GUIDELINES: HOW TO MODIFY RISK FACTORS FOR HAIs

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DISCUSSION TOPICS

- Impact of healthcare-associated infections
- Risk factors, interventions and guidelines for preventing HAIs
  - Central line-associated bloodstream infections
  - Surgical site infections
  - Urinary tract infections
- Challenges in infection control

HEALTHCARE-ASSOCIATED INFECTIONS: IMPACT

- 1.7 million infections per year
- 98,987 deaths due to HAI
  - Pneumonia 35,967
  - Bloodstream 30,665
  - Urinary tract 13,088
  - SSI 8,205
  - Other 11,062
- 6th leading cause of death (after heart disease, cancer, stroke, chronic lower respiratory diseases, and accidents)¹

¹ National Center for Health Statistics, 2004
**COST ESTIMATES FOR HEALTHCARE-ASSOCIATED INFECTIONS (HAIs)**

<table>
<thead>
<tr>
<th>HAI</th>
<th>Cost per HAI + SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilator-associated pneumonia</td>
<td>25,072 ± 4,132</td>
<td>8,682-31,316</td>
</tr>
<tr>
<td>Healthcare-associated bloodstream infections</td>
<td>23,242 ± 5,184</td>
<td>6,908-37,260</td>
</tr>
<tr>
<td>Surgical site infections</td>
<td>10,443 ± 3,249</td>
<td>2,527-29,367</td>
</tr>
<tr>
<td>Catheter-associated urinary tract infections</td>
<td>758 ± 41</td>
<td>728-810</td>
</tr>
</tbody>
</table>

Costs based on literature review 1985-2005, adjusted to US 1995 dollars

**PATHOGENS ASSOCIATED WITH HAIs**: NHSN, 2006-2007

**PATHOGENS CAUSING HAIs, NHSN, 2006-2007**

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  - Urinary tract infections
- Challenges in infection control

**HAZARDS IN THE ICU**

More HCPs and more invasive devices = higher HAI rates

KEY INFECTION CONTROL INTERVENTIONS

- Compliance with CDC recommendations, Category IA and IB
- Surveillance
- Isolation (based on transmission mechanism)
  - Standard: Gloves for contact with all body fluids except sweat
  - Contact: via direct or indirect contact = gloves, gowns (MRSA, VRE)
  - Droplet: via large droplets (<3 feet) = mask, private room (pertussis)
  - Airborne: via small droplets (>3 feet) = N95 respirator (TB, measles)
- Hand hygiene (before and after patient care)
- Proper disinfection and sterilization (devices, environment)
- Occupational health
  - Pre- and post-exposure prophylaxis

SOURCE OF INFECTION PREVENTION STRATEGIES

Evidence-Based

- Centers for Disease Control and Prevention
- The Joint Commission
- Centers for Medicare and Medicaid Services (CMS)
- Institute for Healthcare Improvement (IHI)
- Professional Organizations: APIC, SHEA, AAMI, AORN, SGNA, AIA, SGNA, ASGE

INFECTION PREVENTION STRATEGIES

- Centers for Disease Control and Prevention
  - Prevention of Catheter-Associated UTI, 2009
  - Guideline for Isolation Precautions, 2007
  - Management of MDR Organisms, 2006
  - Preventing HA Pneumonia, 2003
  - Environmental Infection Control in HCF, 2003
  - Hand Hygiene in Healthcare Settings, 2002
  - Prevention of Surgical Site Infections, 1999
  - Management of Occupational Exposure to HBV, HCV, HIV, 2002
  - Infection Control in Healthcare Personnel, 1998

- SHEA
  - Management of HCWs Infected with HBV, HCV, HIV, March 2010
  - Disinfection and Sterilization of Prion-Contaminated Medical Instruments, February 2010
  - Compendium of Strategies to Prevent HAIs, October 2008
    - Surgical Site Infection
    - CLA-Bloodstream Infection
    - Catheter-Associated UTI
    - Ventilator-Associated Pneumonia
    - Clostridium difficile
    - Methicillin-resistant S. aureus

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IMPACT OF BLOODSTREAM INFECTIONS

- Approximately 250,000 nosocomial BSIs per year
- Major risk = use of an intravascular device
- Rate of BSIs varies by:
  - Hospital size, unit, and service
  - Population served (elderly/infants, acute/chronic)
  - Type of device
  - Time-trends
  - Endemic/Epidemic
**Sources of CR-BSI**

- Early (first 7-14 d) – Insertion related
- Late (>14 d) – Maintenance related (breach in aseptic technique when manipulating hubs, connectors, or stopcocks or contamination of infusate itself or line breaks)
- Hematogenous – relates to infections at other sites and occurs only in severely ill patients (ICU, hematology-oncology, etc).

Sherertz et al, J Clin Micro 1997;35:641

**Prevention of CLA-BSI Depends of Eliminating Routes of Infection**

- Skin-catheter interface
  - Aseptic insertion key (insertion bundle)
  - Focus on site of catheter insertion through the skin
- Infection via contaminated hub
  - Aseptic maintenance of hub (maintenance bundle)
  - Focus on disinfection of hub; maintaining a closed system
- Contaminated infusate
  - Intrinsic contamination: Focus on good manufacturing practice
  - Extrinsic contamination: Focus on sterile fluid compounding
- Hematogenous seeding
  - Focus on preventing bacteremia (e.g., prophylactic antibiotics for neutropenic patients)

**PATHOGENS ASSOCIATED WITH CLA-BSIs:**

Hidron AI, et al. ICHE 2008;29:966-1011

**STRATEGIES TO PREVENT CLA-BSI IN ACUTE CARE HOSPITALS**

- Best practices (at insertion)
  - Use a catheter checklist (B-II)
  - Perform hand hygiene before catheter insertion (B-II)
  - Avoid the femoral for access (A-I)
  - In adults, preferentially use the subclavian vein
  - Use an all-inclusive catheter kit or cart (B-II)
  - Use maximal sterile barrier precautions (mask, cap, sterile gown, sterile gloves; cover patient with a large sterile drape}(A-I)
  - Use CHG antiseptic (CHG-alcohol) for skin preparation (A-I)


- Best practices (after insertion)
  - Disinfect (CHG-alcohol, 70% alcohol) catheter hubs, needless connectors, and injection ports before accessing the catheter (B-II)
  - Remove non-essential catheters (A-II)
  - For non-tunneled CVCs change dressing every 5-7 days; more frequently if soiled (A-I)
  - Replace administration sets not used for blood/blood products at intervals not longer than 96 hours (A-II)
  - Use antimicrobial ointment for hemodialysis catheter insertion sites (A-I)

CR-BSI = Central line-associated bloodstream infections

100,000 LIVES CAMPAIGN:
CLA-BSI BUNDLE

- Hand hygiene
- Maximal barrier precautions
- Chlorhexidine skin antisepsis
- Optimal catheter site selection, with subclavian vein as the preferred site for non-tunneled catheters
- Daily review of line necessity, with prompt removal of unnecessary lines

INFECTION CONTROL INTERVENTIONS

- 2000: Addition of 2% chlorhexidine/70% isopropyl alcohol (ChoraPrep®) to the central line dressing kit.
- 2001: Mandatory training for nurses on IV line site care and maintenance.
- 2003: Full body drape added to central line kit. MD could choose kit containing a catheter impregnated with antiseptic or antibiotic.
- 2005: 2nd generation impregnated catheter included in all central line kits (except for Neonatal ICU).
- 2006: Pilot in MICU of IHI bundle to prevent CLA-BSI.
- 2007: Implementation of the IHI bundle in all ICUs.
- 2008: Implementation of Infection Control Liaison Program

IMPACT OF UNC HEALTH CARE REDUCTION
IN CLA-BSI, 1999-2008

- Infections prevented
  - 887
- Deaths prevented (based on attributable mortality)
  - 222 to 266 death preventing (attributable mortality 25% to 30%)
- Savings (2005 dollars)
  - $20,615,654

CENTRAL LINE-ASSOCIATED BSI RATE:
NHSN, 2006-2007

<table>
<thead>
<tr>
<th>Unit</th>
<th>Infection Rate (pooled mean)</th>
<th>Infection Rate (10% - 90%)</th>
<th>Central Line Utilization Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burn ICU</td>
<td>5.6</td>
<td>0.0 – 13.5</td>
<td>0.39</td>
</tr>
<tr>
<td>Coronary ICU</td>
<td>2.1</td>
<td>0.0 – 5.3</td>
<td>0.40</td>
</tr>
<tr>
<td>Surgical CT ICU</td>
<td>1.4</td>
<td>0.0 – 3.4</td>
<td>0.72</td>
</tr>
<tr>
<td>Medical ICU</td>
<td>2.4</td>
<td>0.0 – 5.3</td>
<td>0.58</td>
</tr>
<tr>
<td>Med/Surg ICU, teaching</td>
<td>2.0</td>
<td>0.0 – 4.2</td>
<td>0.59</td>
</tr>
<tr>
<td>Med/Surg ICU, others</td>
<td>1.5</td>
<td>0.0 – 3.6</td>
<td>0.46</td>
</tr>
<tr>
<td>Pod Med/Surg ICU</td>
<td>2.0</td>
<td>0.0 – 6.0</td>
<td>0.46</td>
</tr>
<tr>
<td>Pod Med ICU</td>
<td>1.0</td>
<td>NA</td>
<td>0.38</td>
</tr>
<tr>
<td>Surgical ICU</td>
<td>2.3</td>
<td>0.0 – 5.1</td>
<td>0.61</td>
</tr>
<tr>
<td>Trauma ICU</td>
<td>4.0</td>
<td>0.3 – 7.7</td>
<td>0.65</td>
</tr>
<tr>
<td>Adult SDU (surg)</td>
<td>2.4</td>
<td>0.0 – 3.5</td>
<td>0.26</td>
</tr>
<tr>
<td>Med inpatient floor</td>
<td>1.8</td>
<td>0.0 – 3.4</td>
<td>0.24</td>
</tr>
</tbody>
</table>
Innovations to Reduce Risk

**PROTECTIVE DISK WITH CHG**

- Bacteria can recolonize the skin and CHG suppresses regrowth
- CHG patch provides contact around the insertion site and 7 day continuous release of CHG provides ongoing antimicrobial protection
- Randomized, controlled trials show CHG patch reduces risk of infection (JAMA 2009;301:1231 and Ann Hematol 2009;88:267)

**CENTRAL LINE INFECTION RATES (/1000 days)**

<table>
<thead>
<tr>
<th>ICU</th>
<th>BSI</th>
<th>CL day</th>
<th>Rate</th>
<th>BSI</th>
<th>CL day</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICU</td>
<td>7</td>
<td>3971</td>
<td>1.8</td>
<td>4</td>
<td>3984</td>
<td>1.0</td>
</tr>
<tr>
<td>CICU</td>
<td>6</td>
<td>1604</td>
<td>3.7</td>
<td>2</td>
<td>2190</td>
<td>0.9</td>
</tr>
<tr>
<td>SICU</td>
<td>9</td>
<td>2749</td>
<td>3.3</td>
<td>6</td>
<td>3222</td>
<td>1.9</td>
</tr>
<tr>
<td>NSICU</td>
<td>5</td>
<td>1434</td>
<td>3.5</td>
<td>0</td>
<td>1298</td>
<td>0.0</td>
</tr>
<tr>
<td>TICU</td>
<td>1</td>
<td>1758</td>
<td>0.6</td>
<td>2</td>
<td>1924</td>
<td>0.8</td>
</tr>
<tr>
<td>PICU</td>
<td>14</td>
<td>2878</td>
<td>4.9</td>
<td>4</td>
<td>2495</td>
<td>1.6</td>
</tr>
<tr>
<td>Overall</td>
<td>42</td>
<td>14394</td>
<td>2.9</td>
<td>18</td>
<td>15113</td>
<td>1.2</td>
</tr>
</tbody>
</table>

**CENTRAL LINE INFECTION RATES (/1000 days)**

- Reduced BSIs from 42 (2.9/1000 device days) to 18 (1.2/1000 device days) (p=0.001)
- Preventing 24 infections avoided $720,000 in costs and 5 deaths (costs ~$65,000)
- Implementing CHG patch hospitalwide should save ~$3.93 million [should have 97 BSI rather than 218 BSI, preventing 121](costs ~$250,000)

**SSIs: IMPACT**

- 27,000,000 surgical procedures per year
- 2-5% of surgical patients develop an SSI
  - 290,000 infections per year
  - ~70% superficial, ~30% organ/space infections
- SSIs account for ~22% of nosocomial infections
- 2nd most common nosocomial infection
- Each SSI results in 7-10 additional hospital days at a large cost
- Patients with SSI have a 2-11-fold higher risk of death

SSI: Primary Risk Factors

- Endogenous microorganisms
  - Skin-dwelling microorganisms
    - Most common source
    - S. aureus most common isolate
    - Fecal flora (gnr) when incisions are near the perineum or groin
  - Exogenous microorganisms
    - Surgical personnel (members of surgical team)
    - OR environment (including air)
    - All tools, instruments, and materials

PATHOGENS ASSOCIATED WITH SSIs: NHSN, 2006-2007

SSI: Intrinsic/Patient Risk Factors

- Age-extremes
- Nutritional status-poor
- Diabetes-controversial; increased glucose levels in post-op period ↑ risk
- Smoking-nicotine delays wound healing ↑ risk
- Obesity>20% ideal body weight
- Remote infections ↑ risk
- Endogenous mucosal microorganisms
- Preoperative nares S. aureus-CT patients
- Immunosuppressive drugs may ↑ risk
- Preoperative stay-surrogate for severity of illness

CDC SURGICAL SITE INFECTION PREVENTION GUIDELINES - 1999

Category IA and IB

- No prior infections
- 15 air changes/hr in OR
- Do not shave in advance
- Keep OR doors closed
- Control glucose in diabetes pts
- Use sterile instruments
- Stop tobacco use
- Cover hair
- Shower with antiseptic soap
- Wear sterile gloves
- Prep skin with approp. agent
- Gentle tissue handling
- Surgical team nabs short
- DPC for heavily contaminated wounds
- Surgical team scrub hands
- Exclude I/C surgical team
- Give prophylactic antibiotics
- Exclude I/C surgical team
- Closed suction drains (when used)
- Give prophylactic antibiotics
- Pos pressure ventilation in OR
- Sterile dressing x 24-48 hr
- SSI surveillance with feedback to surgeons

INSTITUTE FOR HEALTHCARE IMPROVEMENT

- Appropriate use of antibiotics
  - Antibiotics within 1 hour before surgical incision (vancomycin within 2 hours)
  - Prophylactic antibiotic consistent with national guidelines
  - Discontinuation of prophylactic antibiotics within 24 hours after surgery
- Appropriate hair removal
  - Clip versus shave

Innovations to Reduce Risk
**CHLORHEXIDINE-ALCOHOL**

**CHG-ALCOHOL VERSUS PI FOR SURGICAL-SITE ANTISEPSIS**

NEJM 2010;362:18-26

- Background—patient’s skin is a major source of pathogens that cause SSI and optimization of preoperative skin antisepsis may decrease SSIs
- Methods—Randomly assigned patients undergoing clean contaminated surgery to CHG-alcohol or PI scrub and paint
- Results—SSIs lower in CHG-alcohol group to PI group (9.5% vs 16.1%). CHG better for superficial incisional and deep incisional but not organ-space infections
- Conclusion—CHG-alcohol superior for preventing SSIs

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**CATHETER-ASSOCIATED URINARY TRACT INFECTIONS (CA-UTI)**

- **Prevalence, Incidence**
  - Most common site of HAI: Accounts for more than 30% of all reported HAIs by acute care hospitals
  - Estimated >560,000 healthcare-associated UTIs annually
  - 15-25% patients in hospitals have a urethral catheters
  - Most hospitalized patients are catheterized for only 2-4 days but many longer
  - Incidence of bacterurias associated with indwelling catheter is 3-8% per day

- **Adapted from CDC:** [http://www.cdc.gov/HAI/pdfs/toolkits/CAUTItoolkit_3_10.pdf](http://www.cdc.gov/HAI/pdfs/toolkits/CAUTItoolkit_3_10.pdf)

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**PATHOGENESIS OF CA-UTI**

- **Source of microorganisms**
  - Endogenous: migration of meatal, rectal, vaginal colonization
  - Exogenous: via contaminated hands of HCP during catheter insertion or manipulation of the collecting system

- **Maki DG, Tambyah PA. Emerg Infect Dis 2001;7:1-6**

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**CA-UTIs**

- Introduction of bacteria into the bladder at the time of catheter insertion
- Extraluminal migration of bacteria or perianal bacteria into the bladder along the outer surface of the catheter
- Intraluminal retrograde migration of bacteria into the bladder from the drainage bag along the inner surface of the catheter following a catheter care violation

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**CAUTI Prevention-IHI**

- Avoid unnecessary catheters
- Insert urinary catheters using aseptic technique
- Maintain urinary catheters based on recommended guidelines
- Review urinary catheters necessity daily and remove promptly
CAUTI Prevention-IHI

- Avoid unnecessary urinary catheters
  - Explicit criteria for appropriate insertion should be in place and verification that criteria are met prior to insertion
  - Indications
    - Preoperative use for selected surgical patients
    - Urine output monitoring in critically ill patients
    - Management of acute urinary retention and urinary obstruction
    - Assistance in pressure ulcer healing for incontinent patients
    - As an exception, at patient request to improve comfort or for comfort during end-of-life care
  - Strategies: require verification that criteria are met; build criteria for catheter insertion into order entry systems and require documentation of need at time of order; review cases of insertion that do not meet criteria

CAUTI Prevention-IHI

- Insert urinary catheters using aseptic technique
  - Use appropriate hand hygiene
  - Insert catheter using aseptic technique and sterile equipment (gloves, drape, sponges, antiseptic solution for cleaning urethral meatus, sterile lubricant gel)
  - Use as small a catheter as possible consistent with proper drainage
  - Strategies: checklist for indications for catheter use and insertion; kits; education and training of staff; competency assessment

CAUTI Prevention-IHI

- Maintain catheters based on recommended guidelines
  - Maintain sterile, continuously closed drainage system
  - Keep catheter properly secured to prevent movement and urethral traction
  - Keep collection bag below the level of the bladder
  - Maintain unobstructed urine flow
  - Empty collection bag regularly
  - Strategies: verify and document five items at least once per shift; avoid irrigating catheters, disconnecting the catheter from the drainage bag, and replacing catheters routinely

CAUTI Prevention-IHI

- Review urinary catheter necessity daily and remove promptly (duration of catheterization is the most important risk factor for development of infection)
  - Daily review of catheter necessity is recommended
  - Strategies: automatic stop orders; daily reminders by nurses to physicians; alerts in computerized ordering systems; daily assessment at the start of every shift with the requirement to contact physician if criteria are not meet

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CHALLENGES IN THE PREVENTION AND MANAGEMENT OF HEALTHCARE-ASSOCIATED INFECTIONS

- Changing population of hospital patients
  - Increased severity of illness
  - Increased numbers of immunocompromised patients
  - Increased numbers of older patients
  - Shorter duration of hospitalization
  - More and larger intensive care units
  - Larger step-down units
- Limited financial resources: Biopatch, CHG-Alcohol, etc
- Growing frequency of antimicrobial-resistant pathogens and emerging pathogens

EMERGING INFECTIOUS DISEASES SINCE 1990

- 1993 (US) - Hantavirus pulmonary syndrome (Sin nombre virus)
- 1994 (US) – Human granulocyte ehrlichiosis
- 1994 (Australia) – Hendra virus
- 1996 (England) – Variant Creutzfeldt-Jakob disease (vCJD)
- 1998 (Malaysia) – Nipah virus
- 1999 (US) - West Nile encephalitis (West Nile virus)
- 2001 (US) - Anthrax attack via letters
- 2001 (Netherlands) – Human metapneumovirus
- 2002 (US) – Vancomycin-resistant S. aureus
- 2003 (US) – Monkeys
- 2003 (China→worldwide) - SARS (coronavirus)
- 2003 (US) – Monkeypox
- 2007-present (Asia) – Avian influenza (H5N1)
- 2009 Novel H1N1 influenza

CHALLENGES IN THE PREVENTION AND MANAGEMENT OF HEALTHCARE-ASSOCIATED INFECTIONS

- Lack of compliance with hand hygiene and other infection preventive measures (e.g., endoscope)
- Difficulty in elimination of infection control practices that have proven ineffective
- Limited infection prevention resources
- Implementation of bundles demonstrated to reduce HAIs
- Public reporting of HAIs
- CMS non-reimbursement for HAIs
- Health insurance reimbursement tied to quality goals
- Development of new diagnostic and therapeutic technology that challenges the patient's defense mechanisms

EMERGING RESISTANT PATHOGENS: HEALTH CARE FACILITIES

- Staphylococcus aureus: Oxacillin (occ. vancomycin, linezolid)
- Enterococcus: Penicillin, aminoglycosides, vancomycin, linezolid, dalfopristin-quinupristin
- Enterobacteriaceae: ESBL producers, carbapenems
- Pseudomonas aeruginosa, Acinetobacter sp: Multiple
- Mycobacterium tuberculosis: MDR (INH, rifampin), XDR (multiple)

ICP ACTIVITIES

- 1975 to 1990
  - Surveillance
  - Outbreak investigations
  - Exposure evaluations
  - Education
  - JCAHO
  - Policy development and review
  - Sterilizer monitoring
  - Dialysis water
- 1991 to 2003 (new)
  - Targeted surveillance
  - OSHA TB
  - OSHA Bloodborne
  - Molecular epidemiology
  - MRSA, VRE
  - BT preparedness
  - Construction rounds
- Future
  - Public health reporting
  - Mandated influenza vaccine
  - Mandated MRSA surveillance
  - Cost analyses
  - Comprehensive surveillance
  - Transparency

ICP ACTIVITIES

- 2004 to 2008 (new)
  - IHI bundles
  - CMS core measures
  - NSQUIP (VAs, others)
  - NDNQI (ANA)
  - Other CQI initiatives
  - MRSA active surveillance
  - Unannounced TJC visits
  - Avian influenza preparedness
  - Endoscope sampling
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- Lack of compliance with hand hygiene and other infection preventive measures (e.g., endoscope)
- Difficulty in elimination of infection control practices that have proven ineffective
- Limited infection prevention resources
- Implementation of bundles demonstrated to reduce HAIs
- Public reporting of HAIs (redirects IP resources)
- CMS non-reimbursement for HAIs
- Health insurance reimbursement tied to quality goals
- Development of new diagnostic and therapeutic technology that challenges the patient’s defense mechanisms

CONCLUSIONS

- Healthcare-associated infections are associated with significant patient morbidity and mortality
- Implement bundles and guidelines demonstrated to reduce SSIs, UTIs and CLA-BSI infections
- Improved compliance with infection prevention recommendations needed to prevent HAIs
- New issues: emerging pathogens/MDROs; public reporting; CMS non-reimbursement for HAIs; older/more immunocompromised patients; lack of compliance with infection prevention measures, etc

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HAIs CONTINUE TO INCREASE

- Number of older patients with chronic diseases
- Number of immunocompromised patients
- Development of new diagnostic and therapeutic technology that challenges the patient’s defense mechanisms
- Inconsistent implementation of infection control practices
- Misuse of antibiotics
- Difficulty in elimination of infection control practices that have proven ineffective

Thank you