

## GUIDELINES: HOW TO MODIFY RISK FACTORS FOR HAIs

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## DISCUSSION TOPICS

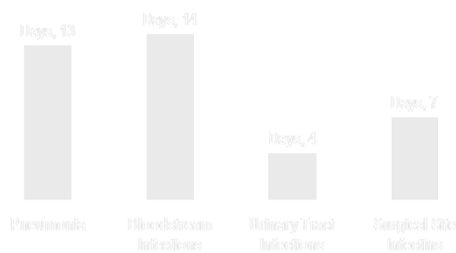
- Impact of healthcare-associated infections
- Risk factors, interventions and guidelines for preventing HAIs
  - Central line-associated bloodstream infections
  - Surgical site infections
  - Urinary tract infections
- Challenges in infection control

## HEALTHCARE-ASSOCIATED INFECTIONS: IMPACT

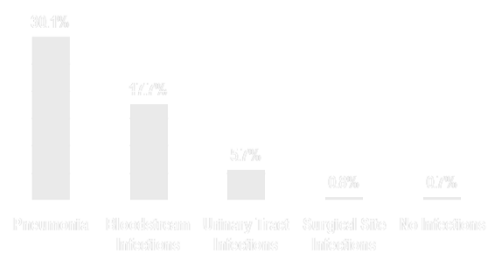
- 1.7 million infections per year
- 98,987 deaths due to HAI
  - Pneumonia 35,967
  - Bloodstream 30,665
  - Urinary tract 13,088
  - SSI 8,205
  - Other 11,062
- 6<sup>th</sup> leading cause of death (after heart disease, cancer, stroke, chronic lower respiratory diseases, and accidents)<sup>1</sup>

<sup>1</sup> National Center for Health Statistics, 2004

## INCREMENTAL HOSPITAL DAYS DUE TO COMMON HAIs



## MORTALITY RATE OF COMMON HAIs

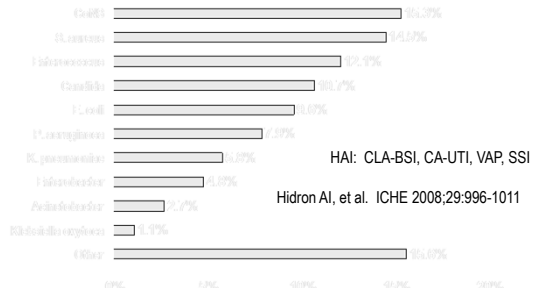


### COST ESTIMATES FOR HEALTHCARE-ASSOCIATED INFECTIONS (HAIs)

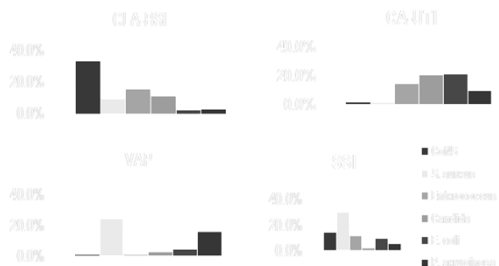
HAI	Cost per HAI ± SE	Range
Ventilator-associated pneumonia	25,072 ± 4,132	8,682-31,316
Healthcare-associated bloodstream infections	23,242 ± 5,184	6,908-37,260
Surgical site infections	10,443 ± 3,249	2,527-29,367
Catheter-associated urinary tract infections	758 ± 41	728-810

Anderson DJ, et al. ICHE 2007;28:767-773  
 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



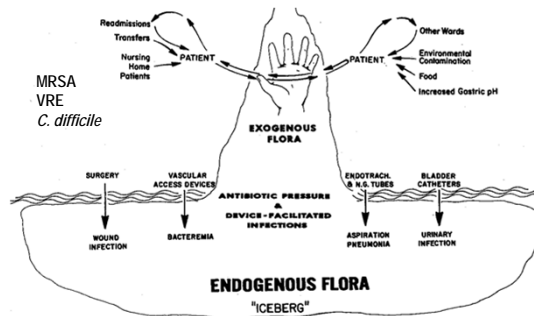
### DISCUSSION TOPICS

- 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

### RISK FACTORS FOR HEALTHCARE-ASSOCIATED INFECTIONS



### HAZARDS IN THE ICU



Weinstein RA. Am J Med 1991;91(suppl 3B):180S

**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

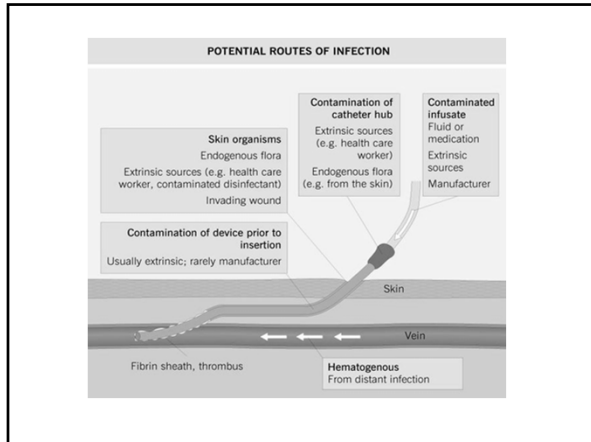
- Centers for Disease Control and Prevention
  - Prevention of Catheter-Associated UTI, 2009
  - Guideline for D/S in Healthcare Facilities, 2008
  - Guideline for Isolation Precautions, 2007
  - Management of MDR Organisms, 2006
  - Preventing HA Pneumonia, 2003
  - Environmental Infection Control in HCF, 2003
  - Hand Hygiene in Healthcare Settings, 2002
  - Prevention of Intravascular Device-Related Infections, 2002, 2010
  - Prevention of Surgical Site Infections, 1999
  - Management of Occupational Exposure to HBV, HCV, HIV, 2002
  - Infection Control in Healthcare Personnel, 1998

## INFECTION PREVENTION STRATEGIES

- 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*

## 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



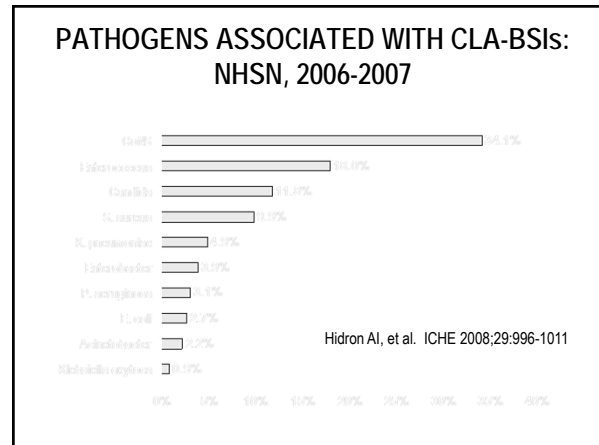
### Sources of CR-BSI

- 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)



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

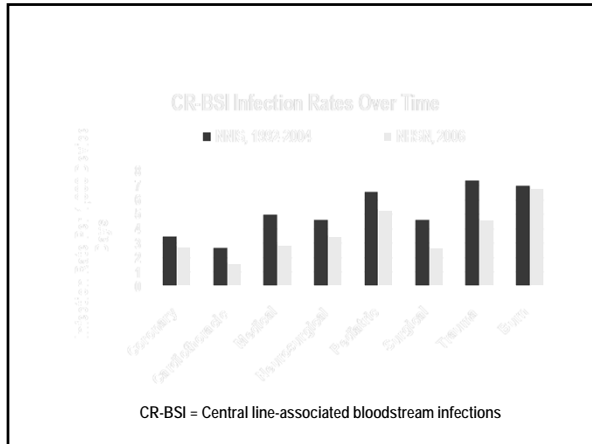
- Best practices (at insertion)
  - Use a catheter checklist (B-II)
  - Perform hand hygiene before catheter insertion (B-II)
  - Avoid the femoral for access (A-I)
  - In adults, preferentially use the subclavian vein
  - Use an all-inclusive catheter kit or cart (B-II)
  - Use maximal sterile barrier 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)

Marschall J, et al. ICHE 2008;29 (suppl 1):S22-S30

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

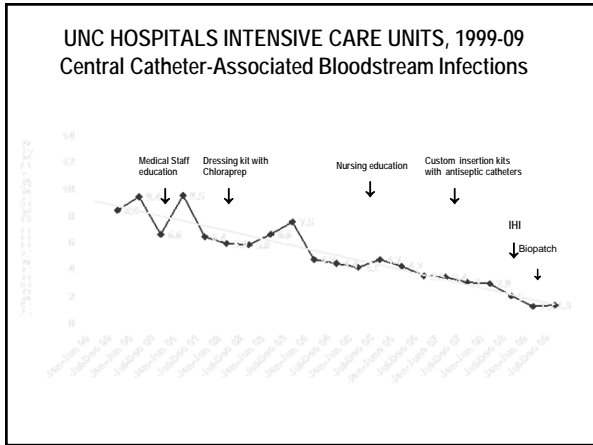
- Best practices (after insertion)
  - Disinfect (CHG-alcohol, 70% alcohol) catheter hubs, needless connectors, and injection ports before accessing the catheter (B-II)
  - Remove non-essential catheters (A-II)
  - For non-tunneled CVCs change dressing every 5-7 days; more frequently if soiled (A-I)
  - 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)

Marschall J, et al. ICHE 2008;29 (suppl 1):S22-S30



- ### 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: 2<sup>nd</sup> 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
  - 2009: Implementation of Biopatch.



- ### 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

Unit	Infection Rate (pooled mean)	Infection Rate (10% - 90%)	Central Line Utilization Ratio
Burn ICU	5.6	0.0 - 13.5	0.59
Coronary ICU	2.1	0.0 - 5.3	0.40
Surgical CT ICU	1.4	0.0 - 3.4	0.72
Medical ICU	2.4	0.0 - 5.3	0.58
Med/Surg ICU, teaching	2.0	0.0 - 4.2	0.59
Med/Surg ICU, others	1.5	0.0 - 3.6	0.46
Ped Med/Surg ICU	2.9	0.0 - 6.0	0.46
Ped Med ICU	1.0	NA	0.38
Surgical ICU	2.3	0.0 - 5.1	0.61
Trauma ICU	4.0	0.3 - 7.7	0.65
Adult SDU (surg)	2.4	0.0 - 3.5	0.26
Med Inpatient floor	1.8	0.0 - 3.4	0.24

## Innovations to Reduce Risk

## CHG PATCH



## 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)

Before (Feb-Oct 08) and After (Feb-Oct 09) Introduction of CHG Patch

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

## CENTRAL LINE INFECTION RATES (/1000 days)

Before (Feb-Oct 08) and After (Feb-Oct 09) Introduction of Biopatch

- 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

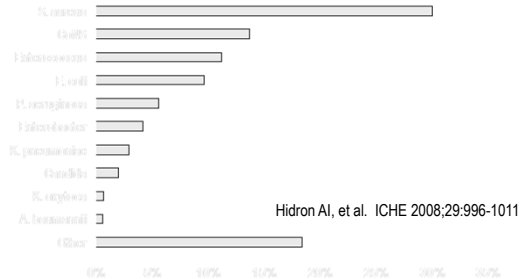
- 27,000,000 surgical procedures per year
- 2-5% of surgical patients develop an SSI
  - 290,000 infections per year
  - ~70% superficial, ~30% organ/space infections
- SSIs account for ~22% of nosocomial infections
  - 2<sup>nd</sup> most common nosocomial infection
- Each SSI results in 7-10 additional hospital days at a large cost
- Patients with SSI have a 2-11-fold higher risk of death  
[www.cdc.gov/ncidod/dhqp/FAQ\\_SSI.html](http://www.cdc.gov/ncidod/dhqp/FAQ_SSI.html) (3/15/09)

## 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

Mangram AJ, et al. Infect Control Hosp Epidemiol. 1999;20(4):250-278.

## 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                | Wear a mask                                |
| Shower with antiseptic soap     | Cover hair                                 |
| Prep skin with approp. agent    | Wear sterile gloves                        |
| Surgical team nails short       | Gentle tissue handling                     |
| Surgical team scrub hands       | DPC for heavily contaminated wounds        |
| Exclude I/C surgical team       | Closed suction drains (when used)          |
| Give prophylactic antibiotics   | Sterile dressing x 24-48 hr                |
| Pos pressure ventilation in OR  | 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

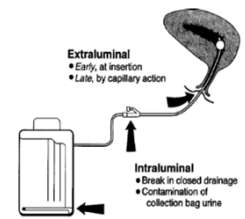
## CATHETER-ASSOCIATED URINARY TRACT INFECTIONS (CA-UTI)

- 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)

## 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

## 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

## 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

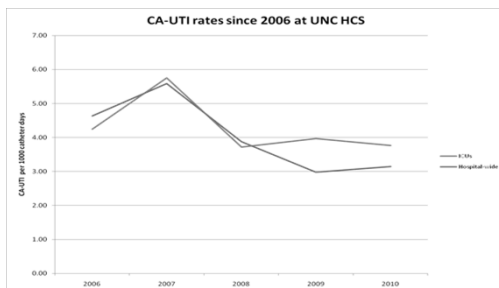
- Insert urinary catheters using aseptic technique
  - Use appropriate hand hygiene
  - Insert catheter using aseptic technique and sterile equipment (gloves, drape, sponges, antiseptic solution for cleaning urethral meatus, sterile lubricant gel)
  - Use as small a catheter as possible consistent with 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 met



## 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

### 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
- 1995 (Worldwide) - Kaposi sarcoma (HHV-8)
- 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 (China→worldwide) - SARS (coronavirus) ✓ ✓
- 2003 (US) – Monkeypox ✓
- 1997-present (Asia) – Avian influenza (H5N1)
- 2009 Novel H1N1 influenza ✓ ✓

### 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)



### 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

### ICP ACTIVITIES

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>● 1975 to 1990               <ul style="list-style-type: none"> <li>■ Surveillance</li> <li>■ Outbreak investigations</li> <li>■ Exposure evaluations</li> <li>■ Education</li> <li>■ JCAHO</li> <li>■ Policy development and review</li> <li>■ Sterilizer monitoring</li> <li>■ Dialysis water</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>● 1991 to 2003 (new)               <ul style="list-style-type: none"> <li>■ Targeted surveillance</li> <li>■ OSHA TB</li> <li>■ OSHA Bloodborne</li> <li>■ Molecular epidemiology</li> <li>■ MRSA, VRE</li> <li>■ BT preparedness</li> <li>■ Construction rounds</li> </ul> </li> </ul> |
|---|--|

### ICP ACTIVITIES

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>● 2004 to 2008 (new)               <ul style="list-style-type: none"> <li>■ IHI bundles</li> <li>■ CMS core measures</li> <li>■ NSQUIP (VAs, others)</li> <li>■ NDNQI (ANA)</li> <li>■ Other CQI initiatives</li> <li>■ MRSA active surveillance</li> <li>■ Unannounced TJC visits</li> <li>■ Avian influenza preparedness</li> <li>■ Endoscope sampling</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>● Future               <ul style="list-style-type: none"> <li>■ Public health reporting</li> <li>■ Mandated influenza vaccine</li> <li>■ Mandated MRSA surveillance</li> <li>■ Cost analyses</li> <li>■ Comprehensive surveillance</li> <li>■ Transparency</li> </ul> </li> </ul> |
|--|--|

## 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 (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

## 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

Thank you

[disinfectionandsterilization.org](http://disinfectionandsterilization.org)

## 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