Nosocomial Infections in the ICU

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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

Nosocomial Infections

- 70% are due to antibiotic-resistant organisms
- Invasive devices are more important than underlying diseases in determining susceptibility to nosocomial infection

## Nosocomial Infections in the US

<table>
<thead>
<tr>
<th></th>
<th>1975</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of admissions (millions)</td>
<td>37.7</td>
<td>35.9</td>
</tr>
<tr>
<td>Number of patient days (millions)</td>
<td>299.0</td>
<td>190.0</td>
</tr>
<tr>
<td>Average length of stay (days)</td>
<td>7.9</td>
<td>5.3</td>
</tr>
<tr>
<td>Number of nosocomial infections</td>
<td>2.1</td>
<td>1.9</td>
</tr>
<tr>
<td>(millions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidence of nosocomial infections</td>
<td>7.2</td>
<td>9.8</td>
</tr>
<tr>
<td>(per 1,000 patient-days)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Incidence of Nosocomial Infections in ICUs
### US, 1995-2000

<table>
<thead>
<tr>
<th>Infections/1,000 device days</th>
<th>MICU</th>
<th>SICU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilator-associated pneumonia</td>
<td>6.4</td>
<td>12.1</td>
</tr>
<tr>
<td>Catheter-associated UTI</td>
<td>5.9</td>
<td>4.3</td>
</tr>
<tr>
<td>Catheter-associated BSI</td>
<td>5.3</td>
<td>4.9</td>
</tr>
</tbody>
</table>

## Attributable Costs of Nosocomial Infections

<table>
<thead>
<tr>
<th>Infection</th>
<th>Cost per Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound infections</td>
<td>$3,000 - $27,000</td>
</tr>
<tr>
<td>Sternal wound infection</td>
<td>$20,000 - $80,000</td>
</tr>
<tr>
<td>Catheter-associated BSI</td>
<td>$5,000 - $34,000</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>$10,000 - $29,000</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>$700</td>
</tr>
</tbody>
</table>

Major Sites of Nosocomial Infections

- Urinary tract infection
- Surgical site infection
- Bloodstream infection
- Pneumonia (ventilator-associated)
Nosocomial Urinary Tract Infections

- Most common hospital-acquired infection (40% of all nosocomial infections)
  - 1 million cases of nosocomial UTI per year in the US
- Of nosocomial infections, lowest mortality & cost
- >80% associated with urinary catheter
Nosocomial Urinary Tract Infections

- 25% of hospitalized patients will have a urinary catheter for part of their stay
- 20-25 million urinary catheters sold per year in the US
- 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

Risk Factors for Nosocomial UTIs

- Female gender
- Other active site of infection
- Diabetes mellitus
- Renal insufficiency
- Duration of catheterization
- Insertion of catheter late in hospitalization
- Presence of ureteral stent
- Using catheter to measure urine output
- Disconnection of catheter from drainage tube
- Retrograde flow of urine from drainage bag
Prevention of Nosocomial UTIs

• Avoid catheter when possible & discontinue ASAP
• Aseptic insertion by trained HCW
• Maintain closed system of drainage
• Ensure dependent drainage
• Minimize manipulation of the system
• Silver coated catheters
Nosocomial Urinary Tract Infections: Silver Alloy Catheters

- **Advantages:**
  - Most studies have demonstrated a significant decrease in incidence of UTI
  - Insertion, care no different than for 1st generation catheter
- **Disadvantage:**
  - Cost (~$5 more per catheter)
- **Supporting evidence:** reasonably strong (high strength of evidence for impact & effectiveness at low cost & complexity)
- **Primary goal:** should still remain avoiding the use of catheters when possible & discontinuing as soon as possible
Nosocomial Bloodstream Infections

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

<table>
<thead>
<tr>
<th>Catheter Type</th>
<th>BSIs 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>
## 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><em>S. aureus</em></td>
<td>20.2%</td>
</tr>
<tr>
<td>3</td>
<td>Enterococci</td>
<td>9.4%</td>
</tr>
<tr>
<td>4</td>
<td><em>Candida</em> spp</td>
<td>9.0%</td>
</tr>
<tr>
<td>5</td>
<td><em>E. coli</em></td>
<td>5.6%</td>
</tr>
<tr>
<td>6</td>
<td><em>Klebsiella</em> spp</td>
<td>4.8%</td>
</tr>
<tr>
<td>7</td>
<td><em>Pseudomonas aeruginosa</em></td>
<td>4.3%</td>
</tr>
<tr>
<td>8</td>
<td><em>Enterobacter</em> spp</td>
<td>3.9%</td>
</tr>
<tr>
<td>9</td>
<td><em>Serratia</em> spp</td>
<td>1.7%</td>
</tr>
<tr>
<td>10</td>
<td><em>Acinetobacter</em> 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

• Limit duration of use of intravascular catheters
  – No advantage to changing catheters routinely
• Maximal barrier precautions for insertion
  – Sterile gloves, gown, mask, cap, full-size drape
  – Moderately strong supporting evidence
• Chlorhexidine prep for catheter insertion
  – Significantly decreases catheter colonization; less clear evidence for BSI
  – Disadvantages: possibility of skin sensitivity to chlorhexidine, potential for chlorhexidine resistance
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)
Risk Factors for VAP

- Duration of mechanical ventilation
- Chronic lung disease
- Severity of illness
- Age
- Head trauma
- Elevated gastric pH

- Aspiration of gastric contents
- Reintubation
- Upper abdominal or thoracic surgery
- Supine head position
- NG tube
Prevention of VAP

• Semirecumbent position of ventilated patients (head of bed at 45°)
Barrier Precautions for Resistant Organisms

- Gowns, gloves for patient contact
- Dedicated noncritical equipment
- Effectiveness not clearly established
- Push by some for surveillance cultures to detect colonization with MRSA & VRE
Many infections are inevitable, although some can be prevented

Each infection is potentially preventable unless proven otherwise