

## Prevention of Hospital-Acquired Infections (HAIs)

### *Learning Objectives-*

- Understand the morbidity and cost of nosocomial infections and understand the new rules for Medicare reimbursement in this context
- Understand what you can do as a healthcare provider to prevent infections, including performing optimal hand hygiene and other preventative techniques
- Understand and implement isolation precautions appropriately (Contact, Enteric Contact, Droplet, Airborne)
- Understand the impact of infections from multidrug resistant pathogens and what have been some basic preventative measures
- Be able to describe common healthcare-associated infections and their major risk factors

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### *Example Case-*

A 72 year-old man with multiple medical problems including diabetes and COPD presents with a femur fracture after a mechanical fall. Ultimately, he goes to the operating room on hospital day #2. His postoperative course is complicated by bleeding from the surgical site with need for increased monitoring, as well as slow recovery with limited mobility and difficult to control pain. He is getting ready to leave the hospital on hospital day #6 when he spikes a fever to 38.6 and is noted to have an oxygen saturation in the mid 80s. He is found to have a right lower lobe infiltrate on chest xray and is diagnosed with a hospital-acquired pneumonia and sputum ultimately grows out MRSA.

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### *The Burden of Hospital-acquired Infections*

- The Centers for Disease Control estimates that nearly 2 million patients develop health-care associated infections each year and almost 100,000 people die due to these infections.<sup>1</sup>
- Such infections often increase length of hospitalization and result in billions of dollars in excess costs annually.<sup>2</sup>
- The Centers for Medicare & Medicaid Services (CMS) has identified several “reasonably preventable” hospital-acquired infections for which hospitals will no longer receive additional payment to compensate for the extra cost of treatment<sup>3,4</sup>:
  - Catheter-associated urinary tract infection (CAUTI)
  - Catheter-associated blood stream infections (CABSI)
  - Surgical site infection after specific orthopedic procedures
  - Mediastinitis following coronary artery bypass grafting
- In 2009, a reported \$21 million were saved through payment penalties for these and other hospital-acquired conditions. For 2011, additional conditions being considered are ventilator-associated pneumonia, surgical site infection following implantation of devices, and clostridium difficile-associated disease.<sup>4</sup>
- In addition, CMS has added new quality measures for 2010 including postoperative urinary catheter removal on postoperative day 1 or 2.<sup>4</sup>

### *Basic Preventive Measures*

#### *Hand Hygiene- the best way to prevent spread of most nosocomial infections!*

- Dr. Semmelweis proved the critical importance of hand hygiene more than a century ago, and yet we still struggle to implement his findings into our practice.
- Historically, healthcare providers have had poor compliance with handwashing (as low as 20-50% per hospital patient encounter) and proper technique.<sup>5</sup> There is an increasing movement towards penalizing healthcare workers for this.<sup>6</sup>
  - In one report, the mean observed washing time was less than 10 seconds.<sup>8</sup> Another study demonstrated that VRE hand carriage eradication required a 30 second wash, whereas a five second wash did nothing.<sup>9</sup>
- Per CDC recommendations, when using soap & water: wet hands first, apply soap, and rub hands vigorously for at least 15 seconds covering all surfaces of hands and fingers. Rinse and dry with disposable towel and use towel to turn off the faucet.<sup>7</sup>

- Studies have shown that providers are more compliant with alcohol-containing hand disinfection.<sup>5</sup> Fortunately, hand gels work marvelously to kill almost all pathogenic germs.
  - All surfaces of hands and fingers must be covered while applying for at least 15 seconds. In general, all healthcare workers are required to “gel in” and “gel out” of each patient encounter.
  - This method is *not* effective against spore-forming bacteria such as *Clostridium difficile* (C. diff), or if hands are visibly soiled, so *washing with soap and water* are required in this situation.

#### Personal Items- what you bring into a patient's room

- The stethoscope can be a source of bacterial carriage for organisms such as MRSA, VRE.
  - Whenever possible, use the temporary stethoscopes in the patient's room that are dedicated for use in that room only.
  - If using your own stethoscope, clean your stethoscope with an alcohol-based solution between patients. This has been shown to greatly reduce transmission.<sup>10,11</sup>
  - The rate of recovery of C. diff from stethoscopes has been low,<sup>12</sup> however similar precautions should still be taken. Keep in mind that the C. diff spores may not be eradicated by alcohol-based solutions, and one should consider using Sani Wipes containing bleach in this situation.
- Providers' white coats have been found to be contaminated with bacteria such as MRSA.<sup>13</sup> The UK has initiated a dress code in which providers have been instructed to not wear ties or white coats. At UW Medicine, our dress code does not prohibit these items. However, regardless of what clothing is worn, all healthcare workers are required to abide by one simple rule: *everything that touches patients must be clean*. Thus, if coat cuffs or neckties become soiled, they must be vigorously cleaned or removed.
- Other items of concern include artificial fingernails, rings, blood pressure cuffs, and electrodes.<sup>5</sup>

#### Standard precautions<sup>14</sup>

- Hand hygiene must occur before and after every patient contact and, if worn, after gloves are removed. Remember: Gel In and Gel Out.
- Gloves and gowns should be worn if there is concern for soiling.
- Masks and eye protection should be worn if body fluid splashing is expected.

*Isolation precautions*<sup>14,15,16</sup> (Please note that some of following information may relate specifically to UWMC, so contact infection control at your hospital site with questions)

#### Contact precautions:

- Indications: colonized or infected with multidrug resistant organisms (MRSA, VRE, ESBL, etc.). Also, disseminated or primary severe mucocutaneous HSV, localized herpes zoster in an immune competent patient, enteroviruses or other infectious gastroenteritides, anthrax.
- For providers:
  - When entering room, hand hygiene per routine should be performed. Gowns should be fully fastened at neck and waist. Gloves should be worn up to wrists of isolation gown.
  - When leaving room, gloves should be removed first, then gowns (avoid touching the front and sleeves as these are contaminated). Next hand hygiene should occur.
  - Use patient-dedicated or disposable equipment when in room. Otherwise, disinfect equipment that will be reused in another patient's room.
- For patients: gown should be worn outside of room, such as during transportation
- When can contact precautions be discontinued:
  - Controversial, but should at least be continued in the context of an outbreak.
  - In other situations, three negative surveillance cultures for a pathogen such as VRE or MRSA over 1-2 weeks in an immune competent patient no longer on antimicrobial therapy may be acceptable to discontinue contact precautions.
  - For mucocutaneous HSV, when lesions are dry and crusted.

#### Enteric contact precautions:

- Indications: Patients infected by or colonized with C. diff, or patients with diarrhea in whom testing for C. diff is still pending.

- For providers and patients: Take the same precautions outlined above in Contact precautions, except that *hands must be washed with soap and water* after gloves are removed, because the spores of *C. diff* are not killed by hand gel.
- When can enteric contact precautions be discontinued:
  - Generally, enteric contact precautions are continued for the entire duration of the admission.
  - In exceptional cases for prolonged admissions, patients who have been treated with a full course of antibiotics and who have total resolution of their symptoms may be tested to document clearance of *C. diff*. Please work with your infection control practitioner in these cases.

Droplet precautions: respiratory secretions larger than 5 micrometers that typically do not remain suspended in the air

- Indications: respiratory symptoms that include fever +cough; viral respiratory diseases (seasonal influenza, RSV, parainfluenza, adenovirus); meningococcal meningitis; mumps, rubella; pertussis, parvovirus B19, strep pharyngitis, scarlet fever. Some respiratory viruses are transmitted by both droplets and contact and require both precautions.
- For providers: Wear surgical mask and eye protection when within 3 feet of patient. Usually glove & gown use is also required.
- For patients: Wear surgical mask when outside of the room
- Generally speaking, precautions should be continued until symptoms have resolved or patient has received a specified duration of antibiotic therapy. Duration of precautions may need to be extended and confirmatory negative testing may be necessary for immunocompromised patients due to prolonged duration of viral shedding.
- For 2009 H1N1 flu, both droplet *and* contact precautions are required for routine patient care. When aerosolizing procedures such as resuscitation, intubation, nebulizer treatments, or airway suctioning are being performed, an N95 mask or PAPR should be worn.<sup>17</sup>

Airborne: respiratory secretions smaller than 5 micrometers that may remain suspended in the air.

- Indications: Pulmonary TB, avian or H1N1 influenza, disseminated varicella/herpes zoster (or localized zoster in an immunocompromised patient), smallpox, measles, SARS.
- For providers: Airborne infection isolation room (a monitored negative pressure room with at least 6-12 air exchanges per hour), fit-tested N95 or other high-level respirator mask such as a PAPR (Personal Air Purifying Respirator) mask.
- For patients: If patient must leave room for testing, receiving department should be informed and PAPR cart materials should be transported.

#### Prevention and control of multidrug resistant bacteria<sup>18</sup>

- Attributable medical and societal costs of antimicrobial-resistant infections are considerable. In one study, the medical costs related to such infections were about \$19K-\$29K per patient, excess duration of hospital stay was 6-13 days, and attributable mortality was 6.5%.<sup>19</sup>
- Risk of infections with MRSA and VRE have been associated with previous antimicrobial therapy, previous colonization, invasive procedures, underlying chronic conditions, and extensive contact with the healthcare system.
- The wise use of antibiotics not only reduces the selection of drug-resistant organisms, but also reduces toxic side effects, shortens length of stay, cuts risk of *C. diff* infection, and saves money. The art and science of judicious antibiotic use is called Antimicrobial Stewardship. Both UWMC and HMC have antimicrobial stewardship programs; please contact us through the inpatient ID consult teams!
- As outlined above, hand hygiene and contact isolation still apply as the most important measures for prevention. Private rooms and cohorting of patients and staff are also helpful.
- Active surveillance cultures of MRSA from patients' nares or VRE from rectal swabs can be effective in minimizing spread of these infections in the setting of an outbreak or in high-risk settings such as the ICU.
- For prevention of MRSA, decolonization with mupirocin, chlorhexidine washes, and systemic therapy have not demonstrated effectiveness in routine settings. However, UWMC guidelines do recommend special preventative procedures for certain populations<sup>14</sup>:
  - Surgical patients are recommended to have the following:

- Shower or bathe with chlorhexidine two times prior to surgery.
- Cardiac surgery patients receive prophylaxis with intranasal mupirocin in addition to chlorhexidine showers.
- Targeted high risk cardiac patients may receive prophylaxis with vancomycin as well as cefazolin.
- Those known to be infected or colonized with MRSA receive prophylaxis with vancomycin in addition to a cephalosporin prior to surgery.
- For adult ICU patients:
  - In accordance with Washington State law, all patients admitted to the ICU are screened for MRSA carriage upon admission by cultures from nares or open wounds. Those who are found to be positive are placed in contact precautions, and educational counseling on this topic is provided. In selected circumstances, decolonization may be attempted in consultation with the ID consult service.
  - All ventilated patients receive daily oral cleansing with chlorhexidine.
  - All patients are cleansed daily with 2% chlorhexidine impregnated disposable cloths.
- For VRE, nonabsorbable antibiotics to reduce carriage have had limited effectiveness.

### Common Hospital-Acquired Infections

#### Catheter-Associated Urinary Tract Infection (CAUTI)<sup>20,21</sup>

- Impact:
  - UTI is the most common hospital-acquired infection and the majority of cases of nosocomial UTIs are related to indwelling urinary catheters.
  - Each episode of CAUTI costs in the range of \$600 and each episode of urinary tract-related bacteremia is close to \$3000.
- Important features:
  - Duration of indwelling catheter is clearly associated with CAUTI.
  - In the typical patient, it is important to distinguish CAUTI from asymptomatic bacteriuria and pyuria as this can lead to inappropriate treatment and may potentially be harmful.
  - Foley catheters are also associated with decreased mobility—and bedsores and DVT—as well as increased risk of falls. Foley catheter = “one-point restraint.”
- Prevention:
  - Restrict use to patients who truly need them, i.e. urinary retention, close monitoring of urinary output in critically ill patients, urinary incontinence that poses a risk to the patient if there is associated major skin breakdown or a surgical site that is uncontrollable with ultrasorb pads, or by patient request at end of life.
  - **Remove urinary catheters as soon as possible.**
  - Multimodal interventions in hospitals that incorporate educational programs, electronic or nursing reminders for either indications for placement or early removal may be effective.
  - Condom catheters and intermittent catheterization are less likely to cause bacteriuria in certain groups.
  - Antimicrobial urinary catheters (silver alloy and nitrofurazone) may reduce risk of bacteriuria during short-term catheterization, but a reduction in symptomatic CAUTI in long-term use has not been demonstrated.
  - Urinary catheters should be changed early in the course of treatment for CAUTI.

#### Catheter-Associated Bloodstream Infections (CABSIs)<sup>22</sup>

- Impact: An estimated 80,000 central venous catheter (CVC)-associated nosocomial bloodstream infections occur annually. Single episode can incur tens of thousands of dollars in excess cost due to increased length of stay and extra therapy.
- Definition: Same organism is retrieved from both the blood and the catheter (the tip if possible) without evidence of infection with an identical organism at a different site, such as in sputum or urine.

- Epidemiology: Most frequent causes have been coagulase-negative staphylococcus (31%), *Staphylococcus aureus* (20%), enterococci (9%), and candida. Gram negative infections are less frequent. There has been an increasing rate of MRSA and other resistant infections.<sup>23</sup>
- Prevention:
  - Educational programs involving didactic and “hands-on” demonstrations have had some benefit, although compliance to educational programs can wane over time. Therefore, we now have a 100% compliance policy at UW Medicine: all providers must be trained in proper insertion technique before placing lines. To become certified, contact ISIS.
  - Site selection: subclavian appears to be associated with lower risk of colonization in comparison to the internal jugular site. Femoral insertion sites are associated with the highest risk of catheter colonization and CRBSI.
  - Skin antisepsis: 2% chlorhexidine is superior to other solutions
  - Line placement:
    - Hand hygiene prior to placement!
    - Maximum barrier precautions (mask, cap, sterile gown and gloves, and a large sterile drape that covers the patient) and maintenance of sterile field.
    - Mandatory use of a dedicated CVC insertion cart.
    - Mandatory assistance from a trained RN and use of a checklist during insertion to ensure compliance with best practices.
    - Use of ultrasound to avoid mechanical complications and reduce the number of attempts.
  - Catheter maintenance: sutureless securement devices and chlorhexidine-impregnated sponge or gel dressings may have some benefit. These are currently being utilized at UWMC.
  - Type of CVC: The biofilm that forms after catheter insertion may be protective of bacteria and antibiotic coated catheters have been studied.
    - Triple lumen catheters used at UW Medicine have a coating of chlorhexidine & silver sulfadiazine on the external surface and lumen surface.
    - For uncoated catheters, typically should use Teflon or polyurethane.
    - Antibiotic-coated catheters currently available include chlorhexidine & silver sulfadiazine, minocycline-rifampin, and silver in carbon/platinum. The data are conflicting whether these anti-infective catheters truly reduce colonization and CRBSI. However, the majority of data indicate that resistance to such lines does not occur.
  - Antibiotic lock solutions can decrease rate of CABSI in hemodialysis patients with long-term catheters but have not been shown to be consistently effective in those with short-term CVCs and there is concern for generation of multidrug resistant organisms.
  - Replacement of catheters: assess need for CVC daily. Routine exchange over a guidewire has not been effective for infection prevention; however, in select circumstances of isolated lumen infection in tunneled CVCs, guidewire exchange may have benefit as part of treating these infections.

#### *Hospital-acquired (Nosocomial) Pneumonia (HAP)*

- Impact: Pneumonias make up 15% of healthcare-associated infections.<sup>1</sup>
- Definition: HAP occurs >48 hours after admission and was not brewing previously.
- Risk Factors:
  - Intubation, advanced age, chronic lung disease, aspiration, depressed consciousness, lying flat.
  - Increased gastric pH due to H2 blockers, antacids, PPIs. In a recent hospital-based cohort study, use of acid-suppressive medications was associated with 30% increased odds of hospital-acquired pneumonia.<sup>24</sup>
- Prevention via the “VAP Bundle” of best practices:
  - Reconsideration of GI prophylaxis in patients who are not high-risk for developing stress ulcer.
  - Semirecumbent positioning (HOB >30 degrees).
  - Incentive spirometry or supervised deep breathing exercises can reduce risk of postoperative pulmonary complications.
  - Sedation “holiday” once daily when appropriate.
  - Topical CHG oral scrub once daily.

- In the ventilated patient, continuous aspiration of subglottic secretions (CASS) and silver-coated endotracheal tubes may have some benefit although are costly.
- Also in the ICU, selective decontamination of the digestive tract using nonabsorbable antibiotics may have a mortality benefit, although it is not yet routinely recommended due to concern for antibiotic resistance.<sup>25</sup>

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*Topic and case-related questions:*

- 1) What are some risk factors for developing a hospital-acquired pneumonia and what are some basic preventative measures?
  - 2) What role can PPIs have as a risk factor for hospital-acquired pneumonias?
  - 3) What are risk factors for MRSA and what can be done to prevent it?
  - 4) What is the most common cause of hospital-acquired infection and what can be done to prevent this?
  - 5) What is the single best way to decrease spread of nosocomial infection?
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**References:**

1. Klevens RM, Edwards JR, et al. Estimating health-care associated infections and deaths in US hospitals 2002. *Public Health Rep.* 2007 Mar-Apr;122(2):160-6.
2. *Journal of Hospital Medicine.* Vol 1, Issue S1. Pages 88-89. 6 Feb 2006.
3. <http://www.cms.hhs.gov>
4. Hale, D. ACPHospitalist. CMS updates payments, quality measures for 2010. [www.acphospitalist.org/archives/2009/10/coding.htm](http://www.acphospitalist.org/archives/2009/10/coding.htm)
5. Curtis, LT. Prevention of hospital-acquired infections: review of non-pharmacological interventions. *J Hosp Infect* 2008; 69:204-219.
6. Gawande A. On washing hands. *N Engl J Med* 350:1283, March 25, 2004.
7. Boyce JM, Pittet D. Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Centers for Disease Control and Prevention. *Morbidity and Mortality Weekly Report* 2002; 51 (RR-16):1.
8. Quraishi ZA, McGuckin M. Duration of handwashing in intensive care units: a descriptive study. *Am J Infect Control* 1984;12:83.
9. Noskin GA, Stosor V. Recovery of vancomycin-resistant enterococci on fingertips and environmental surfaces. *Infect Control Hosp Epidemiol* 1995;16: 577.
10. Schroeder A, Schroeder MA, D'Amico F. What's growing on your stethoscope? (And what you can do about it). *J Fam Pract.* 2009 Oct;58(10):513.
11. Jones JS, Hoerle D, Riekse R: Stethoscopes: A potential vector of infection? *Ann Emerg Med* September 1995;26:296-299.
12. Alleyne SA, Hussain A, Clokie M. Stethoscopes: Potential vectors of C diff. *Journal of Hospital Infection* 2009; 73(2): 187-189.
13. Treacle AM, Thom KA, Furuno JP. Bacterial contamination of healthcare workers' white coats. *Am J Infect Control.* 2009 Mar;37(2):101-5. Epub 2008 Oct 3.
14. <https://departments.medical.washington.edu/uwmcpcs/pcshomepages/HEIC/index.htm>
15. Garner JS. Guidelines for isolation precautions. Hospital infection control practices advisory committee. *Infect Control Hosp Epidemiol* 1996; 17:53.
16. Siegel JD, Rhinehart E, Jackson M, et al. Healthcare Infection Control Practices Advisory Committee 2007 Guideline for Isolation Precautions: Preventing transmission of infectious agents in healthcare settings, June 2007.
17. [http://www.cdc.gov/h1n1flu/guidelines\\_infection\\_control.htm#g](http://www.cdc.gov/h1n1flu/guidelines_infection_control.htm#g)
18. Siegel JR, Rhinehart E, Jackson M, et al. Management of multidrug-resistant organisms in healthcare setting 2006. [www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf](http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf).
19. Roberts R, Hota B, Ahmad I. Hospital and societal costs of antimicrobial-resistant infections in a Chicago teaching hospital: implications for antibiotic stewardship. *Clin Infect Dis* 2009 Oct 15; 49(8):1185-6.
20. Saint S, Meddings J, Calfee D. Catheter-associated urinary tract infection and the medicare rule changes.
21. Brautner B. Management of catheter-associated urinary tract infection. *Curr Opin Infect Dis* 2010; 23:76-82.
22. Walz M, Memtsoudis S, Heard S. Prevention of central venous catheter bloodstream infections. *J Intensive Care Med* 1/19/2010
23. Wisplinghoff H., Bischoff T, Tallent S, et al. Epidemiology of catheter related bloodstream infections. *Clin Infect Dis.*2004; 39(3): 309-317.
24. Herzig SJ; Howell MD; Ngo LH et al. Acid-suppressive medication use and the risk for hospital-acquired pneumonia. *JAMA.* 2009 May 27;301(20):2120-8
25. De Smet A; Dekluytmans A; Cooper B, et al. Decontamination of the digestive tract and oropharynx in ICU patients. *NEJM* 2009. 360:20.