Prevention of Nosocomial Infections

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Disclosures

» Member of the Speaker's Bureau for Allergan
  » Dalvance and Teflaro
  » I intend to discuss off-label uses of drugs during this talk

Objectives

» Define nosocomial infection
» Review the four most common causes of nosocomial infections
  » Diagnosis
  » Treatment
  » Prevention
Objectives

- Discuss other potential preventive strategies for nosocomial infections
  - Hand Hygiene
  - Isolation
  - Vaccines

Nosocomial Infections

- The term “nosocomial” comes from two Greek words: “nosus” meaning “disease” + “komeion” meaning “to take care of.”
- “Nosocomial” should apply to any disease contracted by a patient while under medical care. Not those that are just “Hospital Acquired”
- A nosocomial infection is specifically one that was not present or incubating prior to the patient’s admission to the hospital.

Nosocomial Infections

- Infections acquired in the hospital that are caused by viral, bacterial, or fungal pathogens
- The most common causes include:
  - Blood stream infections (BSI)
  - Pneumonia (e.g. ventilator associated pneumonia [VAP])
  - Urinary tract infections (UTIs)
  - *Clostridium difficile* infection (CDI)
Risk factors for developing a nosocomial infection

- Duration of hospital stay
- Indwelling catheters
- Mechanical ventilation
- Use of total parenteral nutrition (TPN)

Risk factors for developing a nosocomial infection

- Antibiotic usage
- Use of histamine (H₂) receptor blockers (owing to relative bacterial overgrowth)
- Age—more common in neonates, infants, and the elderly
- Immune deficiency

Catheter-Related Bloodstream Infections (CRBSI)
CRBSI

- In ICUs 15 million central vascular catheter (CVC) line days in the ICU per year are reported
- CRBSI increase length of stay and cost
- There are 80,000 CRBSIs in ICUs each year
- Hospital wide a total of 250,000 cases of BSIs have been estimated to occur annually

CRBSI

- Based on moderate evidence the use a midline catheter or peripherally inserted central catheter (PICC), instead of a short peripheral catheter, when the duration of IV therapy will likely exceed 6 days
- Gauze or opaque dressings should not be used to cover the catheter insertion site
- Remove the catheter if the patient develops signs of phlebitis (warmth, tenderness, erythema or palpable venous cord), infection, or a malfunctioning catheter

CRBSI

- Obtain paired blood cultures from the CVC and peripheral stick when CRBSI is suspected prior to starting antibiotics
- Cather tip culture previously recommended in the IDSA guidelines from 2009 is no longer recommended
- CVC entry site exudate culture should be obtained if present
CRBSI treatment

- Duration of antimicrobial therapy for CRBSI depends on the clinical circumstances.
- In uncomplicated CRBSI with negative blood cultures following catheter removal or guidewire exchange and institution of appropriate antibiotic therapy, the duration of therapy is usually 10 to 14 days; day 1 is the first day of which negative blood cultures

CRBSI Treatment

- Four- Six weeks of therapy is recommended in patients with recent prosthetic valve placement or those with prosthetic valves, even if investigation fails to show evidence of endocarditis.
- In the setting of persistent bacteremia >72 hours following catheter removal the recommended duration is at least four to six weeks.

CRBSI Treatment

- Patients with complications related to bacteremia:
  - Suppurative thrombophlebitis
  - Endocarditis
  - Osteomyelitis
  - Metastatic infection
- In general, the patient should receive antibiotic therapy for at least 7 to 10 days following device removal prior to the placement of a new CVC.
**CRBSI Treatment**

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Preferred antimicrobial agent</th>
<th>Alternative antimicrobial agent</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Klebsiella pneumonia</em></td>
<td>Cefepime</td>
<td>Piperacillin</td>
<td>Susceptible</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>Ceftriaxone</td>
<td>Piperacillin</td>
<td>Susceptible</td>
</tr>
<tr>
<td><em>Enterococcus faecalis</em></td>
<td>Vancomycin</td>
<td>None</td>
<td>Susceptible</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>Methicillin</td>
<td>None</td>
<td>Susceptible</td>
</tr>
</tbody>
</table>

* Penicillin, if the strain is susceptible.

¶ Pediatric experience is limited.

Δ Additional alternative agents include linezolid, tedizolid, ceftaroline, telavancin, dalbavancin, and oritavancin.

◊ Pending susceptibility results for the isolate.

1. **References:**
CRBSI General Guide

- No need to replace a peripheral catheter any more than every 72-96 hours to reduce risk of infection and phlebitis in adults
- Do not use fever alone as an indication to remove a CVC unless there is clinical suspicion
- Guidewire exchange of a CVC can be performed if there is no sign of infection

CRBSI Prevention

- Avoid the use of a femoral site for CVC
- Subclavian site remains preferred over a jugular >>>> femoral
  - In renal patients the subclavian site may need to be avoided due to risk of stenosis

CRBSI Prevention

- Ultrasound guidance should be used in placement of CVCs
- Place a CVC with the minimum amount of ports needed
- Remove the CVC as soon as possible
Hospital Acquired and Ventilator Associated Pneumonia (HAP/VAP)

- Pneumonia that develops after more than 48 hours of hospitalization or mechanical ventilation.
- Incidence of VAP ranges 10 to 25%
- Estimated all-cause mortality of VAP is 25 to 50%

HAP/VAP

Moving away from the term Healthcare Associated Pneumonia (HCAP); diagnosis made < 48 hours after admission with any of the following risk factors:

1. Hospitalized in an acute care hospital for > 48 hours
2. Resided in a nursing home or long-term care facility;
3. Received recent IV antibiotic therapy, chemotherapy, or wound care within the 30 days preceding the current diagnosis;
4. Attended a hospital or hemodialysis clinic
Potential sources of bacteria causing ventilator-associated pneumonia. Bacteria residing in the oropharynx and gastrointestinal tract can contaminate the subglottic secretion pool, as demonstrated. Subglottic secretions above the endotracheal tube cuff are aspirated into the trachea and disseminated into the distal airways and lung parenchyma by the force of the ventilator (inset).

Figure Legend:
- Subglottic suctioning endotracheal tubes was shown in a meta-analysis to have lower rates of VAP in patients who were intubated for more than 24 hours.
- Head of bed elevation has not been shown to definitively reduce the rates of VAP.
- Clinical guidelines recommend that the head of the bed be elevated at least 30 degrees and patients not be left supine to prevent aspiration.

HAP/VAP

Table 1: Suggested Empirical Treatment Options for Clinically Suspected Ventilator-Associated Pneumonia in Patients Where Sputum and / or Bronchoalveolar Lavage Fluid Grow Only One or Two Common Respiratory Pathogens

- [Table content is not legible in the image.]

HAP/VAP
HAP/VAP

- Cefotolozane/Tazobactam is in a phase 3 study to evaluate its efficacy in VAP. Currently it is being used off label for pneumonia at a higher dose of 3g IV Q8 hours instead of 1.5g IV Q8 hours.
- Ceftazidime/Avibactam just completed a study on HAP in February 2017. Results were presented at the 27th annual meeting of the European Congress of Clinical Microbiology and Infectious Disease.

HAP/VAP Prevention

- Use non-invasive positive pressure ventilation (NPPV) to prevent endotracheal intubation.
- Once intubated, encourage daily weaning trials and sedation holidays.
- Re-intubation is associated with a higher rate of VAP due to the increase risks of aspiration.
HAP/VAP Prevention

- Antimicrobial-coated endotracheal tubes were shown in the North American Silver-Coated Endotracheal Tube (NASCENT) study to be associated with lower rates of VAP occurrence and microbiologically confirmed VAP when compared to conventional tubes.
- These tubes were not associated with decreased mortality, duration on vent, or length of stay in the ICU and were more costly ($90 vs $2).

HAP/VAP Prevention

- Selective digestive tract decolonization (SDD) - Not recommended due to increase risk of the development of bacterial resistance.
- Oral decontamination using chlorohexidine has been shown in systemic reviews and meta-analysis to reduce the rate of VAP.
- Strength of chlorohexidine affects outcome.
- Effect is most pronounced in cardiac surgery patients.

HAP/VAP Prevention

- One of the largest hurdles is to have health care providers follow published guideline recommendations.
- Use of “bundles” in the ICU have not been well studied, but generally recommended.
- Even when implemented studies have shown that ICU physicians and nurses do not follow published recommendations for prevention of VAP: 37% and 22.3% respectively.
Catheter Associated Urinary Tract Infection (CA-UTI)

CA-UTI

- The most common cause of health care-associated infection worldwide
- Rates of unnecessary urethral catheterization has been reported between 21% and 50% in studies

CA-UTI

- Definition:
  - The presence of symptoms or signs compatible with UTI with no other identified source of infection in a patient who has an indwelling catheter in place
  - ≥10^7 colony forming units (cfu)/mL of ≥1 bacterial species in a single catheter urine specimen or in a midstream voided urine specimen from a patient whose catheter has been removed within the previous 48 hrs
CA-UTI

- This differs from catheter associated asymptomatic bacteriuria (CA-ASB)
- CA-ASB should not be screened for except in specific circumstances:
  - Pregnancy
  - Research

CA-UTI

| Signs and symptoms compatible with CA-UTI include new onset or worsening |
|--------------------|-----------------------------|
| Fever              | Flank pain                  |
| Rigors             | Costovertebral angle tenderness |
| Altered mental status | Acute hematuria           |
| Malaise            | Pelvic discomfort           |
| Lethargy with no other identified cause |

CA-UTI

- In those whose catheters have been removed, dysuria, urgent or frequent urination, or suprapubic pain or tenderness
- In patients with spinal cord injury, increased spasticity, autonomic dysreflexia, or sense of unease are also compatible with possible CA-UTI
CA-UTI

The presence of pyuria in an asymptomatic patient is not an indication for antimicrobial treatment regardless of the amount.

Absence of pyuria in a patient with symptoms of CA-UTI should prompt for investigation of other causes.

Odor or cloudiness of the urine alone should not be used to differentiate CA-ASB from CA-UTI or as an indication for urine culture or antimicrobial therapy.

CA-UTI Diagnosis

- A urine culture should be obtained prior to the start of antimicrobials in an individual suspected of having a CA-UTI.
- The specimen should be collected after a new catheter is in place.
- If the catheter is no longer needed a culture of a voided midstream urine specimen should be obtained.

CA-UTI Treatment

- Target empiric antimicrobial treatment based on local antibiograms.
- Duration of treatment is generally 7 days.
  - 10-14 days of treatment can be considered in patients who are slow to respond to initially.
  - In women ≤ 65 y/o whose catheter has been removed and has no signs of pyelonephritis a 3 day course of antibiotics could be considered.
CA-UTI Funguria

- Common finding in uncontrolled hospitalized diabetics, patients in the ICU, patients on prolonged courses of antibiotics who are asymptomatic should not be treated
  - It is not a marker for systemic disease in asymptomatic patients
  - It is a marker for colonization

CA-UTI Funguria

- Asymptomatic Funguria does not require treatment
  - Exceptions:
    - Neutropenia
    - Very low birthweight infants (<1500 g)
    - Urinary tract manipulation
  - Renal transplant is no longer considered an absolute indication to treat asymptomatic Candiduria

CA-UTI Funguria Treatment

- Remove the catheter
- For fluconazole sensitive Candida:
  - 200-400mg daily for 14 days
CA-UTI Funguria Treatment

- If fluconazole resistant:
  - *C. glabrata*: amphotericin B deoxycholate 0.3 to 0.6 mg/kg IV daily with or without flucytosine 25 mg/kg orally four times daily for 1 to 7 days or flucytosine alone for two weeks
  - *C. krusei*: amphotericin B deoxycholate 0.3 to 0.6 mg/kg IV for 1 to 7 days
  - Amphotericin B deoxycholate bladder irrigation 50 mg/L sterile water daily for 5 days can be used for patients

CA-UTI Prevention

- Possible reasons to use a catheter
  - a) Urinary retention
  - b) Obstruction to the urinary tract
  - c) Close monitoring of the urine output of critically ill patients
  - d) Urinary incontinence that poses a risk to the patient because of Stage 3 or greater ulcer to the sacral area
  - e) Comfort care for terminally ill patients

- There is insufficient evidence to recommend the use of antimicrobial coated catheters
- Guidelines do not recommend the use of prophylactic antibiotics in patients with urinary catheters
  - Systemic
  - Bladder irrigation
  - Topical
CA-UTI Prevention

- Consider alternatives to the indwelling catheter such as intermittent catheterization
- If a catheter is in place document why
- Assess the need for the inserted catheter daily
- Remove it as soon as possible

Case Presentation


Case Presentation

64-year-old woman with history of a Bertolotti syndrome presented to an ER due to symptoms related to medication withdrawal.
- She was concerned that her medication was habit forming and within 24 hours after stopping her tramadol and tizanidine developed a cough, myalgias, nausea, weakness and rhinorhea; similar symptoms to when she had done this in the past.
- ROS negative for GI symptoms such as abdominal pain or diarrhea.
Case Presentation

- Afebrile, blood pressure 150/70 mmHg, heart rate 115 bpm
- ER performed a urinalysis although the patient had no evidence of urinary symptoms.
- UA showed 4 epithelial cells per high-powered field (hpf), 10 WBC per hpf as well as large leukocyte esterase, negative nitrites and only rare bacteria.

Case Presentation

- Prior to discharge the patient was prescribed a seven-day course of cefpodoxime 100 mg twice a day.
- No urine culture was ordered

Case Presentation

- 4-5 days after ER discharge the patient developed watery diarrhea
- The frequency increased to 10 per day with associated lower abdominal pain
- She developed fever as high as 39.2°C and presented to the emergency department
Case Presentation

- Vitals at that presentation showed fever, BP 105/71 mmHg, HR 128 bpm, RR 20 bpm
- Repeat urinalysis showed pyuria once again.
- CBC showed elevated white count of 19.3 K/mm³

Case Presentation

- The patient was admitted for sepsis and because of recent antibiotic use was started on oral vancomycin empirically
- Stool PCR was positive for C. difficile toxin
- Over the next 4 days the patient’s diarrhea decreased in frequency and her fever as well as elevated WBCs resolved

Case Presentation

- She was eventually discharged to complete her course of oral vancomycin
- In a recent study of a University Hospital and was found that 62% of patients admitted to the General medicine service had a urinalysis despite 85% of these patients not having any symptoms related to a urinary tract infection
**Clostridium difficile infection (CDI)**

- Clostridium difficile is a causative agent of antibiotic-associated colitis.
- It is caused by a disruption in the normal fecal flora in a patient who have been previously exposed/colonized with C. diff.
- The route of transmission of C. diff is fecal-oral.
- Risk factors for acquiring C. diff include exposure to health care settings such as hospitals, nursing homes, other long-term care facilities, and dialysis centers.

**Risk factors**

- **Antibiotic exposure:**
  - Highest Risk: fluoroquinolones > clindamycin > broad spectrum cephalosporins > penicillins.
  - Moderate risk: macrolides > trimethoprim-sulfamethoxazole.
  - Rare: aminoglycosides > tetracyclines > metronidazole > vancomycin.
CDI

- Risk factors
  - Age ≥ 65
  - Gastric acid suppression with either a proton pump inhibitor or H-2 blocker

CDI - Treatment

- Stop inciting antibiotic(s)
- Begin treatment if clinical suspicion high
- Assess severity of disease

CDI - Treatment

- Scoring system devised to identify patients with severe infection
  - One point:
    - Age > 60 years
    - Temperature > 38.3°C,
    - Serum albumin < 2.5 g/dL (25 g/L)
    - WBC > 15,000 cells/μL
CDI- Treatment

- Scoring system devised to identify patients with severe infection
  - Two points:
    - Endoscopic evidence of pseudomembranous colitis OR
    - Treatment in the intensive care unit

CDI- Treatment

- Mild to Moderate disease initial episode:
  - Metronidazole 500mg PO TID or 250mg PO QID for 10-14 days
  - Avoid use of oral vancomycin when possible to avoid increased risk of developing vancomycin resistant enterococcus

CDI- Treatment

- Mild to Moderate disease initial episode:
  - Vancomycin 125mg PO Q6 hours for 10-14 days
  - Reserve for pregnant woman or those allergic/intolerant to metronidazole
CDI- Treatment

- Second episode:
  - Repeat same treatment
  - Most studies do not recommend further treatment with metronidazole after a second course of due to its dose-dependent risk of peripheral neuropathy
  - Consider fidaxomicin 200mg PO BID for 10 days

- Recurrent disease:
  - Prolonged vancomycin taper:
    - 125mg PO QID for 7-14 days
    - 125mg PO BID for 7 days
    - 125mg PO Daily for 7 days
    - 125mg PO Every Other Day for 7 days
    - 125mg PO Every Third Day for 14 days

- Recurrent disease:
  - Vancomycin 125mg PO Q6 hours x 14 days followed by rifaximin 400 mg three times for 20 days
  - Consider fecal transplant
CDI - Treatment

Severe disease:
- Vancomycin 125mg PO Q6 hours
  - Higher doses of vancomycin (250mg, 500mg)
    Has not been shown to be of benefit given
dose absorption kinetics or oral vancomycin
  in the colon

Add IV antibiotics:
- Patients unable to tolerate PO or have signs
  of ileus
  - Metronidazole 500mg IV Q8 hours
  - Tigecycline was used in a small case series of
    4 refractory patients with some success

Vancomycin enema
- Patients with ileus and/or cannot tolerate
  oral vancomycin
  - 500 mg every 6 hours (in 100 mL 0.9%
sodium chloride)
CDI Treatment

- Surgery
  - In patient with severe CDI, surgical intervention is advisable in the setting of peritoneal signs, severe ileus, or toxic megacolon.
  - Subtotal colectomy
  - Diverting loop ileostomy and colonic lavage

C. diff Treatment

- Monoclonal antibodies
  - Bezlotoxumab FDA approved in 2016 for use in secondary prevention
    - Patients at high risk for recurrent CDI
    - Age ≥ 65
  - Bezlotoxumab binds to toxin B
  - Not to be used in severe disease

C. diff Treatment

- IV immunoglobulins (IVIG)
  - Small case reports and limited data on efficacy
  - Not currently recommended
CDI - Prevention

- Use antibiotics sparingly
- Avoid gastric acid suppression
- Follow contact isolation practices to prevent spread in hospitalized patients*

C. Diff Treatment

- Hand wash with soap and water
  - Alcohol based scrubs used in the US cannot kill C. diff spores
- Patient’s at high risk of recurrent CDI
  - Consider prophylactic vancomycin 125mg PO BID vs QID

Hand Hygiene - how compliant are we?
Ignaz Semmelweis was a physician in 1847 Vienna, Austria. He noticed that fever was more common on a maternity ward where medical students worked than it was on the ward where midwives provided care. He believed that the students were contaminating their hands while dissecting cadavers and began telling them to wash their hands in chlorinated lime after dissection and before examining patients.

The rate of infection fell sharply, as did the mortality rate. 12 women developed postpartum fever on a ward where the students had no contact with cadavers, which prompted Semmelweis to infer that infection was also transmitted by living organisms. He began to ask that hand washing be performed between all patient examinations.

Few physicians believed Semmelweis' theory and refused to publish his findings. In 1851, and again in 1855, he was appointed to hospitals with high infection and mortality rates and his hand antisepsis methods resulted in significant decreases in infection and mortality.
Hand Hygiene

- Globally health care workers are compliant with hand hygiene ~50%
- There are lower rates of compliance with physicians when compared to nursing and allied health staff
- In addition, there is variability in the type of institution and level of training as well as specialty

Hand hygiene - excuses?

- I'm too busy
- My skin gets too irritated
- I wore gloves
- I didn't think of it
- Patient care comes first

Hand Hygiene

- Before and after any direct contact with patients
- Immediately after removal of gloves
- Before handling an invasive device not requiring a surgical procedure, including central intravascular catheters, urinary catheters or peripheral vascular catheters
- After touching blood, body fluids, secretions, excretions, non-intact skin or contaminated items, even if gloves are worn
Hand Hygiene

- When moving from a contaminated to a clean body site on the same patient
- After contact with inanimate objects in the immediate vicinity of the patient
- After using the lavatory

Isolation
Standard Precautions

- Applies to all patients
  - Hand hygiene
  - Use of Personal Protective Equipment (PPE)
  - Respiratory hygiene

Contact precautions

- Infectious diarrhea
- Multidrug resistant organisms (MDRO)
- Viral conjunctivitis
- Lice, scabies

Contact precautions

- Adenovirus (contact + droplet)
- Respiratory Syncytial Virus (RSV)
- Severe Acute Respiratory Syndrome (SARS)
- Zoster
Droplet Precautions

- Use of Surgical mask
  - Adenovirus (droplet + contact)
  - Influenza
  - Mumps
  - Rubella
  - Meningococcal

Airborne Precautions

- Use of N95 mask
  - Measles
  - Tuberculosis (primary or laryngeal)
  - Varicella (airborne + contact)
  - Zoster (disseminated or immunocompromised patient); (airborne + contact)
  - Middle Eastern Respiratory Syndrome Coronavirus (MERS-CoV)
  - SARS
Vaccinations

Vaccines

- Primary prevention is best
- No vaccine is 100% effective
- Herd immunity helps to increase overall vaccine effectiveness

Flu Vaccines

- This year the following flu vaccines were recommended:
  - Standard trivalent inactivated vaccine
  - High dose, including Quadrivalent
  - Recombinant Cell culture
  - Adjuvant
Flu Vaccine

- Early-season 2016-17 flu vaccination coverage among HCP was 68.5%, similar to early-season coverage during the 2015-16 season (66.7%).
- During the previous two seasons, flu vaccination coverage increased by 12-13 percentage points from early season to the end of the season.

Flu Vaccine

By occupation:
- Highest among physicians (83.0%),
- Nurse practitioners/physician assistants (82.8%),
- Pharmacists (81.4%),
- Nurses (80.7%),
- Other clinical professionals (72.3%).


Lowest:
- Administrative and nonclinical support staff (65.3%)
- Assistants and aides (56.8%).

By work setting:
- Early season flu vaccination highest among HCP working in hospitals (80.8%).
- Lowest among HCP working in long-term care (LTC) settings (55.1%).

The most common reason reported for not getting vaccinated:
- Fear of experiencing side effects or getting sick from the vaccine
- The second most common reason was that they don’t think that flu vaccines work.

Pneumococcal Vaccine

- Effective in preventing invasive pneumococcal disease
- Two current available vaccines:
  - Pneumococcal conjugate vaccine (PCV13)
  - Pneumococcal polysaccharide vaccine (PPSV23)

Pneumococcal Vaccine

- PCV13 originally only approved for children, but in 2011 was approved for adults 50 years or older by the FDA
- Studies showed that PCV 13 was 75% effective in protecting vaccinated individuals against invasive pneumococcal disease 45% effective against pneumococcal pneumonia
- The PPSV23 protects 50-85% of vaccinated individuals with healthy immune systems against invasive pneumococcal disease

Pneumococcal Vaccinations

- Adults who are immunocompetent and aged 65 years or older should receive 13-valent pneumococcal conjugate vaccine (PCV13) followed by 23-valent pneumococcal polysaccharide vaccine (PPSV23) at least 1 year after PCV13.
- Current recommendations are that adults receive 1 dose of PCV13 and 1, 2, or 3 doses of PPSV23 depending on indication.
Pneumococcal Vaccinations

- When both PCV13 and PPSV23 are indicated, PCV13 should be administered first; PCV13 and PPSV23 should not be administered during the same visit.
- If PPSV23 has previously been administered, PCV13 should be administered at least 1 year after PPSV23.
- When two or more doses of PPSV23 are indicated, the interval between PPSV23 doses should be at least 5 years.

Pneumococcal Vaccinations

- No additional doses of PPSV23 are indicated for adults who received PPSV23 at age 65 years or older.
- When indicated, PCV13 and PPSV23 should be administered to adults whose pneumococcal vaccination history is incomplete or unknown.

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References


Questions??