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Centers for Disease Control and Prevention

Metrics and Decision-Making for Antibiotic Stewardship in Human Medicine

Antibiotic Use and Resistance: Moving Forward Through Shared Stewardship
November 12-14, 2014
Atlanta, GA
Key points

 Why measure?

 What to measure?

 How to measure?
Why measure?

- What gets measured gets done.
Antibiotic use is common in healthcare

1 in 2

More than half of all hospital patients receive an antibiotic.
Antibiotic prescriptions per 1000 persons of all ages according to state

Why Measure--
Goals and Objectives of Antibiotic Stewardship

- **Goals**
  - Improved population health
  - Optimal prescribing of antibiotics
  - Sustainable changes in clinical practice

- **Objectives**
  - Better clinical outcomes
  - Reduction in antibiotic resistant infections
  - Economic benefit
What to measure

- Outcome measures
- Process measures
Outcome measures

• Better clinical outcomes
  • Decreased morbidity, mortality overall
  • Fewer adverse events (C. difficile infections, adverse drug reactions, drug-drug interactions)

• Reduction in antibiotic resistance
  • Fewer resistant infections
  • Less spread of resistant bacteria

• Economic benefit
  • Lower healthcare costs for infections and complications
  • Reduced pharmacy and consumer costs for antibiotics
Estimated burden of healthcare-associated CDI

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

- Hospital-acquired, post-discharge (up to 4 weeks): 50,000 cases, $0.3 billion in excess costs, and 3,000 deaths annually

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

- Decreasing the use of antibiotics that most often lead to *C. difficile* infection by 30% could lead to 26% fewer of these infections.

- Patients getting broad-spectrum antibiotics are up to 3x more likely to get another infection from an even more resistant germ.

30%
Reducing prescriptions of high-risk antibiotics by 30% in hospitals can lower deadly diarrhea infections by 26.

*Vitalsigns*
www.cdc.gov/vitalsigns
Clinical outcomes better with antimicrobial management program

<table>
<thead>
<tr>
<th>Category</th>
<th>AMP</th>
<th>RR</th>
<th>(95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.8</td>
<td>(2.1-3.8)</td>
</tr>
<tr>
<td>Cure</td>
<td></td>
<td>1.7</td>
<td>(1.3-2.1)</td>
</tr>
<tr>
<td>Failure</td>
<td></td>
<td>0.2</td>
<td>(0.1-0.4)</td>
</tr>
</tbody>
</table>

AMP = Antibiotic Management Program
UP = Usual Practice

Increased resistance for individual patients

Pathogen and Antibiotic Exposure | Increased Risk
--- | ---
Carbapenem-resistant Enterobacteriaceae | 15 fold
  • Carbapenems
ESBL-producing organisms | 6 - 29 fold
  • Cephalosporins

Increased resistance in facilities—resistance in *P. aeruginosa* vs. carbapenem use rate

$r = 0.41, p = .004$ (Pearson correlation coefficient)

45 LTACHs, 2002-03 (59 LTACH years)

Gould et al. ICHE 2006;27:923-5
Rates of antibiotic resistant organism infections per 100 intensive care unit, with and without intervention

<table>
<thead>
<tr>
<th>Organism</th>
<th>No Rotation</th>
<th>Rotation</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gram-positive organisms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em>, oxacillin resistant</td>
<td>3.4</td>
<td>1.6</td>
<td>.02</td>
</tr>
<tr>
<td><em>Staphylococcus epidermidis</em>, oxacillin resistant</td>
<td>7.0</td>
<td>4.6</td>
<td>.05</td>
</tr>
<tr>
<td><em>Enterococcus</em> spp., gentamicin resistant</td>
<td>2.4</td>
<td>0.8</td>
<td>.01</td>
</tr>
<tr>
<td><em>Enterococcus</em> spp., vancomycin resistant</td>
<td>1.6</td>
<td>0.8</td>
<td>.17</td>
</tr>
<tr>
<td>Gram-negative organisms*a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Stenotrophomonas maltophilia</em></td>
<td>1.4</td>
<td>1.3</td>
<td>.86</td>
</tr>
<tr>
<td><em>Pseudomonas</em> spp.</td>
<td>2.9</td>
<td>1.1</td>
<td>.01</td>
</tr>
<tr>
<td><em>Acinetobacter</em> spp.</td>
<td>3.0</td>
<td>0.5</td>
<td>.0003</td>
</tr>
<tr>
<td><em>Burkholderia cepacia</em></td>
<td>0.4</td>
<td>0.0</td>
<td>.07</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>0.3</td>
<td>0.0</td>
<td>.14</td>
</tr>
</tbody>
</table>

Improving antibiotic use saves money

- “Comprehensive programs have consistently demonstrated a decrease in antimicrobial use with annual savings of $200,000 - $900,000”

IDSA/SHEA Guidelines for Antimicrobial Stewardship Programs, http://www.journals.uchicago.edu/doi/pdf/10.1086/510393
Process measures

- Facility stewardship programs
- Optimal prescribing
- Rates of use
Core Elements of Hospital Antibiotic Stewardship Programs

http://www.cdc.gov/getsmart/healthcare/implementation/core-elements.html
Process Measures

- Components of the program
  - Leadership commitment
  - Accountability
  - Drug expertise
  - Action
  - Tracking
  - Reporting
  - Education
Prescribing Practices Vary

- More than half of all hospital patients receive an antibiotic.
- Doctors in some hospitals prescribed 3 times as many antibiotics as doctors in other hospitals.
Optimal prescribing

- Steps in the prescribing process
  - Indication for prescription
  - Appropriateness
    - Consistent with guidelines/best practice
  - De-escalation/antibiotic time out
    - Change of therapy as indicated to a different antibiotic or IV to PO
  - Laboratory confirmation/review
Antibiotic prescriptions per 1000 persons of all ages according to state

How to measure

- Healthcare clinical and administrative data
  - Provider/prescriber-specific
  - Facility-specific
  - Aggregate—facilities, regions, national

- Outcomes
  - Patient outcomes
  - Laboratory data
  - Cost data

- Process
  - Antibiotic use data--benchmarking and tracking
  - Practice data, clinical decision support
  - Program components
Measuring Antibiotic Use

- Assessments of aggregate use
  - Proprietary data

- Facility-specific antibiotic administration data
  - Electronic records

- Detailed assessments of appropriate antibiotic use
  - Antibiotic use assessment
## Antimicrobial Class-Specific Usage Rates and Standardized Utilization Ratios (SURs)

<table>
<thead>
<tr>
<th>Location</th>
<th>ABX Days</th>
<th>Observed</th>
<th>Predicted</th>
<th>SUR*</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICU</td>
<td></td>
<td>4000</td>
<td>1000</td>
<td>4.0</td>
<td>Excessive</td>
</tr>
<tr>
<td>SICU</td>
<td></td>
<td>2000</td>
<td>2000</td>
<td>1.0</td>
<td>Consistent</td>
</tr>
<tr>
<td>Medical Ward</td>
<td></td>
<td>3000</td>
<td>4000</td>
<td>0.75</td>
<td>Lower Use</td>
</tr>
<tr>
<td>Surgical Ward</td>
<td></td>
<td>1000</td>
<td>3000</td>
<td>0.33</td>
<td>Much Lower</td>
</tr>
<tr>
<td>Hospital</td>
<td></td>
<td>170,250</td>
<td>171,000</td>
<td>0.99</td>
<td>Consistent</td>
</tr>
</tbody>
</table>

*SUR = ratio of the observed vs. predicted usage for the patient population defined by the location (e.g., MICU, SICU, etc)
The California Antimicrobial Stewardship Program Initiative

Spotlight on Antimicrobial Stewardship Programs

The following hospitals have agreed to share progress on the implementation of their Antimicrobial Stewardship Programs (ASP). Activities listed were defined by the California HAI Advisory Committee as those that comprise varying levels of Program implementation. An "v" indicates the hospital is currently performing the activity.

<table>
<thead>
<tr>
<th>Hospital Name</th>
<th>Basic Program</th>
<th>Intermediate Program</th>
<th>Advanced Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children's Hospital &amp; Research Center</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Oakland, Major Teaching, 190 beds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID Physician: Brian Lee, MD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="mailto:blee@mail.cho.org">blee@mail.cho.org</a></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharmacist: Cynthia Huwe, PharmD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="mailto:chuwe@mail.cho.org">chuwe@mail.cho.org</a></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eden Medical Center</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Castro Valley, Community, 144 beds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID Physician: Jeffrey Silvers, MD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="mailto:silver@sutterhealth.org">silver@sutterhealth.org</a></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID Pharmacist: Christopher Martinez</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="mailto:martino@sutterhealth.org">martino@sutterhealth.org</a></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Santa Barbara Cottage Hospital</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Santa Barbara, Community, 450 beds</td>
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</tr>
</tbody>
</table>
Complementary measures

- Prescribing
  - Objective
  - Prospective
  - May be more acceptable

- Appropriateness
  - Subjective
  - Retrospective
  - More difficult to interpret
Challenges

- Complexity
  - Behavioral, institutional, ecological focus

- Institutional variability
  - One size can’t fit all

- Access to and management of data
  - Electronic, proprietary, unfiltered

- Analysis of data, risk adjustment
  - Where to set the benchmarks
Summary and Conclusions

• Reduction in use is not an end in itself but a natural outcome of better practices

• Benchmarking is a useful tool, but continuous quality improvement within each setting is the process objective

• Optimal prescribing is a key goal to complement appropriateness of use

• Access to and management of electronic data is a significant challenge
The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.