Healthcare-Associated Infections

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Disclosure: Dr. Dellit has no significant financial interest in any of the products or manufacturers mentioned.
Patient Safety and Infection Control

- Prevention, monitoring, and feedback
  - Healthcare-associated infections
    - Catheter-associated bloodstream infections
    - Catheter-associated UTI
    - Ventilator-associated pneumonia
    - Surgical site infections
  - Transmission of multidrug-resistant/marker organisms
    - MRSA
    - VRE
    - ESBL-producing organisms $\rightarrow$ MDR Enterobacteriaceae
    - Carbapenem-resistant Enterobacteriaceae (KPC, NDM-1)
    - C. difficile
    - Aspergillus in burn and immunocompromised populations
    - Tuberculosis
Increasing Regulation and Reporting

- CMS and “medical errors”
  - FY2008
    - Catheter-associated urinary tract infection
    - Vascular catheter-associated infections
    - Mediastinitis after CABG
  - FY2009
    - SSI following select orthopedic procedures
      - Spinal fusion
      - Elbow and shoulder arthroplasty
    - SSI following bariatric surgery

- Mandatory reporting of healthcare-associated infections (HB 1106)
  - Central line infections in ICU: July 2008
  - Ventilator-associated pneumonia: January 2009
  - Selected surgical site infections: January 2010
    - Cardiac surgery
    - Total hip and knee arthroplasty
    - Hysterectomy
# Healthcare Facility HAI Reporting to CMS via NHSN – Current and Proposed Requirements (8/1/2011)

<table>
<thead>
<tr>
<th>HAI Event</th>
<th>Facility Type</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLABSI</td>
<td>Acute Care Hospitals Adult, Pediatric, and Neonatal ICUs</td>
<td>January 2011</td>
</tr>
<tr>
<td>CAUTI</td>
<td>Acute Care Hospitals Adult and Pediatric ICUs</td>
<td>January 2012</td>
</tr>
<tr>
<td>SSI</td>
<td>Acute Care Hospitals Colon and abdominal hysterectomy procedures</td>
<td>January 2012</td>
</tr>
<tr>
<td>I.V. antimicrobial start <em>(proposed)</em></td>
<td>Dialysis Facilities</td>
<td>January 2012</td>
</tr>
<tr>
<td>Positive blood culture <em>(proposed)</em></td>
<td>Dialysis Facilities</td>
<td>January 2012</td>
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<tr>
<td>Signs of vascular access infection <em>(proposed)</em></td>
<td>Dialysis Facilities</td>
<td>January 2012</td>
</tr>
<tr>
<td>CAUTI (proposed)</td>
<td>Inpatient Rehabilitation Facilities</td>
<td>October 2012</td>
</tr>
<tr>
<td>CLABSI (proposed)</td>
<td>Long Term Care Hospitals</td>
<td>October 2012</td>
</tr>
<tr>
<td>CAUTI (proposed)</td>
<td>Long Term Care Hospitals</td>
<td>October 2012</td>
</tr>
<tr>
<td>MRSA Bacteremia</td>
<td>Acute Care Hospitals Facility-wide</td>
<td>January 2013</td>
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<tr>
<td>C. difficile LabID Event</td>
<td>Acute Care Hospitals Facility-wide</td>
<td>January 2013</td>
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<tr>
<td>HCW Influenza Vaccination</td>
<td>Acute Care Hospitals, OP Surgery, ASCs</td>
<td>January 2013</td>
</tr>
<tr>
<td>SSI (proposed)</td>
<td>Outpatient Surgery/ASCs</td>
<td>January 2014</td>
</tr>
</tbody>
</table>
Need to bring state and CMS requirements into alignment!
Central Line-Associated Bloodstream Infections (CLA-BSI)

- ICU CVC utilization 0.38 – 0.69 catheters/pt
  - 20 million catheter-days per year in US
- ICU rate 0.9 to 3.5 per 1000 catheter-days (NHSN mean)
  - 80,000 CLA-BSI annually in US ICUs
  - Attributable mortality 0-35%
- Healthcare cost $296 million to $2.3 billion
  - Attributable cost $15,000-$56,000
  - Prolonged ICU and hospital LOS (5 and 7 days, respectively)

National healthcare Safety Network (HNSN) Report, Data Summary for 2010
# NHSN CLA-BSI Pathogens

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coag-negative staphylococci</td>
<td>27</td>
<td>37</td>
<td>34</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>16</td>
<td>13</td>
<td>10*</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>8</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td><em>Candida sp.</em></td>
<td>8</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td><em>Enterobacter</em></td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td><em>E. Coli</em></td>
<td>6</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

*MRSA 5.6%, MSSA 4.3%

Infect Control Hosp Epidemiol 2008;29:996-1011
Prevention of Catheter-Associated BSI

- IHI “Central Line Bundle”
  - Hand hygiene
  - Chlorhexidine skin prep
  - Maximal barriers
    - Full drape
    - Mask, hair cover, sterile gown, sterile gloves
  - Optimal catheter site selection
  - Daily review of line necessity

- Maintenance of long-term catheters

Institute for Healthcare Improvement
Skin Prep for Vascular Devices

<table>
<thead>
<tr>
<th></th>
<th>10% povidone-iodine</th>
<th>70% Isopropyl alcohol</th>
<th>2% Chlorhexidine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colonization</td>
<td>9.3</td>
<td>7.1</td>
<td>2.3</td>
</tr>
<tr>
<td>CR-bacteremia</td>
<td>2.6</td>
<td>2.3</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Rate per 100 catheters

Lancet 1991;338:338-43

CVC alone: RR 0.51 (0.27 – 0.97)

Ann Intern Med 2002;136:792-801
Bundle in Action – Keystone Project

Reduction in mean rate from 7.7 to 1.4 per 1000 catheter-days

National Reduction in CLA-BSI
Central Line Checklist Usage

Does your organization use a central line checklist?  
N = 1718

- Yes: 72%
- No: 13%
- Don't Know: 15%

For the central lines you placed, participated in the placement of, or observed being placed in the last 3 months, in what percentage of cases was a central line checklist used?  
N = 1228

Frequency of Checklist Usage:
- Don't know: 10%
- > 80%: 69%
- 61% - 80%: 8%
- 41% - 60%: 6%
- 21% - 40%: 2%
- 20% or less: 8%
- Never: 1%
Hospital-Acquired UTI

- 40% of healthcare-associated infections
- 80% due to indwelling urethral catheter

Survey of Hospital Monitoring

<table>
<thead>
<tr>
<th>Presence</th>
<th>Duration</th>
<th>UTI rates</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>No monitoring (%)</td>
<td>No monitoring (%)</td>
<td>No monitoring (%)</td>
<td>No monitoring (%)</td>
</tr>
</tbody>
</table>

Potential Strategies

- Insertion/care
- Catheter reminders/automatic stop orders
- Bladder US scanners
- Condom catheters
- Antimicrobial catheters


Aymptomatic bacteriuria vs.
Symptomatic UTI in patients without localizing GU symptoms
CA-UTI Pathogens
NHSN 2006-2007

- Candida sp, 21%
- Pseudomonas, 10%
- Enterococcus, 15%
- Klebsiella sp, 9%
- Enterobacter sp, 4%
- E. coli, 21%
- S. aureus, 2%
- Acinetobacter, 1%
- Coag neg Staphylococcus, 3%
- Coag neg Staphylococcus, 3%

Infect Control Hosp Epidemiol 2008;29:996-1011
Catheter-Associated UTI

- Duration of catheterization is primary risk
- Providers unaware of catheter status
  - Students 21%
  - Interns 22%
  - Residents 27%
  - Attendings 38%
- Daily assessment of need, especially when transferred from ICU to floor

Ventilator-Associated Pneumonia

- Rate 0.7 – 6.0 per 1000 ventilator days (NHSN 2010)
  - 10-30% of intubated patients
  - Incidence increases with duration of MV
    - Day 1-5: 3% risk per day
    - Day 6-10: 2% risk per day
    - > 10 days: 1% risk per day
- Attributable mortality rate 33-50%
- Increased LOS 7-9 days
- Cost of $40,000 per patient
- Accounts for 50% of ICU antimicrobials
- Clinical vs. microbiologic definitions
  - Poor external quality measure

Am J Respir Crit Care Med 2005;171:388-416
NHSN Pneumonia Definitions

- **Clinical definition alone (PNU1)**
  - Radiographic infiltrate/consolidation/cavitation AND
  - Fever (>38C) or WBC (<4K or >12K) AND
  - Two of following
    - Purulent sputum/increased suctioning
    - Worsening cough, dyspnea, or tachypnea
    - Rales or bronchial breath sounds
    - Worsening gas exchange

- **Clinical and lab definition (PNU2)**
  - As above with one of the detailed criteria
  - Positive blood, pleural fluid, or quantitative BAL/PSB

- **No minimum time for mechanical ventilation**

*Anticipate change to Ventilator Associated Conditions in 2013*
CDC NHSN 2013 Proposal:
Ventilator-Associated Events

Surveillance Definitions for Ventilator-Associated Events:
- For use in acute and long-term acute care hospitals and inpatient rehabilitation facilities.
- For use in patients ≥18 years of age who are on mechanical ventilation ≥3 calendar days.
- NOTE: patients on rescue mechanical ventilation (e.g., HFV, ECMO, mechanical ventilation in prone position) are EXCLUDED.

- Patient has a baseline period of stability or improvement on the ventilator, defined by ≥2 calendar days of stable or decreasing FiO₂ or PEEP. Baseline FiO₂ and PEEP are defined by the minimum daily FiO₂ or PEEP measurement during the period of stability or improvement.

- After a period of stability or improvement on the ventilator, the patient has at least one of the following indicators of worsening oxygenation:
  1) Minimum daily FiO₂ values increase ≥ 0.20 (20 points) over baseline and remain at or above that increased level for ≥2 calendar days.
  2) Minimum daily PEEP values increase ≥ 3 cmH₂O over baseline and remain at or above that increased level for ≥2 calendar days.

**Ventilator-Associated Condition (VAC)** → **Public Reporting Definition**

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, the patient meets both of the following criteria:

1) Temperature > 38 °C or < 36 °C, or white blood cell count ≥ 12,000 cells/mm³ or ≤ 4,000 cells/mm³.

AND

2) A new antimicrobial agent(s) is started, and is continued for ≥4 calendar days.

**Infection-related Ventilator-Association Complication (IVAC)** → **Public Reporting Definition**

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, ONE of the following criteria is met:

1) Purulent respiratory secretions (from one or more specimen collections)
   - Defined as secretions from the lungs, bronchi, or trachea that contain ≥25 neutrophils and ≤50 squamous epithelial cells per low power field [ppf, x100].
   - If the laboratory reports semi-quantitative results, those results must be equivalent to the above quantitative thresholds.

2) Positive culture (qualitative, semi-quantitative or quantitative) of sputum, endotracheal aspirate, bronchoalveolar lavage, lung tissue, or protected specimen brushing

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, ONE of the following criteria is met:

1) Purulent respiratory secretions (from one or more specimen collections—and defined as possible VAP)

AND one of the following:

- Positive culture of endotracheal aspirate, ≥ 10⁵ CFU/ml or equivalent semi-quantitative result
- Positive culture of bronchoalveolar lavage, ≥ 10⁴ CFU/ml or equivalent semi-quantitative result
- Positive culture of lung tissue, ≥ 10⁴ CFU/ml or equivalent semi-quantitative result
- Positive culture of protected specimen brush, ≥ 10⁴ CFU/ml or equivalent semi-quantitative result
- One of the following (without requirement for purulent respiratory secretions):
  - Positive pleural fluid culture (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
  - Positive lung histopathology
  - Positive diagnostic test for Legionella spp.
  - Positive diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus

**Possible Ventilator-Associated Pneumonia** → **Internal Quality Improvement** → **Probable Ventilator-Associated Pneumonia**
NHSN Pooled Mean VAP by Unit 2010 Report

BICU: Burn
CICU: Coronary
CT ICU: Cardiothoracic
MICU: Medical
PICU: Pediatric med/surg
NICU: Neurosurgery
SICU: Surgical
TICU: Trauma

Am J Infect Control 2011;39:798-816
Ventilator Bundle

- Head of bed elevation > 30 degrees
- Daily “sedation awakening” and assessment of readiness to extubate
- Oral care (chlorhexidine)
- Peptic ulcer disease prophylaxis
- Deep vein thrombosis prophylaxis

*Institute for Healthcare Improvement*
Empiric Therapy Without Risk Factors for Multi-Drug-Resistant Pathogens (Early-Onset*)

Potential Pathogens

*S. pneumoniae*

*H. influenzae*

*MSSA*

Susceptible GNB

*E. coli*

*K. pneumoniae*

*Proteus sp.*

*S. marcescens*

Recommended Therapy

Ceftriaxone

or

Fluoroquinolone

(levo, moxi, cipro)

or

Ampicillin/sulbactam

or

Ertapenem

*< 4 days of MV or LOS

Am J Respir Crit Care Med 2005;171:388-416
Empiric Therapy with Risk Factors for Multi-Drug-Resistant Pathogens (Late-Onset*)

Potential Pathogens

Non-MDR pathogens
- *P. aeruginosa*

MDR pathogens
- *K. pneumoniae* (ESBL)
- *Acinetobacter*
- *MRSA*
- *Legionella pneumophila*

* > 4 days of MV or LOS

Combination Antimicrobial Therapy

- Anti-pseudomonal cephalosporin (cefepime, ceftazidime)
  or
- Anti-pseudomonal carbapenem (imipenem, meropenem)
  or
- $\beta$-lactam/$\beta$-lactamase inhibitor (piperacillin-tazobactam)
  
  plus
- Anti-pseudomonal fluoroquinolone (ciprofloxacin or levofloxacin)
  or
- Aminoglycoside (amikacin, gentamicin, or tobramycin)
  
  plus
- Vancomycin or linezolid

Am J Respir Crit Care Med 2005;171:388-416
**Acinetobacter VAP**

Wipe out *Acinetobacter* through active Surveillance and Hand hygiene (W.A.S.H)
- Hand hygiene
- Active surveillance cultures
- Contact precautions
- Chlorhexidine baths
- HAI bundles
- Environmental cleaning
- Minimize shared equipment
- Dakin’s wound care
- Antimicrobial stewardship

(*Percent of VAP due to *Acinetobacter*)
Early VAP
Amp/sulb, ceftriaxone, ertapenem, or moxifloxacin (PCN allergy)

If GPC in clusters on Gram stain, history of MRSA, or risk factors for MRSA, add vancomycin

De-escalation based on quantitative culture
Consider linezolid for documented MRSA pneumonia

Standard duration of therapy 8 days except for Pseudomonas

Late VAP
Imipenem or mero + vancomycin +/- aminoglycoside or ciprofloxacin

Suspicion of VAP

Bronchoscopy or mini-BAL

If initial CPIS $\leq$ 6 without bronchoscopy, re-evaluate at day 3 and discontinue antimicrobials if CPIS $\leq$ 6
Late Onset VAP Pathogens

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>July 03 – June 04 (N=138)</th>
<th>July 08 – June 09 (N=114)</th>
<th>July 09 – June 10 (N=83)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acinetobacter</td>
<td>44 (32%)</td>
<td>4 (4%) ↓</td>
<td>4 (5%) ↓</td>
</tr>
<tr>
<td>MRSA</td>
<td>32 (23%)</td>
<td>8 (7%) ↓</td>
<td>2 (2%) ↓</td>
</tr>
<tr>
<td>MSSA</td>
<td>21 (15%)</td>
<td>30 (26%)</td>
<td>23 (28%)</td>
</tr>
<tr>
<td>Haemophilus</td>
<td>20 (14%)</td>
<td>24 (21%)</td>
<td>13 (16%)</td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>13 (9%)</td>
<td>14 (12%)</td>
<td>15 (18%)</td>
</tr>
<tr>
<td>Enterobacter</td>
<td>4 (3%)</td>
<td>12 (11%)</td>
<td>4 (5%)</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>7 (5%)</td>
<td>7 (6%)</td>
<td>5 (6%)</td>
</tr>
<tr>
<td>Serratia spp.</td>
<td>5 (3%)</td>
<td>7 (6%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>E. coli</td>
<td>6 (4%)</td>
<td>6 (5%)</td>
<td>1 (1%)</td>
</tr>
</tbody>
</table>
# Pseudomonas VAP susceptibilities

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>7/08 to 6/09 N=14 (%)</th>
<th>7/09 to 6/10 N=16 (%)</th>
<th>Total N=30 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amikacin</td>
<td>14 (100)</td>
<td>16 (100)</td>
<td>30 (100)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>11 (79)</td>
<td>15 (94)</td>
<td>26 (87)</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>12 (86)</td>
<td>15 (94)</td>
<td>27 (90)</td>
</tr>
<tr>
<td><strong>Cefepime</strong></td>
<td>13 (93)</td>
<td>15 (94)</td>
<td>28 (93)</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>13 (93)</td>
<td>13 (81)</td>
<td>26 (87)</td>
</tr>
<tr>
<td><strong>Imipenem</strong></td>
<td>12 (86)</td>
<td>10 (63)</td>
<td>22 (73)</td>
</tr>
<tr>
<td><strong>Meropenem</strong></td>
<td>12 (86)</td>
<td>13 (81)</td>
<td>25 (83)</td>
</tr>
<tr>
<td>Pip/tazo</td>
<td>13 (93)</td>
<td>14 (88)</td>
<td>27 (90)</td>
</tr>
<tr>
<td>Timentin</td>
<td>11 (79)</td>
<td>12 (75)</td>
<td>23 (77)</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>13 (93)</td>
<td>15 (94)</td>
<td>28 (93)</td>
</tr>
</tbody>
</table>
Predictive Value of Active Surveillance Cultures for MRSA (July 2008 to Oct 2010)

<table>
<thead>
<tr>
<th></th>
<th>MRSA VAP</th>
<th>Other VAP</th>
<th>Total</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MRSA ASC Positive</strong></td>
<td>26</td>
<td>28</td>
<td>54</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MRSA ASC Negative</strong></td>
<td>11</td>
<td>323</td>
<td>334</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>37</td>
<td>351</td>
<td>388</td>
<td>48%</td>
<td>97%</td>
</tr>
</tbody>
</table>

Sensitivity = 70%
Specificity = 92%

Crit Care Med 2012;40:1437-42
Reassessment of VAP Antimicrobial Therapy Based on Changes in Local Microbiology and Resistance Patterns

Ventilator Associated Pneumonia Orders
EMPIRIC ANTIBIOTIC INITIATION- DAY 0

Allergies: ________________________________  Patient Weight: __________ kg

☐ Ventilated and radiographic evidence of pneumonia (Diagnostic Worksheet on back)

☐ Clinical evidence of pneumonia (fever, ET secretions, leukocytosis)
☐ Bronchoscopy

➔ EARLY VAP = Low MDRO risk patient* AND ≤ 4 days in the hospital
☐ Ceftriaxone 1 gram IV QDay
OR
☐ Ampicillin/sulbactam 3 gram IV every 6hrs

OR, if severe penicillin allergy (anaphylaxis, hives):
☐ Moxifloxacin 400mg IV QDay

If MRSA Surveillance Swab is Positive OR
Unknown Surveillance Status OR Clinically Unstable, ADD
☐ Vancomycin loading dose x1 based on total body weight, 2 g if ≥ 70kg 1.5 g IV if < 70kg
AND
☐ Vancomycin maintenance dose ______ gram (15-20 mg/kg) IV Q_____hrs and
vancomycin trough before 4th dose (goal trough of 15-20 mcg/mL)

➔ LATE VAP = High MDRO risk patient* OR ≥ 5 days
☐ Cefepime 2 gram IV every 8hrs
OR
☐ Meropenem 1 gram IV every 8hrs if known Acinetobacter or other highly drug resistant
organism colonization/infection

If MRSA Surveillance Swab is Positive OR
Unknown Surveillance Status OR Clinically Unstable, ADD
☐ Vancomycin loading dose x1 based on total body weight, 2 g if ≥ 70kg 1.5 g IV if < 70kg
AND
☐ Vancomycin maintenance dose ______ gram (15-20 mg/kg) IV Q_____hrs and
vancomycin trough before 4th dose (Goal trough of 15-20 mcg/mL)

*High risk for infection with multidrug resistant organisms (MDRO) = skilled nursing home resident, hospitalization within
last 6 months, repeat VAP, immunocompromised or known bacterial infections on antimicrobials

Incorporation of MRSA surveillance cultures

Shift from Imipenem to Cefepime for late-onset VAP

• Decreased Acinetobacter
• Pseudomonas susceptibilities
Clostridium difficile infection: Incidence and Cost

- Hospital-onset: 165,000 cases, $1.3 billion in excess costs, and 9,000 deaths annually

- Nursing home-onset: 263,000 cases, $2.2 billion in excess costs, and 16,500 deaths annually

- Community-onset, healthcare-facility associated: 50,000 cases, $0.3 billion in excess costs, and 3,000 deaths annually

Elixhauser et al. HCUP Statistical Brief #50. 2008
**Clostridium difficile**

- **Colonization**
  - 3% healthy adults
  - 20-40% of hospitalized patients

- **Unintended consequence of antimicrobial therapy**
  - Perturbation of competing flora
  - Cephalosporins, clindamycin, and fluoroquinolones

Modified from Clin Infect Dis 1998;26:1027-1036
Emergence of Epidemic Strain

- Epidemic strain associated with *C. difficile* outbreaks in 8 healthcare facilities since 2001
  - 18-bp deletion in negative regulatory gene *tcdC*
    - 20 fold increase in toxin A and B production
  - Binary toxin: unclear contribution to virulence
  - Resistant to fluoroquinolones

- Prospective study of 1703 patients in Quebec in 2004
  - Incidence 22.5 per 1000 admissions
  - 30 day attributable mortality rate of 6.9%
  - Associated with fluoroquinolone and cephalosporin exposure

Diagnosis of C. difficile

- EIA tests for common antigen and toxins
  - 63-99% sensitivity, 75-100% specificity
- Cytotoxicity assay for toxin B
  - Historic “gold standard”, but 48 hour turnaround
- PCR for toxin gene
- Culture
  - Rarely done except in outbreak investigation
- Endoscopy (pseudomembranous colitis)
Management of *Clostridium difficile*

- Limiting antimicrobial exposure
- Infection control
  - Use Soap and Water
  - Contact precautions
  - Environmental cleaning
  - Early identification of cases, universal gloving?
- Evolving treatment strategies
Reduction of *C. difficile* through Antimicrobial Stewardship

**Reduction in antimicrobial use:**
- All: 23%
- Targeted 54%

Clin Infect Dis 2007;45:S112-21
**C. difficile** and the Environment

![Bar chart showing environmental contamination]

**Infect Control Hosp Epidemiol 2010;31:21-7.**

**TABLE 3.** Multivariate Analysis of Risk Factors for Acquisition of *Clostridium difficile* Infection (CDI)

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>HR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior room occupant with CDI</td>
<td>2.35 (1.21–4.54)</td>
<td>.01</td>
</tr>
<tr>
<td>Greater age</td>
<td>1.00 (0.99–1.01)</td>
<td>.71</td>
</tr>
<tr>
<td>Higher APACHE III score</td>
<td>1.00 (1.00–1.01)</td>
<td>.06</td>
</tr>
<tr>
<td>Proton pump inhibitor use</td>
<td>1.11 (0.44–2.78)</td>
<td>.83</td>
</tr>
<tr>
<td>Antibiotic exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norfloxacin</td>
<td>0.38 (0.05–2.72)</td>
<td>.33</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>1.08 (0.67–1.73)</td>
<td>.75</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>0.49 (0.15–1.67)</td>
<td>.23</td>
</tr>
<tr>
<td>Fluoroquinolones</td>
<td>1.17 (0.72–1.91)</td>
<td>.53</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>0.45 (0.14–1.42)</td>
<td>.17</td>
</tr>
<tr>
<td>Third- or fourth-generation cephalosporins</td>
<td>1.17 (0.76–1.79)</td>
<td>.48</td>
</tr>
<tr>
<td>Carbapenems</td>
<td>1.05 (0.63–1.75)</td>
<td>.84</td>
</tr>
<tr>
<td>Piperacillin-tazobactam</td>
<td>1.31 (0.82–2.10)</td>
<td>.27</td>
</tr>
<tr>
<td>Other penicillin</td>
<td>0.47 (0.23–0.98)</td>
<td>.04</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>1.31 (0.83–2.07)</td>
<td>.24</td>
</tr>
<tr>
<td>Vancomycin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral</td>
<td>1.38 (0.32–5.89)</td>
<td>.67</td>
</tr>
<tr>
<td>Intravenous</td>
<td>1.55 (0.88–2.73)</td>
<td>.13</td>
</tr>
<tr>
<td>Aminoglycosides</td>
<td>1.27 (0.78–2.06)</td>
<td>.35</td>
</tr>
<tr>
<td>Multiple (≥3 antibiotic classes)</td>
<td>1.28 (0.75–2.21)</td>
<td>.37</td>
</tr>
</tbody>
</table>

**NOTE.** APACHE, Acute Physiology and Chronic Health Evaluation; CI, confidence interval; HR, hazard ratio.

**Infect Control Hosp Epidemiol 2011;32:201-6**
Rationale for considering extending isolation beyond duration of diarrhea

Clin Infect Dis 2008;46:447-50
Environmental Cleaning

- Vegetative (bacteria) vs. spore state
- Thorough cleaning of environment
- Hypochlorite (1:10 dilution of bleach) or chlorine-releasing (Na dichloroisocyanurate) vs. quaternary ammonium
  - Reduction from 8.6 to 3.3 cases per 1000 pt-days in bone marrow transplant unit, no reduction in other units (Clin Infect Dis 2000;31:995-1000)
  - Reduction from 16.6 to 3.7 cases per 1000 pt days in MICU (Infect Control Hosp Epidemiol 2007;28:205-7)
UV-C Decontamination and Clostridium difficile

Infect Control Hosp Epidemiol 2011;32:737-742
Hydrogen Peroxide Vapor Decontamination and C. difficile

Percent of Environmental Surfaces with Positive C. difficile Cultures

Rate of C. difficile per 1000 pt-days

Pre-HPV  Post-HPV

Infect Control Hosp Epidemiol 2008;29:723-729
Environmental Cleaning: HPV vs. UV-C

**Figure 1.** Number of samples positive for bacterial growth after decontamination with hydrogen peroxide vapor (HPV) and ultraviolet radiation (UVC) for each of the 5 sites.

**Figure 2.** Mean *Clostridium difficile* log reductions for each of the 5 sites after decontamination with hydrogen peroxide vapor (HPV) and ultraviolet radiation (UVC).

Infect Control Hosp Epidemiol 2012;33:507-512
Vancomycin vs. Metronidazole
Stratified by Disease Severity

Severe disease defined as pseudomembranous colitis or ≥ 2 of following:
- Age > 60
- T > 38.3
- Albumin < 2.5 mg/dl
- WBC > 15K

Clin Infect Dis 2007;45:302-7
Fidaxomicin vs. Vancomycin

Cure rate: Fidaxomicin 90.0% vs. Vancomycin 79.4% (P=0.04)

N Engl J Med 2011;364;422-31
Clin Infect Dis 2011;53:440-447
Stool Transplantation?

- Attempt to restore normal gut flora
- 18 patients with recurrent *C. difficile* received donor stool via nasogastric tube
  - 15 family members and 3 clinic staff served as donors
- 2 patients died from unrelated causes
- 15/16 remaining patients cured (94%)

Systematic review of 317 patients in 27 studies demonstrated disease resolution in 92%

Clin Infect Dis 2011;53:994-1002
Patient Safety and Infection Control

- Increasing focus on HAI process and outcome measures
- CMS goal to reduce HAI by 40% by 2013
- Expansion of mandatory reporting of HAI
- Increased linkage of reimbursement to quality
  - CMS preventable “medical errors”