Purpose

- Provide an overview of the major evidence-based methods to prevent healthcare-associated infections (HAIs).

- Illustrate how applying current infection prevention and control measures can markedly reduce these HAIs—maybe even to ZERO.

Hand Hygiene

Hand Hygiene-Let’s Be Realistic

- Good luck getting to (and sustaining) 100% compliance.
- Clinician accountability, driven by administrators, is essential. Infection control is everyone’s responsibility, not just infection control’s!
- Observations of hand hygiene compliance are tedious, personnel resource intensive, and subject to enormous inter-rater variability.
- Electronic monitoring is coming and may provide better coverage and better data!
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Background

- Urinary tract infections (UTIs) often are the most common site of HAI.
- Most UTIs (80%) are associated with urinary catheterization.
- Approximately 25% of inpatients are catheterized.
- Attack rate: 2.0-3.1 UTIs per 100 admissions.

Urinary Tract Infections (UTIs)

UTI Prevention Rule: Make Sure the Patient Really Needs the Catheter

Appropriate indications
- Bladder outlet obstruction
- Incontinence and sacral wound
- Urine output monitored
- Patient’s request (end-of-life)
- During or just after surgery

Why are Catheters Used Inappropriately?

- Perhaps physicians “forget” that their patient has a urinary catheter.
- Study to determine the extent to which physicians are aware which of their inpatients have urinary catheters.
- Surveyed 56 medical teams at 4 sites; 256 providers completed the survey (response rate = 89%)

Urethral Catheters: Lost in Place?

** Urinary Catheter Reminder **

Date: __ / __ / __

This patient has had an indwelling urethral catheter since __ / __ / __.

Please indicate below EITHER (1) that the catheter should be removed OR (2) that the catheter should be retained. If the catheter should be retained, please state ALL of the reasons that apply.

☐ Please discontinue indwelling urethral catheter. OR

☐ Please continue indwelling urethral catheter because patient requires indwelling catheterization for the following reasons (please check all that apply):
- Urinary retention
- Very close monitoring of urine output and patient unable to use urinary or bedpan
- Open wound in sacral or perineal area and patient has urinary incontinence
- Patient too ill or fatigued to use any other type of urinary collection strategy
- Patient had recent surgery
- Management of urinary incontinence on patient’s request
- Other - please specify: __________________________

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Prevention of Catheter-related UTI using Silver Catheters: The Silver Bullet?

- Silver has in vitro antibacterial activity.
- Additional cost of $5.30 per silver catheter tray.
- Is the reduction in catheter-associated UTIs worth the extra cost?

Silver Catheters: What Is The Evidence Base?

- To date, 11 comparative studies and two meta-analyses of silver (the majority being the silver alloy urinary catheter) vs. non-coated Foley catheters have been conducted.
- In every comparative trial, the number of CA-UTIs has been decreased in the impregnated silver-coated catheter group compared to the non-coated catheter group.
- In some of these studies, the number of patients included has been small and thus a statistical significant decrease in CA-UTIs has not been documented (insufficient power). Nevertheless, in every study, a decrease in the rate of CA-UTI or CA-bacteriuria has been documented.

Silver Catheters: What Is The Evidence Base?

- In both meta-analyses, combining a variety of studies to increase the power to detect a difference in efficacy of silver-coated catheters, the authors have concluded that the silver-alloy coated catheter is associated with a significant reduction in CA-UTI and CA-bacteriuria.
- These data strongly support that silver alloy hydrogel impregnated urinary catheters can decrease the risk of CA-UTI or CA-bacteriuria compared to non-coated catheters in patients who are to be catheterized for 3-7 days.

CA-UTI Prevention: Summary Recommendations

- Use urethral catheters only when necessary.
- Use aseptic technique for catheter insertion and manipulation.
- Maintain a closed urinary drainage system.
- Require a urinary catheter insertion indication/order and consider using an administrative urinary catheter “stop order” to limit inappropriate catheterization.
- Consider silver catheters in high-risk patients who require catheterization for 3-7 days.

Preventing Central Venous Catheter-Associated Bloodstream Infections (CVC-BSIs)
Preventing CVC-Related BSIs — First, Think About the Need.

• Use intravascular catheters only when necessary
• Choose the lowest risk catheter appropriate for the patient’s needs
  – Peripheral IV instead of CVC for short-term access in a patient who is not seriously ill
  – Peripherally inserted central catheter (PICC) or tunneled, cuffed CVC instead of percutaneous CVC for long-term access
• Minimize the duration of catheterization

Basic Approaches for the Prevention of CLA-BSIs

<table>
<thead>
<tr>
<th>Basic Practices</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheter Checklist</td>
<td>B-II</td>
</tr>
<tr>
<td>Hand Hygiene</td>
<td>B-II</td>
</tr>
<tr>
<td>Insertion site-Femoral</td>
<td>A-I</td>
</tr>
<tr>
<td>Cart Kit</td>
<td>B-II</td>
</tr>
<tr>
<td>Maximal Barrier Precautions</td>
<td>A-I</td>
</tr>
<tr>
<td>Chlorhexidine (CHG) Skin Prep</td>
<td>A-1</td>
</tr>
</tbody>
</table>

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Basic Practices:
Use a checklist


Basic Practices:
Use Catheter Cart or Kit


Basic Practices:
Use Maximum Barrier Precautions

Effect of Maximal Barrier Precautions during Insertion on CVC Infections


Basic Practices:
Use CHG Skin Prep

- Apply 30 seconds with friction
- Allow 30 seconds to dry


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Chlorhexidine Compared with Povidone-Iodine Solution for Vascular Catheter–Site Care: A Meta-Analysis

<table>
<thead>
<tr>
<th>Study (Reference)</th>
<th>Odds Ratio (95% CI)</th>
<th>Colonies - a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allert et al (7), 1998</td>
<td>1.14 (0.69-1.86)</td>
<td>441</td>
</tr>
<tr>
<td>Shuhar et al (9), 1998</td>
<td>1.08 (0.67-1.71)</td>
<td>303</td>
</tr>
<tr>
<td>Holmes et al (10), 1998</td>
<td>0.92 (0.47-1.81)</td>
<td>248</td>
</tr>
<tr>
<td>Abreu et al (11), 1996</td>
<td>0.24 (0.13-0.45)</td>
<td>375</td>
</tr>
<tr>
<td>Segura et al (12), 1997</td>
<td>0.13 (0.31-0.55)</td>
<td>452</td>
</tr>
<tr>
<td>Horner et al (13), 2000</td>
<td>0.24 (0.30-2.76)</td>
<td>374</td>
</tr>
<tr>
<td>Keshishid and Hick, 2005</td>
<td>0.30 (0.14-0.66)</td>
<td>840</td>
</tr>
</tbody>
</table>


Special Approaches for the Prevention of CLA-BSIs

<table>
<thead>
<tr>
<th>CHG Bath</th>
<th>B- II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coated Catheters</td>
<td>A- I</td>
</tr>
<tr>
<td>BIOPATCH Disk</td>
<td>B- I</td>
</tr>
<tr>
<td>Antimicrobial Locks</td>
<td>A- I</td>
</tr>
</tbody>
</table>


Special Approaches

Special approaches for the prevention of CLA-BSI are recommended if CLA-BSI Rates are Higher Than Institutional Goals despite implementation of the basic CLA-BSI prevention strategies\(^1\)

\(^1\) Marschall J, et al., Infect Control Hospital Epidemiol 2008;29:522-30.

Chlorhexidine (CHG) Baths to Reduce Vancomycin-resistant Enterococcus (VRE)

- **Study design:** Prospective sequential-group single-arm clinical trial. Compared soap and water to 2% CHG cloth baths/cleansing of teaching hospital medical intensive care unit patients from October 2002-December 2003. Assessed VRE colonization/infection/contamination.
- **Results:** 1787 patients treated and tested. CHG resulted in 2.5 log (10) less colonies of VRE on patients skin, less healthcare worker and environmental contamination. VRE acquisition decreased from 26 to 9 per 1,000 patient-days (RR 0.4; 95% CI 0.1-0.9).


Daily Chlorhexidine (CGH) Bathing and MRSA, VRE and Bloodstream Infections (BSIs)

- **Study design:** Before/after (6 months) study of soap and water vs. CHG solution daily bathing on MRSA or VRE acquisition and BSI at six intensive care units at four academic centers.
- **Results:** CHG bathing resulted in a decrease in: MRSA acquisition of 32% (5.04 vs. 3.44 per 1000 patient-days, p=0.046), VRE acquisition of 50% (4.35 vs. 2.19 per 1000 patient-days, p=0.008), of VRE-BSI in VRE-colonized patients (p=0.035).


Meta-analysis of CA-BSI Rates with Antiseptic Catheters

- **Summary:** OR 0.56, 95% CI (0.37-0.84)

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Prevention: Impact of Coated Catheters

Meta-analysis of published studies

<table>
<thead>
<tr>
<th>Nº of studies</th>
<th>Colonization</th>
<th>Bloodstream Infections</th>
<th>&gt;1 week</th>
<th>&lt;1 week</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>0.60 (0.49-0.74)</td>
<td>0.64 (0.46-0.88)</td>
<td>0.35 (0.16-0.67)</td>
<td>0.82 (0.56-1.21)</td>
</tr>
</tbody>
</table>


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


Basic Practices: Avoid using Femoral Vein ¹
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

ANTECUBITAL SPACE

¹ Marschall J. et al., Infect Control Hospital Epidemiol 2008;29:S22-30

Basic Practices: Avoid using Femoral Vein 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 10³ - 10⁴ CFU per cm²

SUBCLAVICULAR SPACE

CHG-impregnated Patch (BioPatch)
Randomized Controlled Trials

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 (54%) even when CHG-silver impregnated catheters were used.


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Timsit’s Randomized Controlled Trial:

Timsit et al., JAMA. 2009;301:1231-1241.

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

Connectors and Antibiotic/Antiseptic Flushes, Dwells, or Locks

<table>
<thead>
<tr>
<th>Market Players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser Access Split-Septum</td>
</tr>
<tr>
<td>Seelok (B. Braun)</td>
</tr>
<tr>
<td>Laser Access Mechanical Valve</td>
</tr>
<tr>
<td>Bionector (Vygon)</td>
</tr>
<tr>
<td>BD Posiflow™</td>
</tr>
<tr>
<td>BD Q-Syte™</td>
</tr>
</tbody>
</table>

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
- **Positive displacement needleless valve (PDV) period:** March-August 2005

<table>
<thead>
<tr>
<th>BSI Rate</th>
<th>SS Period</th>
<th>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>Non-transplant</td>
<td>3.47</td>
<td>7.51</td>
<td>&lt;.0001</td>
<td>2.36</td>
</tr>
<tr>
<td>Cooperative care (CPD TX)</td>
<td>3.80</td>
<td>15.18</td>
<td>&lt;.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

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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.
- **Mechanical valve (MV) period:** January 2004-October 2005.

<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.


Recommendations for Implementing Prevention and Monitoring Strategies:
Approaches that should not be considered a routine part of CLA-BSI prevention

- Do not use antimicrobial prophylaxis for short-term or tunneled catheter insertion or while catheters are in situ (A-I).
- Do not routinely replace CVCs or arterial catheters (A-I).
- Do not routinely use positive-pressure needleless connectors with mechanical valves before a thorough assessment of risks, benefits, and education regarding proper use (B-II).


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></th>
<th>Baseline</th>
<th>3 Months</th>
<th>16-18 Months</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median CVC-BSI Rates per 1,000 CVC-days</td>
<td>2.7</td>
<td>0</td>
<td>0.62</td>
<td>1.4</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

Ventilator-associated Pneumonia

**Background**

- VAP is the most common healthcare-associated infection in critical care patients.
- Risk factors for VAP include age, chronic obstructive lung disease, trauma, gastric aspiration, duration ventilation, elevated gastric pH, etc.
- 10-20% of patients ventilated for >48 hrs will develop VAP.
- 10-15 episodes of VAP per 1,000 ventilator-days (approximately 1% per day of ventilation).

Ventilator Management Changes—The Bundle.

- Chlorhexidine on the unit
- Oral care product
- Sedation reduction vs.
  - Sedation vacation
- Using deep vein thrombosis (DVT) and peptic ulcer disease (PUD) prophylaxis prevent risk for vent patients
- Using ventilator weaning protocol
- Continuous aspiration of subglottic secretions

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Results

2007. The Importance of Nursing Education

Data Feedback – New Way

Vent Bundle Compliance and VAP Infection Rates, Hospital A

The Oral Decontamination with CHG

Comparative Trial of the Silver-Coated Endotracheal Tube

Prevention of VAP

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Methicillin-resistant Staphylococcus aureus (MRSA)

Invasive MRSA (mostly HA-MRSA and mostly BSI) kills nearly 19,000 patients annually in the United States.

Annual Numbers of Deaths (U.S.)

<table>
<thead>
<tr>
<th>Cause</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA (invasive)</td>
<td>~19,000</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>~15,000</td>
</tr>
<tr>
<td>Parkinson’s</td>
<td>19,544</td>
</tr>
<tr>
<td>Homicides</td>
<td>18,124</td>
</tr>
<tr>
<td>Injuries at work</td>
<td>5,113</td>
</tr>
<tr>
<td>Infant mortality</td>
<td>9,070</td>
</tr>
</tbody>
</table>

Recommendations For Preventing MRSA Transmission-Active Detection and Isolation (ADI)

- Conduct a risk assessment;
- Active surveillance testing to identify MRSA-colonized patients;
- Isolation (cohorting) of colonized and infected patients;
- Hand hygiene—before/after patient/environment contact;
- Gown and glove, if patient or contaminated environmental contact anticipated; and
- Routine environmental cleaning.

Does True Universal MRSA Screening Reduce Transmission and MRSA Infections?

Study Design: Observational, prospective interventional study with universal screening using MRSA-PCR on all admissions to three hospitals (total: 850 beds and 40,000 admissions per year) in Evanston, Ill.

- Compared: Passive surveillance (clinical detection-12m); Targeted surveillance cultures (clinical culture + high risk = ICU-12m); or Universal patient screening—21m.
- August 2005 to September 1, 2006.
- Intervention: Nasal screening. MRSA+ contact isolation, topical decolonization (muprison).
- Poisson and segmented regression models used to compare prevalence density.


~ 70% reduction in MRSA-HAIs

The Veteran’s Hospital Administration (VHA) MRSA Control Program

- The national initiative focuses on implementing the VHA MRSA Bundle which consists of four essential elements (ADI):
  - Active Surveillance Testing [AST](Admission/Transfer/Discharge Swabbing)
  - Hand Hygiene
  - Contact Precautions
  - Cultural Transformation (Leadership and Staff Engagement)
- Consistent use of the VHA MRSA Bundle had been shown to markedly reduce MRSA-related infections in the pilot facilities.
- Phase I: The VHA system began doing universal patient testing in 2006 at its approximately 150 hospitals in ICU patients.
- Phase II of the initiative began in March 2007 and was a national roll-out including all VHA medical facilities with all patients (ICU and non-ICU).
- MRSA prevalence on admission ranged from 5% to 22% (clinical culture 1-1.5%; AST 9%-12%).

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Universal surveillance by PCR for *S. aureus* followed by decolonization

- Randomized trial
  - PCR identification of *S. aureus* in patients admitted to the hospital.
  - Decolonization with nasal mupirocin and chlorhexidine baths.

**VHA MRSA Control Program Results**

<table>
<thead>
<tr>
<th>Year</th>
<th>FY06</th>
<th>FY07</th>
<th>FY08</th>
<th>FY09</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU-MRSA-HAI Rate*</td>
<td>1.37</td>
<td>1.36</td>
<td>1.20*</td>
<td>0.79*</td>
</tr>
</tbody>
</table>

Non-ICU MRSA Rate

<table>
<thead>
<tr>
<th></th>
<th>FY06</th>
<th>FY07</th>
<th>FY08</th>
<th>FY09</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.54</td>
<td>0.38</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MRSA-CVC-BSI rate: 0.4 to 0.18 per 1000 CVC-days: P=0.02

In March 2009, the VA expanded the MRSA control program to their long-term care facilities nationwide.

*Rate per 1,000 bed-days 07 vs. 08: P=0.04; 08 vs. 09: P=0.001; # p=0.02

**Conclusions**

- Many, if not most healthcare-associated infections (HAIs) are preventable, with the implementation of simple, evidence-based interventions.
- Implementation of evidence-based prevention interventions, including the latest technology—which may initially cost more but also save more by reducing HAIs, should be a high priority for all infection control personnel.
- We should all be seeking ZERO Tolerance for HAIs.

* calculated for surgical patients only. Number of surgical patients: n=441 in mupirocin/chlorhexidine group, n=367 in placebo group

Thank you!