children)

DECREASED RISK/PROTECTIVE FACTORS:
- Female sex
- Antibiotic administration
- Minocycline-rifampin impregnated catheters

*In at least 2 observational studies
CLINICAL CLUES of CVC INFECTIONS

CVC: Exit site infection (erythema, tenderness, purulence) or tunnel infection (erythema, tenderness, purulence, induration)

High grade bacteremia/fungemia (multiple positive cultures)

Abrupt onset, associated with shock

Symptoms/signs of sepsis (i.e., fever/ hypotension) without obvious source (no identifiable local infection)

Evidence of septic thrombophlebitis of great vein

Continued bacteremia/fungemia despite appropriate therapy

Symptoms/signs of sepsis plus catheter malfunction

Bacteremia with CoNS, Candida, Bacillus, Corynebacterium
Goals of Infection Surveillance: Improve Understanding

Estimate disease incidence:
- Assess program impact, detect outbreaks or problem areas to focus prevention efforts, understand and describe disease burden

Reliability, reproducibility
- Trend over time
- Valid and standardized to the degree possible among practice areas (internal validity)
- Compare to benchmarks (external validity)

The definitions are designed to reflect clinical “truth,” but there is NO method of measurement that is perfect.

Abiding by NHSN definitions improves validity AND provides protection when faced with external review or challenges to the data.

Definitions must be adjusted with time due to the dynamic nature of medicine.
What is BSI?

There are multiple surveillance definitions to be familiar with:

HAI
LCBSI
Secondary BSI due to other site-specific infection
MBI LCBSI
CLABSI
Healthcare Associated Infection (HAI)

All NHSN site specific infections must first meet the NHSN definition of HAI before a site specific infection (e.g., CLABSI) can be reported to NHSN

An infection is considered an HAI if:
- ALL elements of a CDC/NHSN site-specific infection criterion were NOT present on admission but were ALL present on or after the 3rd calendar day of admission to the facility.

All elements of the site-specific definition must occur within a time frame that:
- Does not exceed a gap of 1 calendar day between any two adjacent elements
Laboratory Confirmed BSI (LCBSI)

Must meet ONE of 3 criteria

3 LCBI criteria:
- Recognized pathogen (1 +cx)
- Common skin commensal (≥2 separate +cx with ≤1 day gap between)
- Neonates + common skin commensal

For all: organism cultured from blood is *not related to infection at another site*

Most closely reflects a clinical Primary BSI.
LCBSI Criterion 1

Patient has a recognized pathogen identified from **one or more blood specimens** by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (e.g., not Active Surveillance Culture/Testing (ASC/AST)).

AND

organism cultured from blood is **not related to an infection at another site**

<table>
<thead>
<tr>
<th>Recognized Pathogen (Examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. aureus</td>
</tr>
<tr>
<td>P. aeruginosa</td>
</tr>
<tr>
<td>E. coli</td>
</tr>
<tr>
<td>K. pneumoniae</td>
</tr>
<tr>
<td>S. marcescens</td>
</tr>
<tr>
<td>C. Albicans</td>
</tr>
<tr>
<td>Enterococcus sp.</td>
</tr>
</tbody>
</table>
LCBSI Criterion 2

Patient has at least one of the following signs or symptoms: fever (>38.0°C), chills or hypotension

AND

Organism(s) identified from blood is not related to an infection at another site

AND

The same common commensal (see list) is identified from 2 or more blood cultures drawn on separate occasions, by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (e.g., not Active Surveillance Culture/Testing ASC/AST).

Criterion elements must occur within the Infection Window Period, the 7-day time period which includes the date the positive blood culture was collected, the 3 calendar days before and the 3 calendar days after

Common Commensals (Partial List)

- Diphtheroids [Corynebacterium spp. not C. diphtheriae]
- Bacillus spp. [not B. anthracis]
- Propionibacterium spp.
- Coagulase-negative staphylococci [including S. epidermidis]
- Viridans group streptococci
- Aerococcus spp.
- Micrococcus spp.
LCBSI Criterion 3

Patient ≤ 1 year of age has at least one of the following signs or symptoms: fever (>38.0°C), hypothermia (<36.0°C), apnea, or bradycardia

AND

Organism(s) identified from blood is not related to an infection at another site

AND

The same common commensal is identified from two or more blood specimens drawn on separate occasions (see comment 5 below), by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (e.g., not Active Surveillance Culture/Testing (ASC/AST)).

Criterion elements must occur within the Infection Window Period, the 7-day time period which includes the collection date of the positive blood, the 3 calendar days before and the 3 calendar days after.

Common Commensals (Partial List)

- Diphtheroids [Corynebacterium spp. not C. diphtheriae]
- Bacillus spp. [not B. anthracis]
- Propionibacterium spp.
- Coagulase-negative staphylococci [including S. epidermidis]
- Viridans group streptococci
- Aerococcus spp.
- Micrococcus spp.
The patient must meet one of the NHSN site-specific definitions (CDC/NHSN Surveillance Definitions for Specific Types of Infections, UTI, PNEU or SSI), AND

Either “1” or “2” below must also be true:

1. An organism identified from the site specific infection is used as an element to meet the site-specific infection criterion, AND the blood specimen contains at least one matching organism to that site specific specimen, and is collected during the secondary BSI attribution period.

OR

2. The positive blood specimen is an element used to meet the site-specific infection criterion, and is collected during the site specific infection’s infection window period.

If no site-specific infection, the default is a primary LCBSI
SECONDARY BSI GUIDE FOR ELIGIBLE ORGANISMS (not applicable to VAE)

Positive blood culture and site specific infection suspected

Is the positive site specific culture used as an element to meet the infection site criteria?*

Yes

Site specific culture and blood culture match for at least 1 organism?

No

Can the positive blood culture be used to meet the site specific infection criteria?

Yes

STOP: Secondary BSI

No

STOP: Secondary BSI

STOP: Primary BSI
Hem/Onc/BMT a "special population":

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
</table>
| Complex patient population      | • Highly toxic treatments  
• ICU stays  
• Complications (infection, bleeding, ADEs) |
| Device utilization              | • True need for central line |
| Culturing practices             | • Bad veins  
• Thrombocytopenia |
| Antimicrobial utilization       | • Like water  
• Usually appropriate for severity of illness |
| Surveillance practices          | • Variable? |
| Administrative pressure         | • “Protective” of program and reputation |
| Adjudication                    | • Clinicians don’t consider many “CLABSI” to be preventable  
• Definitions don’t apply well to patient population and leads to rejection of data |
MBI-BSI Criterion 1

Patient of any age meets criterion 1 for LCBI with at least one blood specimen identified by a culture or non-culture based microbiologic testing method, with any of the following *intestinal organisms* (but no other organisms).

AND patient meets at least one of the following:

1. Is an allogeneic hematopoietic stem cell transplant recipient within the past year with one of the following documented during same hospitalization as positive blood specimen:
   - Grade III or IV gastrointestinal graft versus host disease [GI GVHD]
   - ≥1 liter diarrhea in a 24-hour period (or ≥20 mL/kg in a 24-hour period for patients <18 years of age) with onset on or within 7 calendar days before the date the positive blood specimen was collected.

2. Is neutropenic, defined as at least two separate days with values of absolute neutrophil count (ANC) or total white blood cell count (WBC) <500 cells/mm³ within a 7-day time period which includes the date the positive blood specimen was collected (Day 1), the 3 calendar days before and the 3 calendar days after.

### Intestinal pathogens (partial list)

- *Bacteroides* spp.
- *Candida* spp.
- *Clostridium* spp.
- *Enterococcus* spp.
- *Fusobacterium* spp.
- *Peptostreptococcus* spp.
- *Prevotella* spp.
- *Veillonella* spp.
- *Enterobacteriaceae*
MBI-BSI Criterion 2

Patient of any age meets criterion 2 for LCBI with at least one blood specimen identified by a culture or non-culture based microbiologic testing method, with only viridans group streptococci and no other organisms.

AND patient meets at least one of the following:

1. Is an allogeneic hematopoietic stem cell transplant recipient within the past year with one of the following documented during same hospitalization as positive blood specimen:
   - Grade III or IV gastrointestinal graft versus host disease [GI GVHD]
   - ≥1 liter diarrhea in a 24-hour period (or ≥20 mL/kg in a 24-hour period for patients <18 years of age) with onset on or within 7 calendar days before the date the positive blood specimen was collected.

2. Is neutropenic, defined as at least two separate days with values of absolute neutrophil count (ANC) or total white blood cell count (WBC) <500 cells/mm³ within a 7-day time period which includes the date the positive blood specimen was collected (Day 1), the 3 calendar days before and the 3 calendar days after.
MBI-BSI Criterion 3

Patient ≤1 year of age meets criterion 3 for LCBI with at least one blood specimen identified by a culture or non-culture based microbiologic testing method, with only *viridans group streptococci* and no other organisms.

AND patient meets at least one of the following:

1. Is an allogeneic hematopoietic stem cell transplant recipient within the past year with one of the following documented during same hospitalization as positive blood specimen:
   - Grade III or IV gastrointestinal graft versus host disease [GI GVHD]
   - $\geq 20\text{ mL/kg diarrhea}$ in a 24-hour period with onset on or within 7 calendar days before the date the first positive blood specimen is collected.

2. Is neutropenic, defined as at least two separate days with values of absolute neutrophil count (ANC) or total white blood cell count (WBC) $<500\text{ cells/mm}^3$ on or within a seven-day time period which includes the date the positive blood specimen was collected (Day 1), the 3 calendar days before and the 3 calendar days after.
Central Line

Central line
- Catheter must terminate in aorta, pulmonary artery, superior or inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, external iliac or common iliac veins, femoral veins, umbilical artery/vein (neonates)

The following are NOT considered central lines:
- Extracorporeal membrane oxygenation (ECMO)
- Arterial catheters
- Intra-aortic balloon pump (IABP) devices
- Hemodialysis reliable outflow (HeRO) dialysis catheters
- Non-accessed central line (not accessed nor inserted during the hospitalization)
- Peripheral IV or Midlines
- Ventricular Assist Device (VAD)

Infusion: Introduction of a solution through a blood vessel via a catheter lumen
Central Line

Temporary central line: A non-tunneled, non-implanted catheter

Permanent central line:
- Tunneled catheters, including certain dialysis catheters
- Implanted catheters (including ports)
A laboratory-confirmed bloodstream infection (LCBI) where central line (CL) or umbilical catheter (UC) was in place for >2 calendar days when all elements of the LCBI were first present, with day of device placement being Day 1

AND

A CL or UC was in place on the day of the event or the day before. If a patient is admitted or transferred into a facility with a central line in place, day of first access is considered Day 1
How does CLABSI happen?

How patients with central lines can get infected with germs

- Hand or glove touching the line can be dirty
- Skin where line is placed can be dirty
- Where medicines are injected can get dirty

Contamination occurs...

Insertion:
- Patient’s Skin
- Operator (Spit, Hair, Hands)
- Environment

Maintenance:
- Cap is frequently accessed, inadequately cleaned during access, or poorly functioning
- Operator (Spit, Hair, Hands) during assessments + routine dressing changes
- Bacterial migration along catheter tract from skin
CLABSI Prevention Success!

CLABSI incidence is downtrending
46% fewer CLABSI in hospital ICU patients in 2013 than in 2008
Prevention efforts have saved ~ 3,000-6,000 lives and ~$414 million in extra medical costs (2009 compared with 2001)
But, CLABSIIs still occur: ~30,000 per year

ICU CLABSI Rate (per 1000 central-line days) vs. Year

<table>
<thead>
<tr>
<th>Year</th>
<th>DICON Average</th>
<th>10%</th>
<th>25%</th>
<th>50% (median)</th>
<th>75%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014 ICU CLABSI</td>
<td>0.8</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.8</td>
<td>1.4</td>
</tr>
<tr>
<td>2014 House-wide CLABSI</td>
<td>0.69</td>
<td>0.00</td>
<td>0.25</td>
<td>0.53</td>
<td>0.79</td>
<td>1.85</td>
</tr>
</tbody>
</table>

DICON: Unpublished data
Healthcare-associated infections (HAIs) are infections patients can get while receiving medical treatment in a healthcare facility. Working toward the elimination of HAIs is a CDC priority. The standardized infection ratio (SIR) is a summary statistic that can be used to track HAI prevention progress over time; lower SIRs are better. The infection data are collected through CDC’s National Healthcare Safety Network (NHSN). HAI data for nearly all U.S. hospitals are published on the Hospital Compare website.

**CLABSIs**

**CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS**

When a tube is placed in a large vein and not put in correctly or kept clean, it can become a way for germs to enter the body and cause deadly infections in the blood.

- U.S. hospitals reported a significant decrease in CLABSIs between 2012 and 2013.
- Among the 2,390 hospitals in U.S. with enough data to calculate an SIR, 9% had an SIR significantly worse than the national SIR of 0.54.

**CAUTIs**

**CATHETER-ASSOCIATED URINARY TRACT INFECTIONS**

When a urinary catheter is not put in correctly, not kept clean, or left in a patient for too long, germs can travel through the catheter and infect the bladder and kidneys.

- U.S. hospitals reported a significant increase in CAUTIs between 2012 and 2013.
- Among the 2,781 U.S. hospitals with enough data to calculate an SIR, 12% had an SIR significantly worse than the national SIR of 1.06.

**MRSA Bacteremia**

**LABORATORY IDENTIFIED HOSPITAL-ONSET BLOODSTREAM INFECTIONS**

Methicillin-resistant *Staphylococcus aureus* (MRSA) is bacteria usually spread by contaminated hands. In a healthcare setting, such as a hospital, MRSA can cause serious bloodstream infections.

- U.S. hospitals reported a significant decrease in MRSA Bacteremia between 2012 and 2013.
- Among the 2,002 U.S. hospitals with enough data to calculate an SIR, 7% had an SIR significantly worse than the national SIR of 0.92.

**SSIs**

**SURGICAL SITE INFECTIONS**

See page 3 for additional procedures

When germs get into an area where surgery is or was performed, patients can get a surgical site infection. Sometimes these infections involve only the skin. Other SSIs can involve tissues under the skin, organs, or implanted material.

- **SSI: Abdominal Hysterectomy**
  - U.S. hospitals reported no significant change in SSIs related to abdominal hysterectomy surgery between 2012 and 2013.
  - Among the 765 U.S. hospitals with enough data to calculate an SIR, 6% had an SIR significantly worse than the national SIR of 0.86.

- **SSI: Colon Surgery**
  - U.S. hospitals reported a significant increase in SSIs related to colon surgery between 2012 and 2013.
  - Among the 2,030 U.S. hospitals with enough data to calculate an SIR, 7% had an SIR significantly worse than the national SIR of 0.92.

**C. difficile Infections**

**LABORATORY IDENTIFIED HOSPITAL-ONSET C. DIFFICILE INFECTIONS**

When a person takes antibiotics, good bacteria that protect against infection are destroyed for several months. During this time, patients can get sick from *Clostridioides difficile* (*C. difficile*), bacteria that cause potentially deadly diarrhea, which can be spread in healthcare settings.

- U.S. hospitals reported a significant decrease in C. difficile infections between 2012 and 2013.
- Among the 3,557 U.S. hospitals with enough data to calculate an SIR, 13% had an SIR significantly worse than the national SIR of 0.90.

*Statistically significant.*
What’s a Bundle?

“Care bundles are small, straightforward, sets of evidence-based practices... that, when implemented collectively, improve the reliability of their delivery and improve patient outcomes.”

http://www.ihi.org/resources/Pages/ImprovementStories/WhatIsABundle.aspx
IHI Bundle: PREVENTION OF CENTRAL LINE INFECTIONS

During insertion:
- Hand hygiene
- Maximal barrier precautions
- Chlorhexidine skin antisepsis (now CHG-alcohol)
- Optimal catheter site selection, with subclavian vein as the preferred site for nontunneled catheters

During maintenance:
- Daily review of line necessity, with prompt removal of unnecessary lines
Strategies to Prevent Central Line–Associated Bloodstream Infections in Acute Care Hospitals: 2014 Update

Jonas Marschall, MD;1,2a Leonard A. Mermel, DO, ScM;3a Mohamad Fakih, MD, MPH;4 Lynn Hadaway, MEd, RN, BC, CRNI;5 Alexander Kallen, MD, MPH;6 Naomi P. O’Grady, MD;7 Ann Marie Pettis, RN, BSN, CIC;8 Mark E. Rupp, MD;9 Thomas Sandora, MD, MPH;10 Lisa L. Maragakis, MD, MPH;11 Deborah S. Yokoe, MD, MPH12
GRADING THE QUALITY OF EVIDENCE

<table>
<thead>
<tr>
<th>Grade</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. High</td>
<td>Highly confident that the true effect lies close to that of the estimated size and direction of the effect. Evidence is rated as high quality when there is a wide range of studies with no major limitations, there is little variation between studies, and the summary estimate has a narrow confidence interval.</td>
</tr>
<tr>
<td>II. Moderate</td>
<td>The true effect is likely to be close to the estimated size and direction of the effect, but there is a possibility that it is substantially different. Evidence is rated as moderate quality when there are only a few studies and some have limitations but not major flaws, there is some variation between studies, or the confidence interval of the summary estimate is wide.</td>
</tr>
<tr>
<td>III. Low</td>
<td>The true effect may be substantially different from the estimated size and direction of the effect. Evidence is rated as low quality when supporting studies have major flaws, there is important variation between studies, the confidence interval of the summary estimate is very wide, or there are no rigorous studies, only expert consensus.</td>
</tr>
</tbody>
</table>

**NOTE.** Based on Grades of Recommendation, Assessment, Development, and Evaluation (GRADE)\textsuperscript{239} and the Canadian Task Force on Preventive Health Care.\textsuperscript{240}
PREVENTING CLABSI: BEFORE INSERTION

Provide easy access to an evidence-based list of indications for CVC {III}

Require education of HCP involved in insertion, care, and maintenance of CVCs about CLABSI prevention {II}

Bathe ICU patients over 2 mo of age with a CHG preparation on a daily basis {I}
Checklist for Prevention of Central Line Associated Blood Stream Infections

Based on 2011 CDC guideline for prevention of intravascular catheter-associated bloodstream infections:
http://www.cdc.gov/HAI/bsi/bsi.html

For Clinicians:
- Promptly remove unnecessary central lines
- Follow proper insertion practices:
  - Perform hand hygiene before insertion
  - Use sterile gloves and gowns
  - Use ultrasound guidance
  - Use intravascular pressure monitoring
  - Use catheter insertion kits
  - Use aseptic technique
  - Avoid insertion site in adult patients

Handle and maintain central lines appropriately:
- Monitor for signs of infection
- Clean the insertion site and all surrounding areas
- Use aseptic technique
- Use antiseptic solution

FAQs about "Catheter-Associated Bloodstream Infections"
[BSI: Bloodstream Infections]

What is a catheter-associated bloodstream infection?
A "catheter" is a tube that is inserted into a patient's body through a vein or artery. A "catheter-associated bloodstream infection" (CABSI) is an infection that develops in the bloodstream after a catheter is inserted. CABSIs are often caused by bacteria or fungi that are carried into the bloodstream from the catheter.

Can a catheter-associated bloodstream infection be treated?
Yes, CABSIs can be treated with antibiotics. However, it is important to identify and treat the bacteria or fungi that are responsible for the infection as soon as possible.

What are some of the things that hospitals are doing to prevent catheter-associated bloodstream infections?
Hospitals are taking steps to prevent CABSIs, such as:
- Using sterile techniques during catheter insertion
- Cleaning the insertion site and surrounding areas
- Monitoring for signs of infection
- Using antiseptic solutions
- Using catheter insertion kits
- Avoiding insertion site in adult patients

For Facilities:
- Monitor and provide prompt feedback to adherence to hand hygiene
- Provide education to staff on catheter insertion and handling
- Provide instructions to staff on central line insertion, handling, and maintenance

Supplemental strategies for consideration:
- Use chlorhexidine-based skin antisepsis
- Use antiseptic-impregnated catheters
- Use chlorhexidine-impregnated dressings

National Center for Emerging and Zoonotic Infectious Diseases
Centers for Disease Control and Prevention

Co-sponsored by:

http://www.cdc.gov/HAI/bsi/bsi.html
BTHE ICU PATIENTS >2 MONTHS OF AGE WITH A CHG PREPARATION DAILY

Intervention = Daily bathing with 2% CHG impregnated washcloth
Design & setting : Cross-over study in MICU
Result: CHG associated with decreased rate (per 1,000 pt-days) of CLABSI (4.1 vs 10.4)

REDUCE MRSA

Cluster-randomized trial in 74 ICUs

MRSA screening and isolation vs. targeted decolonization of MRSA carriers vs. universal decolonization

Decolonization: CHG daily bathing + nasal mupirocin

Result: Universal decolonization reduced rate of all Primary BSI significantly. Decreased MRSA BSI also, but NS.

1 BSI prevented per 99 patients decolonized.

PREVENTING CLABSI: AT INSERTION

Have a process in place to ensure adherence to infection prevention practices (e.g., checklist){II}

Perform hand hygiene prior to catheter insertion or manipulation {II}

Avoid using the femoral artery for central venous access in obese patients {I}

- Consider risks and benefits of different insertion sites
- Do not use peripherally inserted CVCs (PICCs) as a strategy to reduce CLABSI

Use an all-inclusive catheter cart or kit {II}

Use ultrasound guidance for internal jugular insertion {II}

Use maximum sterile barrier precautions during CVC insertion (mask, cap, sterile gown, and sterile gloves; patient covered with full body sterile drape) {II}

Use alcohol-chlorhexidine for skin antisepsis {I}

CVC Bundle Checklist:
- [] Hand Hygiene
- [] Mask, cap, gown, sterile gloves, full body drape
- [] CHG-alcohol skin antisepsis
- [] Optimal line site selection
确保适当的护士与患者比例，并限制在ICU中使用浮动护士。

在接触到导管之前，消毒导管头、无针连接器和注射口。

移除不必要的导管。

对于非隧道化CVCs，每5-7天更换透明敷料并使用CHG-基质的抗微生物剂进行站点护理。

如果没有使用血液、血液制品或脂类的输液器每96小时更换一次。

PREVENTING CLABSI: SPECIAL APPROACHES

Use antiseptic or antimicrobial-impregnated CVCs in adult patients in specific situations:
- Higher than desired CLABSI rate
- Patients with recurrent CLABSI
- Patients at higher risk of severe sequelae from a CLABSI (e.g. prosthetic valves)

Use an antiseptic-containing dressing for CVCs inpatients over 2 mo of age

Use an antiseptic-containing hub/connector cap/port protector to cover connectors

Use antimicrobial locks for CVCs in specific situations:
- HD catheters
- Limited access and history of recurrent CLABSI
- Patients at higher risk of severe sequelae from a CLABSI

AVOID:
- Antimicrobial prophylaxis
- Routine replacement of CVCs
PREVENTING CLABSI: UNRESOLVED ISSUES

Routine use of needleless connectors

IV therapy teams
  - PICC teams have been shown to reduce BSI (but unknown in CLABSI, specifically)

Silver-coated catheter connectors

Standard transparent dressings (nonantimicrobial)

Impact of CHG-containing products on CHG-resistance
Central Line Associated BSI: High Stakes

CLABSI is a **rare event**. Every case is examined for root cause.

**Public reporting** is the rule
- [https://www.medicare.gov/hospitalcompare/](https://www.medicare.gov/hospitalcompare/)

**Financial penalties** for CLABSI are a reality (since 2008) and increasing with VBP.

**Reputation** may be affected.

2015: Required CLABSI reporting is house-wide (adult and pediatric ICUs, medical, surgical wards)
Standardized Infection Ratio (SIR)

Observed N CLABSI / Predicted N CLABSI

SIR >1 rate is higher than comparator
SIR <1 rate is lower than comparator
If predicted <1 then no SIR is calculated

Regression modeling used to calculate “Predicted” based on NHSN reference population
- 2015 SIRs based on 2006-2008 NHSN baseline
- 2016 SIR “re-baseline” based on 2015 NHSN population

Adjustment factors for CLABSI SIR: location/unit type, bed size, medical school affiliation, facility type (e.g. children/women’s hospital), birthweight if NICU

\[
SIR = \frac{\text{Observed (O) HAIs}}{\text{Predicted (P) HAIs}}
\]

1. CLABSIs in Adult/Pediatric ICUs

North Carolina 2015 CLABSIs in Adult/Pediatric Medical, Surgical and Medical/Surgical Wards & ICUs

- North Carolina hospitals reported 626 infections, compared to the predicted 1104 infections.
  - This was better than the 2006-2008 national experience.
  - This number is larger than the number of CLABSIs reported in previous years.
- CLABSIs surveillance was expanded to include medical, surgical and medical/surgical wards. In previous years, surveillance was limited only to adult and pediatric ICUs.
- In 2015, North Carolina did not meet the U.S. Department of Health and Human Services goal to reduce CLABSIs by 50% from the 2006-2008 baseline experience.
- The most commonly identified organisms from adult and pediatric CLABSIs patients were *Candida* and other yeasts/fungi.

### Table 1. N.C. Central Line Associated Bloodstream Infections (CLABSIs) in Adult/Pediatric Medical, Surgical and Medical/Surgical Wards & ICUs, by Year, 2012-2015

<table>
<thead>
<tr>
<th>Year</th>
<th># Observed Infections</th>
<th># Predicted Infections</th>
<th>How Does North Carolina Compare to the National Experience?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>310</td>
<td>637</td>
<td>★Better: Fewer infections than were predicted (better than the national experience)</td>
</tr>
<tr>
<td>2013</td>
<td>315</td>
<td>613</td>
<td>★Better: Fewer infections than were predicted (better than the national experience)</td>
</tr>
<tr>
<td>2014</td>
<td>248</td>
<td>644</td>
<td>★Better: Fewer infections than were predicted (better than the national experience)</td>
</tr>
<tr>
<td>2015*</td>
<td>626</td>
<td>1104</td>
<td>★Better: Fewer infections than were predicted (better than the national experience)</td>
</tr>
</tbody>
</table>

*In 2015, CLABSIs surveillance was expanded to include medical, surgical and medical/surgical wards.
Figure 2.

NC Central Line-Associated Bloodstream Infections (CLABSI) in Adult/Pediatric ICUs & Wards
Standardized Infection Ratios (SIR), by Unit Type, 2015

How to Understand Figure 2:
- In 2015, neurologic ICUs had the highest number of observed infections, performing WORSE than predicted by the national experience.
- In 2015, all adult/pediatric reporting locations except neurologic ICUs and burn ICUs did BETTER when compared to the national experience.
- The number of observed infections in nine of the 16 unit types was higher than the HHS 5-year goal.

http://epi.publichealth.nc.gov/cd/hai/figures.html
Figure 3.

NC Central Line-Associated Bloodstream Infections (CLABSI) in Adult/Pediatric ICUs & Wards
Standardized Infection Ratios (SIR), by Hospital Group, 2015

How to Understand Figure 3:
- In 2015 all hospital groups had fewer observed infections than predicted and did BETTER compared to the national experience.
- Hospitals with less than 100 beds were the only hospital size group that met the targeted HHS 5-year goal.

http://epi.publichealth.nc.gov/cd/hai/figures.html
IC effect on primary BSI

The Effect of a Nationwide Infection Control Program Expansion on Hospital-Onset Gram-Negative Rod Bacteremia in 130 Veterans Health Administration Medical Centers: An Interrupted Time-Series Analysis

- Local MDRO coordinator
- Culture transformation
- Education
- Leadership

Vertical (MRSA+ only)
- Active surveillance
- Contact precautions

CONCLUSIONS

Healthcare-associated bloodstream (BSI) cause significant morbidity and mortality

The most important risk factor for BSI is presence of a central venous catheter

Clinical definition and surveillance definition of catheter-related BSI are NOT the same

A near 0 rate of CLABSI is possible using existing technology and appropriate practice strategies

Current guidelines should be followed for the prevention of CLABSI
Key References

Clinical Management of catheter-related infections.

Prevention of catheter-related infections.
- *Clinical Infectious Diseases*; 2011; 52: e1-e32.

SHEA Compendium: Strategies to Prevent CLABSI.
- *Infection Control and Hospital Epidemiology*; 2014; 35: 753-771.

Sepsis-3 definition and management.