Nosocomial Infections
For VCU M2 Microbiology Class

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Shifting Vantage Points on Nosocomial Infections

Many infections are inevitable, although some can be prevented

Each infection is potentially preventable unless proven otherwise

Sufficient data now exist to prove that the mortality of hospital acquired infections represents a leading cause of death in the United States.

Richard P. Wenzel, MD, M.Sc
Outline

• Epidemiology of nosocomial infections
  – Incidence
  – Morbidity and mortality
  – Excess cost
  – Overview of pathogenesis

• 4 major nosocomial infections
  – VAP, UTI, SSI, BSI

• Infection Control 101
  – Transmission based precautions
  – Hand hygiene
  – Process of care measures

• Mandatory Public Reporting of NI
NOSOCOMIAL INFECTIONS

- Infection in a hospitalized patient
- Not present or incubating on admission
- Hospital acquired infection
Nosocomial Infections

• 5-10% of patients admitted to acute care hospitals acquire infections
  – 2 million patients/year
  – ¼ of nosocomial infections occur in ICUs
  – 90,000 deaths/year
  – Attributable annual cost: $4.5 – $5.7 billion
  • Cost is largely borne by the healthcare facility not 3rd party payors

Major sites of infection in medical ICU

Nosocomial infections occur predominantly in Intensive Care Units

SITES OF NOSOCOMIAL INFECTIONS

• Urinary tract 40%
• Pneumonia 20%
• Surgical site 17%
• Bloodstream (IV) 8%
PATHOGENESIS OF NOSOCOMIAL INFECTIONS

- 3 ingredients
  - Susceptible host
  - Virulent organism
  - Portal (mode) of entry
PATHOGENESIS OF NOSOCOMIAL INFECTIONS

- Host defenses depressed by underlying disease or treatment, malnutrition, age
- Anatomic barriers breached (IV’s, foleys, vents etc.)
- Exposure to virulent pathogens
  - many resistant to multiple antibiotics
Where do the microbes come from?

- Patient's own flora
- Cross transmission from medical personnel
- Cross transmission from patient to patient
- Hospital environment - inanimate objects
  - air
  - dust
  - IV fluids & catheters
  - washbowls
  - bedpans
  - endoscopes
  - ventilators & respiratory equipment
  - water, disinfectants etc
The Inanimate Environment Can Facilitate Transmission


~ Contaminated surfaces increase cross-transmission ~
SOURCES OF PATHOGENS IN NI

• Reactivation of latent infection: TB, herpes viruses
  – Less common

• **Endogenous**: normal commensals of the skin, respiratory, GI, GU tract
  – common

• **Exogenous**
  – Inanimate environment: *Aspergillus* from hospital construction, *Legionella* from contaminated water
  – Animate environment: hospital staff, visitors, other patients
    • Cross transmission- common
MECHANISMS OF TRANSMISSION

- **Contact**: direct (person-person), indirect (transmission through an intermediate object--contaminated instruments
  - *Cross transmission*
- **Airborne**: organisms that have a true airborne phase as pattern of dissemination (TB, Varicella)
- **Common-vehicle**: common animate vehicle as agent of transmission (ingested food or water, blood products, IV fluids)
- **Droplet**: brief passage through the air when the source and patient are in close proximity
- **Arthropod**: not reported in US
Nosocomial Pneumonia
NOSOCOMIAL PNEUMONIA

- Lower respiratory tract infection
- Develops during hospitalization
- Not present or incubating at time of admission
- Does not become manifest in the first 48-72 hours of admission
EPIDEMIOLOGY

• 13-18% of nosocomial infections
• 6-10 episodes/1000 hospitalizations
• Leading cause of death from NI
• Economic consequences
  – prolongation of hospital stay 8-9 days
  – Costs $1 billion/year
Nosocomial Pneumonia

- Cumulative incidence = 1-3% per day of intubation
- Early onset (first 3-4 days of mechanical ventilation)
  - Antibiotic sensitive, community organisms (S. pneumoniae, H. influenzae, S. aureus)
- Late onset
  - Antibiotic resistant, nosocomial organisms (MRSA, Ps. aeruginosa, Acinetobacter spp, Enterobacter spp)
PREDISPOSING FACTORS

- Endotracheal intubation!!!!!!!!!!!!!!!
- ICU
- Antibiotics
- Surgery
- Chronic lung disease
- Advanced age
- immunosuppression
PATHOGENESIS

- Oropharyngeal colonization
  - upper airway colonization affected by host factors, antibiotic use, gram negative adherence
  - hospitalized pts have high rates of gram negative colonization

- Gastric colonization
  - increased gram negatives with high gastric pH
  - retrograde colonization of the oropharynx
Multiresistant bacteria are a problem in VAP

<table>
<thead>
<tr>
<th>Organism</th>
<th>% of all isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. aeruginosa</em></td>
<td>31.7</td>
</tr>
<tr>
<td>MRSA</td>
<td>11.8</td>
</tr>
<tr>
<td><em>A. baumannii</em></td>
<td>11.8</td>
</tr>
<tr>
<td><em>H. influenzae</em></td>
<td>8.4</td>
</tr>
<tr>
<td><em>S. pneumoniae</em></td>
<td>7.7</td>
</tr>
<tr>
<td>MSSA</td>
<td>3.1</td>
</tr>
</tbody>
</table>

*(n = 321 isolates from 290 episodes)*

MRSA Pneumonia: Infection-Related Mortality

Gonzalez, 1999: 56.3%
Rello, 1994: 54.5%
Iwahara, 1994: 38%
DIAGNOSIS AND TREATMENT

• Clinical diagnosis
  - Fever, change in O₂, change in sputum, CXR

• Microbiologic Confirmation
  – Suctioned Sputum sample
  – Bronchoscopy with brochoalveolar lavage

• Empiric antibiotic- clinical acumen
  - Rx based on previous cultures, usual hospital flora and susceptibilities
  - sputum gram stain
  - colonization vs. infection
PREVENTION

– Pulmonary toilet
  • Change position q 2 hours
    – Elevate head to 30-45 degrees
  • Deep breathing, incentive spirometry
  • Frequent suctioning
  • Bronchoscopy to remove mucous plugging
Head of Bed Elevation in VCU Medical ICU: Effect of Feedback

Percent Compliance

Baseline; no feedback

Performance feedback quarterly

Nosocomial Urinary Tract Infections
URINARY TRACT INFECTIONS

- Most common site of NI (40%)
- Affects 1/20 (5%) of admissions
- 80% related to urinary catheters
- Associated with 2/3 of cases of nosocomial gram negative bacteremias
- Costs to health care system up to $1.8 billion
Nosocomial Urinary Tract Infections

- 25% of hospitalized patients will have a urinary catheter for part of their stay
- Incidence of nosocomial UTI is ~5% per catheterized day
- Virtually all patients develop bacteriuria by 30 days of catheterization
- Of patients who develop bacteriuria, 3% will develop bacteremia
- Vast majority of catheter-associated UTIs are silent, but these comprise the largest pool of antibiotic-resistant pathogens in the hospital

PATHOGENESIS

• Source of uropathogens
  – Endogenous- most common
    - catheter insertion
    - retrograde movement up the urethra (70-80%)  
      - patient’s own enteric flora (E.coli)
  – Exogenous
    - cross contamination of drainage systems
    - may cause clusters of UTI’s
PATHOGENESIS

- Major risk factors: 1) pathogenic bacteria in periurethral area  2) indwelling urinary catheter
  - Duration catheterization
- Bacterial factors:
  - properties which favor attachment to uroepithelium, catheters
- Growth in biofilm
- Bladder trauma decreases local host defenses
## ETIOLOGIC AGENTS: CA-UTI

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>% Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>32</td>
</tr>
<tr>
<td>Proteus spp</td>
<td>14</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>12</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>9</td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>9</td>
</tr>
<tr>
<td>Enterobacter</td>
<td>4</td>
</tr>
<tr>
<td>Candida</td>
<td>4</td>
</tr>
<tr>
<td>Serratia</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>15</td>
</tr>
</tbody>
</table>
Diagnosis and Treatment

• Is this a UTI vs asymptomatic bacteruria?
  – Use clinical judgement
    - Urine WBC- pyuria
    - Bacterial colony counts > $10^3$
    - Clinical signs/symptoms
• No antibiotic treatment for bacteruria
  - resolves with catheter removal
• 7-10 days of therapy for UTI
• Empiric therapy typically initiated pending microbiologic results
Prevention of Nosocomial UTIs

- Avoid catheter when possible & discontinue ASAP - MOST IMPORTANT
- Aseptic insertion by trained HCWs
- Maintain closed system of drainage
- Ensure dependent drainage
- Minimize manipulation of the system
- Silver coated catheters
Surgical Site Infections
SURGICAL SITE INFECTIONS

- 325,000/year (3rd most common)
- Incisional infections
  - Infection at surgical site
  - Within 30 days of surgery
  - Involves skin, subcutaneous tissue, or muscle above fascia
  - Accompanied by:
    - Purulent drainage
    - Dehiscence of wound
    - Organism isolated from drainage
    - Fever, erythema and tenderness at the surgical site
SSI: Superficial
SURGICAL SITE INFECTIONS

• Deep surgical wound infection
  – Occurs beneath incision where operation took place
  – Within 30 days after surgery if no implant, 1 year if implant
  – Infection appears to be related to surgery
  – Occurs at or beneath fascia with:
    • Purulent drainage
    • Wound dehiscence
    • Abscess or evidence of infection by direct exam
    • Clinical diagnosis
SSI: Deep
SURGICAL SITE INFECTIONS

- Risk of infection dependent upon:
  - Contamination level of wound
  - Length of time tissues are exposed
  - Host resistance
  - Receipt of right choice of perioperative antibiotic
  - Proper removal of patient hair
  - Surgical skin antiseptic
  - Surgical hand preparation
SURGICAL SITE INFECTIONS

• Clean wound
  * elective, primarily closed, undrained
  * nontraumatic, uninfected

• Clean-Contaminated wound
  * GI, respiratory, GU tracts entered in a controlled manner
  * oropharynx, vagina, biliary tract entered

• Contaminated wound
  * open, fresh, traumatic wounds
  * gross spillage from GI tract
  * infected urine, bile
## Surgical Site Infections

<table>
<thead>
<tr>
<th>Wound Class</th>
<th>% of Operations</th>
<th>SWI Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td>58</td>
<td>3.3</td>
</tr>
<tr>
<td>Clean-contaminated</td>
<td>36</td>
<td>10.8</td>
</tr>
<tr>
<td>Contaminated</td>
<td>4</td>
<td>16.3</td>
</tr>
<tr>
<td>Dirty-infected</td>
<td>2</td>
<td>28.6</td>
</tr>
</tbody>
</table>
# Pathogens Associated with SWI

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>% of Isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. aureus</td>
<td>17</td>
</tr>
<tr>
<td>Enterococci</td>
<td>13</td>
</tr>
<tr>
<td>Coag - Staph</td>
<td>12</td>
</tr>
<tr>
<td>E. coli</td>
<td>10</td>
</tr>
<tr>
<td>P. aeruginosa</td>
<td>8</td>
</tr>
<tr>
<td>Enterobacter</td>
<td>8</td>
</tr>
<tr>
<td>P. mirabilis</td>
<td>4</td>
</tr>
<tr>
<td>K. pneumoniae</td>
<td>3</td>
</tr>
<tr>
<td>Streptococci</td>
<td>3</td>
</tr>
</tbody>
</table>
RISK FACTORS

- Age (extremes)
- Sex
  - ♀ post cardiac surgery
- Underlying disease
  - obesity (fat layer < 3 cm 6.2%; >3.5 cm 20%)
  - malnutrition
  - malignancy
  - remote infection
PROPHYLACTIC PREOPERATIVE ANTIBIOTICS

• Indicated for clean-contaminated, contaminated operations
• High risk or devastating effect of infection
• Dirty wounds already infected (therapy)
• *Administer at appropriate time (tissue levels)*
  – 30-60 minutes prior to skin incision
Meta-analyses:
Antibiotic Prophylaxis vs Placebo

OR 0.35; TAH; 17 trials

OR 0.35; TAH; 25 trials

OR 0.30; biliary surgery; 42 trials

OR 0.20; CT surgery; 28 trials

**Appropriate Antibiotic Prophylaxis**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Approved Antibiotics</th>
<th>Approved for β-lactam allergy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiac</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vascular</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip/Knee arthroplasty</td>
<td>• Cefazolin</td>
<td>• Vancomycin</td>
</tr>
<tr>
<td></td>
<td>• Vancomycin*</td>
<td>• Clindamycin</td>
</tr>
<tr>
<td><strong>Colon</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral:</td>
<td>• Neomycin + erythromycin</td>
<td>• Clindamycin + gentamicin</td>
</tr>
<tr>
<td></td>
<td>• Neomycin + metronidazole</td>
<td>• Clindamycin + levofloxacin</td>
</tr>
<tr>
<td>Parenteral:</td>
<td>• Cefoxitin</td>
<td>• Metronidazole + gentamicin</td>
</tr>
<tr>
<td></td>
<td>• Cefazolin + metronidazole</td>
<td>• Metronidazole + levofloxacin</td>
</tr>
<tr>
<td><strong>Hysterectomy</strong></td>
<td>• Cefazolin</td>
<td>• Clindamycin + gentamicin</td>
</tr>
<tr>
<td></td>
<td>• Cefoxitin</td>
<td>• Clindamycin + levofloxacin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Metronidazole + gentamicin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Metronidazole + levofloxacin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Clindamycin</td>
</tr>
</tbody>
</table>

*requires documentation of justification*
Much Cleaner Cuts

**PROBLEM:** Infection related to surgery

**PROPOSAL:** Better use of antibiotics, don’t shave with razor prior to surgery, tighten control of blood sugar

**POSSIBLE LIVES SAVED:** 8,000

A hospital is a risky place for people who have had surgery. No matter how much antibacterial solution is painted on before the first cut, opening the body invites lurking microbes. Infections at the surgery site complicate an estimated 780,000 operations a year, or more than 1 in every 40 procedures. For abdominal surgery, the likelihood is as high as 1 in 5. And the complications are tough to treat. Infected patients are two to three times more likely to die and are hospitalized an average of seven days longer than uninfected patients who had the same operation.

Even before the 100K campaign got underway, IHI had been working with a group of 56 hospitals on strategies to lower the rate of surgical-site infections. Results of the yearlong effort, published last month in the *American Journal of Surgery*, showed a re-

Pathophysiology of Shaving & SSI

• Hair removal with a razor can disrupt skin integrity

• Microscopic exudative rashes and skin abrasions can occur during hair removal.

• These rashes and skin abrasions can provide a portal of entry for microorganisms.
### Cochrane Database of Systematic Reviews: Preoperative Hair Removal and SSIs

<table>
<thead>
<tr>
<th>Trial</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 trials compared hair removal with razor or depilatory cream vs no hair removal</td>
<td>No significant difference in SSI</td>
</tr>
<tr>
<td>3 trials compared hair removal with clippers vs shaving</td>
<td>Increased risk of SSI with Shaving (RR=2.02)</td>
</tr>
<tr>
<td>7 trials compared hair removal with shaving vs depilatory cream</td>
<td>Increased risk of SSI with Shaving (RR=1.54)</td>
</tr>
<tr>
<td>One trial each compared shaving the night before vs day of surgery, and clipping the day before vs day of surgery</td>
<td>No significant difference in SSI</td>
</tr>
</tbody>
</table>

Tanner et al. *Cochrane Database of Systematic Reviews* 2006, issue 3, Art No. CD004122
Cochrane Database of Systematic Reviews: Preoperative Hair Removal and SSIs

- If hair removal is necessary then clipping and depilatory creams result in fewer SSIs than shaving with a razor
- There is no difference in SSI if hair is removed one day prior or on the day of surgery

Tanner et al. Cochrane Database of Systematic Reviews 2006, issue 3, Art No. CD004122
Effect of Shaving in Spinal Surgery

789 patients randomized

371 patients shaved
- 4 patients (1.08%) developed SSI

418 patients not shaved
- 1 patient (0.24%) developed SSI

Other SWI PREVENTION measures

- Limit pre-op hospitalization
- Stabilize underlying diseases
- Skin decolonization
  - Chlorhexidine
  - Intranasal Mupirocin for *S. aureus* carriers
- Impermeable drapes
  - Maximum sterile barrier precautions
Nosocomial Bloodstream Infections
NOSOCOMIAL BACTEREMIA

- 4th most frequent site of NI
- Attributable mortality 20%
- Primary
  * IV access devices
  * gram positives (S. aureus, CNS)
- Secondary
  * dissemination from a distant site
  * gram negatives
The CVC is the greatest risk factor for Nosocomial BSI.

As the host cannot be altered, preventive measures are focused on risk factor modification of catheter use, duration, placement and manipulation.
The CVC- is one of the most commonly used catheters in medicine

The CVC is typically placed through a central vein such as the IJ, Subclavian or femoral

The major risk factor is the Central Venous Catheter (CVC)

These serve as direct line for microbial bloodstream invasion
PATHOGENESIS

- **Direct inoculation**
  - * during catheter insertion
- **Retrograde migration**
  - * skin → subcutaneous tunnel → fibrin sheath at vein
- **Contamination**
  - * hub-catheter junction
  - * infusate
Risk Factors for Nosocomial BSIs

- Heavy skin colonization at the insertion site
- Internal jugular or femoral vein sites
- Duration of placement
- Contamination of the catheter hub
Nosocomial Bloodstream Infections

- 12-25% attributable mortality
- Risk for bloodstream infection:

<table>
<thead>
<tr>
<th>Catheter Type</th>
<th>BSI per 1,000 catheter/days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subclavian or internal jugular CVC</td>
<td>5-7</td>
</tr>
<tr>
<td>Hickman/Broviac (cuffed, tunneled)</td>
<td>1</td>
</tr>
<tr>
<td>PICC</td>
<td>0.2 - 2.2</td>
</tr>
</tbody>
</table>

Catheter type and expected duration of use should be taken into consideration
## Nosocomial Bloodstream Infections, 1995-2002

<table>
<thead>
<tr>
<th>Rank</th>
<th>Pathogen</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Coagulase-negative Staph</td>
<td>31.3%</td>
</tr>
<tr>
<td>2</td>
<td>S. aureus</td>
<td>20.2%</td>
</tr>
<tr>
<td>3</td>
<td>Enterococci</td>
<td>9.4%</td>
</tr>
<tr>
<td>4</td>
<td>Candida spp</td>
<td>9.0%</td>
</tr>
<tr>
<td>5</td>
<td>E. coli</td>
<td>5.6%</td>
</tr>
<tr>
<td>6</td>
<td>Klebsiella spp</td>
<td>4.8%</td>
</tr>
<tr>
<td>7</td>
<td>Pseudomonas aeruginosa</td>
<td>4.3%</td>
</tr>
<tr>
<td>8</td>
<td>Enterobacter spp</td>
<td>3.9%</td>
</tr>
<tr>
<td>9</td>
<td>Serratia spp</td>
<td>1.7%</td>
</tr>
<tr>
<td>10</td>
<td>Acinetobacter spp</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

N= 20,978

Edmond M. SCOPE Project.
Risk Factors for Nosocomial BSIs

- Heavy skin colonization at the insertion site
- Internal jugular or femoral vein sites
- Duration of placement
- Contamination of the catheter hub
Prevention of Nosocomial BSIs
Hopkins Model (Central Line Bundle)

• Creation of a central line insertion cart
• Use of a insertion checklist to ensure:
  – Hand hygiene prior to the procedure
  – Sterile gloves, gown, mask, cap, full-size drape
  – Chlorhexidine skin prep of the insertion site
  – Use of subclavian vein as the preferred site
• Bedside nurse empowered to stop the procedure if a step is missed
• Ask every day during rounds whether catheters can be removed

Practice Standardization Leads to Major Reduction in ICU CR-BSIs


Catheter-related bloodstream infections are expensive and result in significant morbidity and mortality.

Simple, inexpensive, and evidence-based interventions to reduce these infections are effective.

Broad use of these interventions could significantly reduce cost, morbidity and mortality.
Hospital Epidemiology 101: prevention and control of nosocomial infections
VCU Hospital Epidemiology and Infection Control

- To prevent transmission of pathogenic microorganisms to patients, visitors, and hospital personnel via an evidence-based approach
- To serve as a resource for patient management via 24-hour coverage by nurse- and physician-epidemiologists
- To establish endemic rates of nosocomial infections
- To quickly detect and terminate outbreaks of nosocomial infections
- To educate healthcare & other workers on the prevention of infection
- To create new knowledge in infection control
RESERVOIRS OF INFECTION

- Personnel
  * hands
  * other skin (scalp)
  * nares- associated with S. aureus colonization

- Patient
  * most important source
  * normal flora of skin, mucosal surfaces

- Environment
  * contaminated antiseptics, dressings, instruments
STRATEGIES TO REDUCE NI

• Modify host.
  – Risk factors such as age, underlying disease are difficult to change.

• Reduce patient exposure to pathogens
  – Important!

• Reduce the number and virulence of nosocomial pathogens
  – Important!
EXPOSURE REDUCTION

- Aseptic technique during patient care
- Handwashing
- Proper isolation of patients known or suspected of harboring infectious diseases
Goal of Isolation

- Prevent transmission of microorganisms from infected or colonized patients to other patients, hospital visitors, and healthcare workers
Types of Isolation Precautions
Standard Precautions

- Used for *all* patients
- Must wear gloves when touching:
  - Blood
  - All body fluids
  - Nonintact skin
  - Mucous membranes
- Wash hands immediately after glove removal and between patients
Standard Precautions

• **Masks, eye protection, face shield:**
  – Wear during activities likely to generate splashes or sprays

• **Gowns**
  – Protect skin and soiling of clothing
  – Wear during activities likely to generate splashes or sprays

• **Sharps**
  – Avoid recapping of needles
  – Avoid removing needles from syringes by hand
  – Place used sharps in puncture-resistant containers
Standard Precautions

• Masks, eye protection, face shield:
  – Wear during activities likely to generate splashes or sprays
Standard Precautions
Airborne Precautions

• Designed to prevent airborne transmission of droplet nuclei or dust particles containing infectious agents

• For patient with documented or suspected:
  – Measles
  – Tuberculosis (primary or laryngeal)
  – Varicella (airborne + contact)
  – Zoster (disseminated or immunocompromised patient; (airborne and contact)
  – SARS (Contact+airborne)
Airborne Precautions

• Room:
  – Negative pressure
  – Private
  – Door kept closed

• Mask
  – Orange ‘duckbill’ mask required to enter room
Empiric Use of Airborne Isolation

- Vesicular rash (*airborne*+*contact*)
- Maculopapular rash with coryza and fever
- Cough + fever + upper lobe pulmonary infiltrate
- Cough + fever + any infiltrate + HIV infection
Droplet Precautions

• Designed to prevent droplet (larger particle) transmission of infectious agents when the patient talks, coughs, or sneezes

• For documented or suspected:
  – Adenovirus (*droplet*+*contact*)
  – Group A strep pharyngitis, pneumonia, scarlet fever (in infants, young children)
  – H. *Influenza* meningitis, epiglottitis
  – Infleunza, Mumps, Rubella
  – Meningococcal infections
Empiric Use of Droplet Precautions

- Meningitis
- Petechial/ecchymotic rash and fever
- Paroxysmal or severe persistent cough during periods of pertussis activity
Airborne Precautions

• Room:
  – Negative pressure
  – Private
  – Door kept closed

• N95 mask required to enter room
Contact Precautions

• Used to prevent transmission of epidemiologically important organisms from an infected or colonized patient through direct (touching patient) or indirect (touching surfaces or objects in the patient’s environment) contact
• Gowns, gloves for patient contact
• Dedicated noncritical equipment
Contact Precautions

- For suspected or documented:
  - Adenovirus (*contact+droplet*)
  - Infectious diarrhea in diapered/incontinent patients
  - Group A strep wound infections
  - MDR bacteria (MRSA, VRE)
  - Viral conjunctivitis
  - Lice, scabies
  - RSV infection
  - Varicella (*Contact+airborne*)
  - Zoster (disseminated or immunocompromised; *contact+airborne*)
  - SARS (*Contact+airborne*)
The inanimate environment is a reservoir of pathogens

Recovery of MRSA, VRE, C. diff, CNS and GNR

Devine et al. Journal of Hospital Infection. 2001;43:72-75
Lemmen et al Journal of Hospital Infection. 2004; 56:191-197
The Inanimate Environment Can Facilitate Transmission

Handwashing
## Hand Hygiene

Single most effective method to limit cross transmission

<table>
<thead>
<tr>
<th>Hand Hygiene</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Compliance</td>
<td>Observational studies of hand hygiene report compliance rates of 5-81%</td>
</tr>
<tr>
<td>Common Reported Barriers To Compliance</td>
<td>Insufficient time, understaffing, patient overcrowding, lack of knowledge of hand hygiene guidelines, skepticism about hand washing efficacy, inconvenient location of sinks and hand disinfectants and lack of hand hygiene promotion by the institution</td>
</tr>
</tbody>
</table>
Hand Hygiene is the single most effective intervention to reduce the cross transmission of nosocomial infections!

**Handwashing**
- Must be "bacteriologically effective"
  - Medicated soap and water
  - Alcohol based hand sanitizer
- Hands must be washed
  - Before and after any patient contact
  - Before any procedure
  - After contact with infected patient or one colonised with multi-resistant bacteria
### Impact of Hand Hygiene on Hospital Infections

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Setting</th>
<th>Impact on Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>Casewell</td>
<td>adult ICU</td>
<td>Klebsiella decreased</td>
</tr>
<tr>
<td>1982</td>
<td>Maki</td>
<td>adult ICU</td>
<td>decreased</td>
</tr>
<tr>
<td>1984</td>
<td>Massanari</td>
<td>adult ICU</td>
<td>decreased</td>
</tr>
<tr>
<td>1990</td>
<td>Simmons</td>
<td>adult ICU</td>
<td>no effect</td>
</tr>
<tr>
<td>1992</td>
<td>Doebbeling</td>
<td>adult ICU</td>
<td>decreased with one hand</td>
</tr>
<tr>
<td>1994</td>
<td>Webster</td>
<td>NICU</td>
<td>MRSA eliminated</td>
</tr>
<tr>
<td>1995</td>
<td>Zafar</td>
<td>nursery</td>
<td>MRSA eliminated</td>
</tr>
<tr>
<td>1999</td>
<td>Pittet</td>
<td>hospital</td>
<td>MRSA decreased</td>
</tr>
</tbody>
</table>

ICU = intensive care unit; NICU = neonatal ICU
MRSA = methicillin-resistant *Staphylococcus aureus*

Source: Pittet D: Emerg Infect Dis 2001;7:234-240
Alcohol Based Hand Sanitizers

- CDC/SHEA hand antiseptic agents of choice
  - Recommended by CDC based on strong experimental, clinical, epidemiologic and microbiologic data
  - Antimicrobial superiority
    - Greater microbicidal effect
    - Prolonged residual effect
  - Ease of use and application
New Technologies

- Hand hygiene - waterless antiseptic solutions
- Antiseptic impregnated central venous catheters
- Antiseptic/silver impregnated urinary catheters
  - Closed system foley/urinary catheters
- Chlorhexidine gluconate for the patient skin antisepsis
  - CVC placement
  - Peripheral IV placement
  - Phlebotomy
Process of Care Measures
Process of Care Measures

• Provide operational and measurable representation of performance
  – HOB elevation, hand hygiene, compliance with central line checklist protocol
• Relate to individual and/or group performance, and are easier to measure than outcomes
• Potentially increase overall accountability as they create opportunities to monitor and improve performance.
• When linked with an outcome, should theoretically improve the outcome

Multilevel feedback of nosocomial infections prevention process of care measures can result in sustained improvement.
Reducing Infections Through Process of Care Measures?

• In 2004, several interventions to reduce HAIs were implemented
  – An ongoing hand hygiene campaign began in 2004;
  – Observations of compliance were performed in ICUs, and this was later expanded to all inpatient and outpatient areas.
  – Feedback provided on HAI frequency and compliance with hand hygiene, avoidance of vascular catheters in the femoral site, and head of bed elevation via highly visible ICU-specific posters on a quarterly basis.

• In 2005
  – In 2005, we implemented a best practices bundle for central line insertion which included placement of a central line cart
  – Mandatory education on central venous catheter insertion was required for all house staff in clinical specialties beginning in 2006.

MRSA (methicillin resistant *S. aureus*)

- First appeared in 1980s
- Carriers not necessarily ill
- Pathogen in SSI, UTI, VAP and BSI
- Infection control procedures
  - Patient contact isolation (contact precaution)
  - Hand hygiene
  - Use of gowns and gloves
- Drug of choice for treatment is vancomycin
- Recent reports of a vancomycin resistant strains of *S. aureus*
- *Certain to be an increasingly difficult management problem*
VRE (vancomycin resistant enterococci)

- *Enterococcus faecalis* and *E. faecium*
- Normal inhabitants of bowel
- Can cause UTI and wound infections in seriously ill patients
- Enterococci now becoming more resistant to many antibiotics
- this includes vancomycin
  - therefore a serious clinical problem
- Cross infection via contaminated equipment documented
  - Thermometers
- Patients with VRE are placed on contact isolation
  - Hand hygiene
  - Gowns and gloves for all patient care
Mandatory Public Reporting of Nosocomial Infections
Status of Mandatory Reporting Legislation for Nosocomial Infections

- Enacted legislation
- Legislation proposed in 2007
- Passed a bill to study the issue

Source: APIC, February 2007
Assumptions and Goals of the Ideal Mandatory Reporting & Disclosure Program

• Maximize accuracy of data collection
• Standardize methodology for data collection & analysis
• Minimize costs to hospitals & government agencies
• Produce data that are valid, fair to hospitals, & useful to consumers

Edmond MB and Bearman GML, *Journal of Hospital Infection* (2007) 65(S2) 182–188
## Examples of Public Reporting-USA

<table>
<thead>
<tr>
<th>State</th>
<th>Data Source</th>
<th>Metrics Reported</th>
<th>Reporting and Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>Administrative claims &amp; clinical data</td>
<td>Class I SSI, VAP, CL-BSI</td>
<td>Mandatory quarterly reports to the Dept of Health which then submits to the General Assembly a summary report to be published on its website</td>
</tr>
<tr>
<td>Virginia</td>
<td>Clinical data using CDC definitions for nosocomial infections</td>
<td>To be set by the State Board of Health</td>
<td>Hospitals required to report selected indicators to the CDC &amp; forward adjusted infection rates to the State Health Department; data may be released to the public on request</td>
</tr>
<tr>
<td>Missouri</td>
<td>Data source not specified</td>
<td>Class I SSI, VAP, CL-BSI</td>
<td>Data collection, analysis and reporting rules to be recommended by an advisory committee. Dept of Health to publish a quarterly report on its website</td>
</tr>
<tr>
<td>Nevada</td>
<td>Data source not specified</td>
<td>SSI, VAP, CL-BSI, UTI</td>
<td>Hospitals report to the Health Division of the Department of Human Resources. No provision for public disclosure.</td>
</tr>
</tbody>
</table>
Virginia Plan for NI Reporting

State Health Department
- VDH serves as repository & releases data to the public on request
- Board of Health determines NIs & patient populations for surveillance

Hospitals
- ICPs transmit data to CDC’s NHSN via web-based software
- ICPs collect NI data using CDC definitions & methodology
- Hospitals transmit rates to VDH

CDC
- CDC calculates risk-adjusted NI rates & electronically transmits data to VA hospitals

Hospitals

CDC
Sufficient data now exist to prove that the mortality of hospital acquired infections represents a leading cause of death in the United States.

Richard P. Wenzel, MD, M.Sc
Many infections are inevitable, although some can be prevented.

Each infection is potentially preventable unless proven otherwise.

The burden is increasingly on healthcare systems to implement known nosocomial risk reduction interventions.
The End