

Prevention of Hospital Acquired Infections

Learning Objectives-

- ✓ List common hospital-acquired infections
 - ✓ Describe risk factors for urinary tract infections, blood stream infections, hospital-acquired pneumonia
 - ✓ Understand optimal hand hygiene techniques
 - ✓ Understand indicated prevention and infection control techniques for procedures
 - ✓ Understand indications for isolation precautions (Standard, Contact, Droplet, Airborne)
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Example Case-

51 year-old woman with a history of heart failure (EF 22%) and atrial fibrillation comes to the ER with increasing shortness of breath and LE edema.

Medications (not taking any because she has no money and ran out of all):

Warfarin, lisinopril, furosemide, spironolactone, metoprolol, amiodarone, digoxin

Physical Examination:

Vital signs: T 37.0C, BP 90/72, HR 122, RR 28, SpO2 90% RA

Obese, bilateral crackles, irregularly irregular HR, +S3, 2+ bilateral LE edema

Labs:

ABG 7.40/30/54/29, WBC 13 (PMN predominance), CK/CKMB/Trop normal, BUN 30, Cr 1.9

EKG: atrial fibrillation

CXR: pulmonary edema, cardiomegaly, perhaps a LLL infiltrate??

ER course:

- Furosemide is given, BP on recheck is 60/48
- R IJ is placed urgently
- Ceftriaxone and azithromycin are administered
- Admitted to ICU

ICU course:

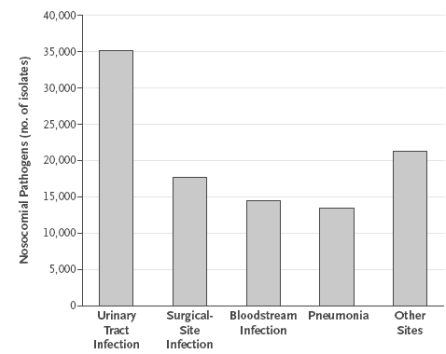
- Increasing respiratory distress, hypotension → dopamine, amiodarone, swan-ganz placed
- Day 2: repeat CXR shows decreased edema, no underlying infiltrate, VSS, antibiotics stopped
- Day 3: still intubated, continued diuresis, increased ACE-I, fails SBT, T 38.8C, WBC 14K, repeat CXR shows increasing LLL infiltrate, cultures sent, started back on ceftriaxone
- Day 4: WBC 16K, Cr 2.4, MRSA grows from sputum, vancomycin started
- Day 5: WBC 26K, hypotensive, MRSA from line → ID consult → 6pm recommendations: change central line
- Day 6: central line pulled, tip grows MRSA; on pressors, worsening renal failure
- Day 7: persistent hypotension despite three pressors, patient dies.

Incidence / Impact of Hospital-acquired Infections-

- 2 million hospital-acquired infections in the US annually
- 99,000 deaths annually (at least half preventable)
- \$6 billion in excess annual costs (each adds > \$15,000 to a patient's hospital bill)
- Only 55% of inpatients receive standard of care for protection
- 10/1/2008: Medicare will no longer cover costs associated with 8 distinct hospital-acquired conditions:
 - Catheter-associated UTI
 - Vascular catheter-associated infection
 - Pressure ulcers
 - In-hospital falls
 - Object left in a patient after surgery
 - Mediastinitis after CABG
 - Air embolism
 - Blood incompatibility
- 10/1/2007: CMS (Center for Medicare and Medicaid Services) required a new Present on Admission (POA) indicator on all diagnoses reported for reimbursement (to indicate if the diagnosis is 'hospital acquired')

Urinary Tract Infections-

- 80% of nosocomial infections
- Catheters often placed without specific indication
- Use of condom catheters, I/O cathing, suprapubic catheters ALL associated with lower rates of infection than indwelling urethral catheterization
- Duration of catheterization is clearly associated with risk of UTI
- Coated catheters (silver-hydrogel, nitrofurazone) have shown some ability to prevent bacteriuria in short-term catheterization, but cost and true ability to decrease systemic UTI is unclear
- Antibiotic irrigation of the catheter / bladder provides no benefit



Burke JP. *N Engl J Med* 2003; 348: 651-6

Prevention of Hospital-Acquired UTIs-

- Use catheter only when clearly indicated
- Use condom catheters whenever possible
- Discontinue catheters as soon as possible

Catheter-Related Bloodstream Infections (CRBSI)

- 250,000 cases each year in the US (mostly from central venous catheters)
- Incidence of nosocomial bloodstream infection: 6/1,000 hospital admissions (51% occur in ICU)
- Attributable cost of CRBSI → \$29K per case, 7-day increase in LOS
- Mortality rate (*crude*) → 27%
- Sites: central venous (CVCs), peripheral, arterial, pulmonary artery, needleless (ports), urinary catheters

- CRBSI defined as:
 - positive blood culture without other clear source, AND
 - ruling out “contaminant” → temp >38°C, chills, or hypotension AND isolated from two blood cultures drawn on separate occasions (coag-neg staph, diphtheroids, bacillus, propionibacterium, micrococcus)

- Typically develop within the 48 hrs after line was placed. If interval > 48 hours, must be evidence that infection was related to the CVC, PLUS, one of the following:
 - at least one positive blood culture obtained from a peripheral vein AND difference in time period between culture drawn from CVC culture versus peripheral blood culture > 2 hours
 - Simultaneous quantitative blood cultures with a $\geq 5:1$ ratio (CVC versus peripheral)
 - Semi quantitative (>15 CFU/catheter segment) OR quantitative (>10 CFU/catheter segment) culture with same organism (species and antibiogram) from the catheter segment and peripheral blood

- Epidemiology
 - Coagulase-negative staphylococci 37 %
 - Staphylococcus aureus 13%
 - Enterococcus 13%
 - Gram-negative rods 14%
 - Escherichia coli 2%
 - Enterobacter 5%
 - Pseudomonas aeruginosa 4%
 - Klebsiella pneumoniae 3%
 - Candida spp. 8%

- Catheter-related risk factors for CRBSI
 - Peripheral intravenous catheters — 0.5 (95% CI 0.2-0.7)
 - Noncuffed central venous catheters
 - Nonmedicated and nontunneled — 2.7 (95% CI 2.6-2.9)
 - Nonmedicated and tunneled — 1.7 (95% CI 1.2-2.3)
 - Cuffed and tunneled central venous catheters — 1.6 (95% CI 1.5-1.7)
 - Arterial catheters for hemodynamic monitoring — 1.7 (95% CI 1.2-2.3)
 - Pulmonary artery catheters — 3.7 (95% CI 2.4-5.0)
 - Peripherally inserted central catheters — 1.1 (95% CI 0.9-1.3)
 - Peripherally inserted midline catheters — 0.2 (0.0-0.5)

Prevention of Hospital-Acquired Catheter-Related Bloodstream Infections-

- Hand hygiene: antiseptic-containing soap or alcohol-based gels or foams PLUS gloves
- Aseptic techniques / barrier precautions during insertion (sterile gloves, long-sleeved surgical gown, a surgical mask, and a large sterile drape); 2% chlorhexidine better than povidone-iodine (RR 0.49, 95% CI 0.28-0.88)
- Dressings and dressing changes: higher rate of colonization and perhaps infection with transparent compared to gauze dressings for CVCs (not for peripheral lines)
- Comprehensive prevention strategy that includes slide-shows, practical demonstrations, in-service training
- Catheter teams
- Choosing best sites for catheter insertion
 - Peripheral lines: use upper extremities rather than lower extremities, use hands rather than wrists/AC
 - Central lines: avoid femoral site; subclavian lines have lower risk than internal jugular lines of infection, but carry other risks
- Choosing best catheter material
 - composed of Teflon or polyurethane are lower risk than polyvinyl chloride or polyethylene
 - antiseptic- or antimicrobial-impregnated CVCs (chlorhexidine/silver sulfadiazine vs. minocycline/rifampin); arguments of allergic reactions and increased resistance are significant; silver-impregnated collagen cuff were less likely than cuffless to become infected
- Changing catheters at appropriate intervals (in a new location, not over a guidewire)
 - Peripheral venous catheter: replace in less than 4 days
 - Central venous catheter: replace in less than 6 days
 - Pulmonary artery catheter: replace in less than 4 days
 - Arterial catheter: replace in less than 5 days
 - Any catheter placed in aseptic technique (emergency setting): replace in less than 48hrs
- Proper catheter-site care: visually assessed at least every other day for erythema or purulence
- Antibiotic-locks: typically not recommended given concern for antibiotic resistance, fungal overgrowth
- Removal of catheters when no longer essential

Hospital-acquired (Nosocomial) Pneumonia (HAP)-

- Occurs 48 hours or more after admission (and was not brewing before)
- HAP is the leading cause of death among hospital-acquired infections (mortality 20 - 50 %)
- Pathophysiology:
 - Microaspiration of organisms in the oropharyngeal or GI tract
 - Rising gastric pH during hospitalization (from illness, medications for GI prophylaxis, tube feedings) allows colonization of more / new microorganisms
 - Hospitalized patients are colonized *quickly* with new microorganisms
- Organisms:
 - Gram-positive cocci (Streptococcus, MRSA, MSSA)
 - Aerobic gram-negative bacilli (E. coli, Klebsiella pneumoniae, Enterobacter spp, Pseudomonas, Acinetobacter)
 - Pneumonia secondary to viruses/fungi is less common except in immunocompromised

Prevention of Hospital-Acquired Pneumonia-

- Hand-washing or disinfection and isolation for pts with MDR
- Reconsideration of GI prophylaxis (do we need that PPI?)
- Semirecumbent positioning (HOB >30 degrees)
- **Surgical patients:**
 - Incentive spirometry or supervised deep breathing exercises: equally effective, reduce risk of *postoperative* pulmonary complications by 50% (most useful in higher risk patients)
 - Use of epidural analgesia / anesthesia (rather than parenteral opiates, when possible)
- **In the ICU:**
 - Continuous aspiration of subglottic secretions (CASS); seems to work, but is expensive
 - silver-coated ET tubes show delayed colonization, lower bacterial colony counts in aspirates (cost : benefit not clear)
- Interesting, but no great evidence yet:
 - “selective decontamination of the digestive tract (SDD) - attempts to coat the mouth with nonabsorbable antibiotics or antiseptics (including chlorhexidine oral rinse) show mixed results

Isolation Precautions-

- **Standard:** used for most conditions
 - Gloves/gown/mask only when likely to touch body fluids
- **Contact:** either through direct contact or fomite
 - Gloves and gown at all times; mask only during procedures
 - All MDROs, major draining abscess, c. difficile, acute viral conjunctivitis, cutaneous diphtheria, rotavirus, Hep A (only if pt incontinent), HSV (primary or disseminated), impetigo, head lice, monkey pox, adenovirus pneumonia, B.cepacia, poliomyelitis, infected pressure ulcer, RSV, SARS, smallpox, tuberculosis (only if extrapulmonary and draining), varicella zoster
- **Droplet:** generated by cough, sneeze, talking, or during procedures such as suctioning, traveling up to 2 meters and depositing in conjunctivae, nasal mucosa, mouth of susceptible host
 - Gloves & gown only if likely to touch body fluids, mask if within 1 meter of patient
 - Pharyngeal diphtheria, epiglottitis (HIB), influenza, Haemophilus influenzae B, any meningococcal disease (Neisseria meningitidis), mumps, Mycoplasma pneumoniae, Parvovirus B19, pertussis, pneumonic plague (Y. pestis), adenovirus pneumonia, group A Strep pneumonia or pharyngitis, rhinovirus, rubella, SARS
- **Airborne:** dissemination of droplet nuclei (<5 microns) or dust particles that are inhaled directly into the alveoli of the susceptible host; can travel through vent systems
 - Gloves & gown only if likely to touch body fluids; mask at all times
 - HSV (disseminated), measles, monkey pox, SARS, smallpox, tuberculosis, varicella zoster

Related sites:

<http://www.ahrq.gov/clinic/ptsafety>

www.cdc.gov/drugresistance/healthcare/ - 12 Steps to Prevent Antimicrobial Resistance

www.jcaho.org - Info on Sentinel Events and use of Root Cause Analysis (RCA)

www.patientsafety.gov or www.va.gov/ncps/ - VA National Center for Patient Safety

www.ahrq.gov/clinic/epcindex.htm

References:

1. Prevention of Hospital-Acquired Infections: A Practical Guide. 2nd Edition. World Health Organization; <<http://www.who.int/csr/resources/publications/whocdscsreph200212.pdf>>
2. O'Grady N, Alexander M, et. al. Guidelines for the prevention of intravascular catheter-related infections. Centers for Disease Control and Prevention. *MMWR Morb Mortal Wkly Rep* 2002; 51(RR-10):1. < <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5110a1.htm>>
3. O'Grady N, Gerberding J, et. al. Patient safety and the science of prevention: the time for implementing the Guidelines for the prevention of intravascular catheter-related infections is now. *Crit Care Med* 2003;31(1):291-2.
4. Johnson J, Kuskowski M, et. al. Systematic review: antimicrobial urinary catheters to prevent catheter associated urinary tract infection in hospitalized patients. *Ann Intern Med.* 2006; 144(2):116-26.
5. Krein, et.al. Use of Central Venous Catheter-Related Bloodstream Infection Prevention Practices by US Hospitals. Mayo Clinic Proceedings. *June 2007;82(6):672-678*
6. Burke J. Infection Control: A Problem for Patient Safety. *N Engl J Med* 2003; 348: 651-6.
7. Veenstra D, Saint S, et. al. Efficacy of antiseptic-impregnated central venous catheters in preventing catheter-related bloodstream infection: a meta-analysis. *JAMA* 1999; 281(3):261-7
8. Haiyakunapruk N, Veenstra D, et. al. Chlorhexidine compared with povidone-iodine solution for vascular catheter-site care: a meta-analysis. *Ann Intern Med* 2002; 136(11):792-801.
9. Offmann K, Weber D, et. al. Transparent polyurethane film as an intravenous catheter dressing. A meta-analysis of the infection risks. *JAMA* 1992; 267(15):2072-6.
10. Hospital-acquired pneumonia in adults: diagnosis, assessment of severity, initial antimicrobial therapy, and preventive strategies. A consensus statement, American Thoracic Society, November 1995. *Am J Respir Crit Care Med* 1996; 153:1711.
11. Guideline for prevention of nosocomial pneumonia. Centers for Disease Control and Prevention [see comments]. *Respir Care* 1994; 39:1191.
12. Craven D, Palladino R, et. al. Healthcare-associated pneumonia in adults: management principles to improve outcomes. *Infect Dis Clin North Am* 2004; 18:939
13. Scheld W. Developments in the pathogenesis, diagnosis and treatment of nosocomial pneumonia. *Surg Gynecol Obstet* 1991; 172 Suppl:42.
14. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. *Am J Respir Crit Care Med* 2005; 171:388.
15. Kollef M, Morrow L, et. al. Clinical characteristics and treatment patterns among patients with ventilator-associated pneumonia. *Chest* 2006; 129:1210.
16. Crabtree T, Pelletier S, et. al. Gender-dependent differences in outcome after the treatment of infection in hospitalized patients. *JAMA* 1999; 282:2143.
17. Rello J, Kollef M, et. al. Reduced burden of bacterial airway colonization with a novel silver-coated endotracheal tube in a randomized multiple-center feasibility study. *Crit Care Med* 2006; 34:276

18. National Center for Health Statistics. Vital statistics of the United States. 119th ed. Washington: U.S. Census Bureau. Statistical abstract of the United States;1999: 99.
19. Wenzel R. The mortality of hospital-acquired bloodstream infections: need for a new vital statistic? *Int J Epidemiol* 1988;17:225-7.
20. Broderick A, Mori M, et.al. Nosocomial infections: validation of surveillance and computer modeling to identify patients at risk. *Am J Epidemiol* 1990;131:734-42.
21. Morrison A, Kaiser D, et. al. A measurement of the efficacy of nosocomial infection control using the 95 percent confidence interval for infection rates. *Am J Epidemiol* 1987;126:292-7.
22. Wenzel R, Osterman C, et. al. Development of a statewide program for surveillance and reporting of hospital-acquired infections. *J Infect Dis* 1979;140:741-6.
23. Pittet D, Wenzel R. Nosocomial bloodstream infection: secular trends in rates and mortality in a tertiary health care center. *Arch Intern Med* 1995;155:1177-84.
24. Edmond M, Wallace S, et. al. Nosocomial bloodstream infections in United States hospitals: a three-year analysis. *Clin Infect Dis* 1999;29:239-44.
25. Wenzel R. Attributable mortality: the promise of better antimicrobial therapy. *J Infect Dis* 1998;178:917-9.
26. Haley R, Culver D, et. al. The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. *Am J Epidemiol* 1985;121:182-205.
27. Wenzel R. The economics of nosocomial infection. *J Hosp Infect* 1995;31:79-87.
28. Darouiche R, Raad I, et. al. A comparison of two antimicrobial-impregnated central venous catheters. *N Engl J Med* 1999;340:1-8.
29. Wenzel R, Edmond M. The evolving technology of venous access. *N Engl J Med* 1999;340:48-9.
30. Bischoff W, Reynolds T, et. al. Handwashing compliance by health care workers: the impact of introducing an accessible, alcohol-based hand disinfectant. *Arch Intern Med* 2000;160:1017-21.
31. Doebbeling B, Stanley G, et. al. Comparative efficacy of alternative hand washing agents in reducing nosocomial infections in intensive care units. *N Engl J Med* 1992;327:88-93.