Antimicrobial Stewardship Metrics
What to do?

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Disclosure

• I have no actual or potential conflict of interest in relation to this program or presentation

• Commercial Interests:
  – none
There are no standard, universally accepted metrics, for assessing the effectiveness of antimicrobial stewardship programs (ASPs).

Goals of ASPs

......optimal clinical outcomes
......appropriate use
......limit the selection of antimicrobial resistant strains
ASPs are struggling to identify appropriate measures of success; Nevertheless......

Accurate measurement is required before any improvement can take place

**Step-back**....
Can we learn from other programs that have demonstrated the value of their efforts?\(^1\)

*Infection Control, in 2016....*

...*interventions that prevent bloodstream infections can be of high value...specifically;*

– 57% fewer bloodstream infections

– Net savings: $1.85 million/hospital over 3 years\(^2\)

Objectives

1. Review milestones in the emergence of Infection Control Programs (ICPs); focusing on the development of metrics for ICPs.

2. Review Joint Commission’s expectations for ASPs with respect to metrics.

3. Review for ASPs:
   - Commonly recommended process and outcome metrics
   - Selecting process measures and performance metrics to measure the performance of ASP’s interventions.

4. Review knowledge gaps in the area of ASP metrics.
Infection Surveillance and Control Programs (ISCPs)

50+ years... and *still* evolving....
Infection Surveillance and Control Programs (ISCPs)

- **1950s – 60s**
  - *Staphylococcal* pandemic (pcn-resistant *S. aureus*)
    “Antibiotic resistance became a serious problem.”
  - Voluntary formation of Infection Control Programs

- **1960s**
  - CDC recommends regular surveillance
  - Data collection to *inform* rational infection control measures

1960s-70s

Who will fund these programs?

Inadequate evidence to mandate infection control programs

### Study on the Effectiveness of Nosocomial Infection Control (SENIC) Project\(^1,2\) (CDC 1970-76)

<table>
<thead>
<tr>
<th>Infection control program</th>
<th>Outcome Hospital infection rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective(^3)</td>
<td>32% reduction</td>
</tr>
<tr>
<td>Not effective</td>
<td>18% increase</td>
</tr>
</tbody>
</table>

\(^1\) Haley. *Am J Epidemiol* 1985; 121:182. \(^2\) Dixon. *MMWR* 2011; 60:58. \(^3\) “Control index” measures the intensity of efforts to intervene to reduce infection risk. Effective program elements: trained personnel, surveillance, active preventive interventions, regular reporting surgical wound infection rates to surgeons.
THE EMERGENCE OF INFECTION SURVEILLANCE AND CONTROL PROGRAMS IN US HOSPITALS: AN ASSESSMENT, 1976

Use of policies advocated by CDC and other authorities

Process measures
1976

Joint Commission Standard for Infection Surveillance & Control Programs
2017

Joint Commission Standard for 
Antimicrobial Stewardship Programs
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What type of antimicrobial stewardship data should organizations collect, analyze, and report?

...not requiring any specific antimicrobial stewardship data

......the organization must determine the antimicrobial stewardship data it will collect, analyze, and report

Where to start......performance metrics

https://www.jointcommission.org/assets/1/6/New_Antimicrobial_Stewardship_Standard.pdf
Good faith effort to foster *real quality improvement*

*Efforts should not.....*

......create incentives for providers to improve *measured* performance,

...without truly improving *quality* of care

”Not just a “checkbox””

Performance metrics - Imperatives for ASPs

Focus on an area of an ASP that is:

• *Important/problematic* to the organization

• Marked *variation* in practice

• Good evidence to support a practice which can be *simply* measured

Performance metrics – case study

• Piperacillin/tazobactam plus vancomycin
  — associated with a higher risk for nephrotoxicity
  — compared to alternative beta-lactams plus vancomycin\textsuperscript{1,2}

• Commonly used antibiotic regimen

Steps to Quality Improvement\textsuperscript{1,2,3}

WHAT are we trying to accomplish?
Avoid PT-V, promote Cef-V, +/- metro\textsuperscript{4}

WHY is it important?
Nephrotoxicity risk

WHO is the specific target population?
Adult ED and hospitalized patients

WHEN will this be carried out?

HOW will this be carried out?

WHAT is the data source?

Steps to Quality Improvement (cont)

- **WHAT** are our measurable goals?

<table>
<thead>
<tr>
<th></th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>% cases on PT-V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% cases on Cefepime-V, +/- metronidazole</td>
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</tbody>
</table>

- **HOW** will we know our changes are working?
  - Less nephrotoxicity
  - Requires **risk-adjustment** for nephrotoxicity
Steps to Quality Improvement (cont)

• **HOW** do we know if the intervention is harmful?
  (Measure unintended consequences)

• **Omitting** metronidazole when indicated e.g., intra-abdominal infections (cefepime-based)

• **Change in** *C. difficile* **incidence**

• **Rates of super-infection due to** *Enterococcus*, ESBL-producing gram-negatives
### Unintended consequences (cont)

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Unintended consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targeting specific agents</td>
<td>Increase in use of other agents, especially agents with a similar spectrum</td>
</tr>
<tr>
<td>e.g., reduce piperacillin/tazobactam</td>
<td>Increase use of other anti-pseudomonal agents (e.g., cabapenems)</td>
</tr>
<tr>
<td>Surgical prophylaxis&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Increased gentamicin nephrotoxicity</td>
</tr>
<tr>
<td>Replace cephalosporins with gentamicin</td>
<td></td>
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</table>

<sup>1</sup> Weeraporn. Ann Transl Med 2017; 5:100.
Steps to Quality Improvement (cont)

**HOW** completely was the intervention implemented?

\[
\% \text{ implemented} = \frac{\# \text{ cases assessed}}{\text{Total} \# \text{ of cases}} \times 100
\]
Validity of data - alternate reasons for results

Example: Intervention reduces specific antibiotic usage

- Intervention
- Shorter length of stay
- Fewer admissions
- Switch to other antibiotics
  - Assessing overall antibiotic use can help sort this out

Reason for reduction in usage?
Your experience with a Joint Commission survey of your ASP?
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Quality Improvement
Defining key processes for improvement and metrics to monitor performance

Processes
- Interventions
- Quality indicators

Outcomes
Demonstrated linkage to improve outcome

Resources: Process and Outcome Metrics

**Hospitals**

- Core Elements¹
- National Quality Partners Playbook on Antibiotic Stewardship²
- Systematic review of Quality Indicators³

**Nursing Homes**

- Core Elements⁴

**Outpatient**

- Core Elements⁵

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Infection-specific quality indicators

- Pneumonia\textsuperscript{1,2}
- Sepsis\textsuperscript{3}
- Urinary tract\textsuperscript{4}
- Appropriate antibiotic use in hospitalized adults\textsuperscript{5}

**Expert consensus**
- Guideline adherence
- Obtain cultures
- Targeted therapy
- Others

Quality of Antimicrobial Prescribing\textsuperscript{1,2}

- Diagnostic criteria
- Empiric therapy
- Obtain cultures
- Culture-directed therapy
- Redundant regimen\textsuperscript{2}
- IV/PO
- Document indication
- Duration of therapy

\* No consensus on what combination of these metrics constitutes "quality prescribing"

\textsuperscript{1} van den Bosch. *Clin Microbiol Infect* 2016; 888e1. \textsuperscript{2} Schultz. *Infect Control Hosp Epidemiol* 2014; 35:1229.
Test the utility of the quality indicator before widespread adoption\textsuperscript{1,2}

Applicability of generic quality indicators for appropriate antibiotic use in daily hospital practice: a cross-sectional point-prevalence multicenter study

C.M.A. van den Bosch \textsuperscript{1,*}, M.E.J.L. Hulscher \textsuperscript{2}, S. Natsch \textsuperscript{3}, J. Wille \textsuperscript{4}, J.M. Prins \textsuperscript{1}, S.E. Geerlings \textsuperscript{1}

4/11 previously selected quality indicators were not clinically useful metrics

- Low applicability
- Low improvement potential
- Feasibility\textsuperscript{3}

Which intervention (process measure) should be selected?

Tailor interventions to the most important issues at your site
Benchmarking Process Measures
Are there data?
Increased use of policies recommended by CDC and others
“VHA is blazing a trail to improve patient safety through better antibiotic use”

... and working with the CDC to advance the science of using antibiotic use data to guide action

Quality Improvement
Defining key processes for improvement and metrics to monitor performance

Processes
• Interventions
• Quality indicators

Outcomes
Demonstrated linkage to improve outcome

Outcomes\textsuperscript{1,2}

- **Antibiotic use measures**
- **Patient outcomes**
  - Mortality, LOS
  - Infection-related mortality
  - Unintended consequences (eg: \textit{C. difficile})
  - Not showing harm\textsuperscript{3}
  - Conservable antibiotic days\textsuperscript{4}
  - Unplanned readmission\textsuperscript{5}
  - Unnecessary FQ days\textsuperscript{5}
- **Resistance**
- **Cost (value of healthcare)**

Antibiotic use measures

National Healthcare Safety Network (NHSN)

- Antibiotic use (AU)
- Standardized Antimicrobial Administration Ratio (SAAR)
Application of NHSN data
Aggregate data

Helps an organization *focus resources*:

- an antibiotic or class of antibiotics
- that appear to be an outlier
- when compared with other facilities

*Your experiences with NHSN data?*

Antibiotic Use (AU) calculation

\[
AU = \frac{\text{Days of therapy (DOT)}}{\text{Days present}^1 \quad \text{or} \quad \text{Admissions}^2}
\]

1. Number of days patient spent any time in a specific unit or facility
2. Number of patients admitted to an inpatient location in the facility

https://www.cdc.gov/getsmart/healthcare/implementation/core-elements.html
Standardized Antimicrobial Administration Ratio

Risk-adjusted

- Patient mix
- Hospital characteristics

SAAR Value =

\[
\frac{\text{Observed number of abx days}}{\text{Predicted number of abx days}}
\]

1 Each SAAR is an observed to predicted ratio for a combination of antibiotics and patient care locations. SAAR (>1.0) indicates more AU than predicted; i.e., achieves statistical significance (different than 1.0).

2 Statistically estimated from nationally aggregated data.
Application of SAARs

A Novel Metric to Monitor the Influence of Antimicrobial Stewardship Activities

Daniel J. Livorsi, MD, MSc;¹,² Erin O’Leary, MPH;³ Tamra Pierce, PharmD;⁴ Lindsey Reese, MD;⁴ Katharina L. van Santen, MSPH;³ Daniel A. Pollock, MD;³ Jonathan R. Edwards, MStat;³ Arjun Srinivasan, MD³

Prospective audit and feedback program:
• implementation of processes to reduce broad-spectrum agents
• greater involvement of an ID physician

....associated with reduction in SAAR values across multiple antimicrobial categories

Findings consistent with efforts to:

• Encourage the prescription of more narrow-spectrum agents

• Not associated with increased LOS or mortality

Application of NHSN data (Aggregate data) (cont)

Does not:

- Inform about the appropriateness (quality) of antimicrobial prescribing

Outcomes

Patient-specific outcomes
Processes

Demonstrated linkage to improve outcome

Validity of linkage based on:
• scientific literature
• expert panel consensus

Outcomes
Patient-specific

Current evidence on hospital antimicrobial stewardship objectives: a systematic review and meta-analysis


- Clinical outcomes (mortality, LOS)
- Adverse events
- Bacterial resistance rates
- Costs
Quality indicators for appropriateness of antibiotic use

Pre-determined outcomes:

- Clinical outcomes (mortality, LOS)
- Adverse events
- Bacterial resistance rates
- Costs

# Literature search identified 14 quality indicators

<table>
<thead>
<tr>
<th>Source</th>
<th>Comments</th>
<th>Number of Quality Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Expert consensus –</strong>&lt;br&gt;RAND-modified Delphi procedure&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Serial review of the literature &amp; discussion, amongst experts</td>
<td><strong>Examples</strong>&lt;br&gt;• Empirical antibiotic therapy per local guide</td>
</tr>
<tr>
<td><strong>Expert consensus –</strong>&lt;br&gt;Antimicrobial stewardship consensus meetings&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td>• De-escalation&lt;br&gt;• ID Consultation&lt;br&gt;• Others</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<sup>2</sup> Dellit. *Clin Infect Dis* 2007; 44:159 or stewardship guideline development group.
Reviewed studies reporting the impact of the 14 quality indicators, on pre-defined outcomes*

**Inclusion**
- Hospital or long-term facilities, adults
- Randomized or non-RCTs controlled trials, until April 2014
- Interrupted time series
- Observational studies

**Methods**
- Pooled outcome data irrespective of study design or type of disorder
- Analyses to assess the risk for bias

No published data identified of the impact of ASPs for the following.......future study?

**Specific quality indicators (n=5)**

1. Documented antibiotic plan
2. Blood cultures
3. Cultures from the site of infection
4. Local guide in agreement with national guidelines
5. Assessment of patients’ adherence

**Facility type**

Stewardship objectives for long-term care facilities

Remaining quality indicators: (n=9) with data evaluating the impact of ASPs

1. Empirical therapy according to the guidelines*

2. De-escalation of therapy*

3. Formal Bedside consultation by an ID specialist*

Prescribing empirical antibiotic therapy according to guidelines (35% relative risk reduction for mortality)\(^1\)

Primarily for community-acquired pneumonia

---

1 relative risk 0.65, 95% CI 0.54–0.80, \(p<0.0001\). Schuts. *Lancet Infect Dis* 2016; 16:847.
De-escalation of therapy (56% relative risk reduction for mortality\(^1\))

### Study definition

- Change to narrow-spectrum antibiotic or stop antibiotics as soon as culture results are available

### Study design

- Mostly observational data

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\(^1\) RR (risk reduction) 0·44, 95% CI 0·30–0·66, p<0·0001. Schuts. *Lancet Infect Dis* 2016; 16:847.
Bedside ID consultation (66% mortality reduction in S. aureus bacteremia)

Significant RRR of 66% (RR 0.34, 95% CI 0.15–0.75, p=0.008. Schuts. *Lancet Infect Dis* 2016; 16:847.)
Overall, limited, low quality data

ASP’s impact was positive for in >1 outcome
- Therapeutic drug monitoring
- Switch from IV to oral therapy
- Use of a list of restricted antibiotics

ASP’s impact was less clear
- Adjusted of therapy per renal function
- Discontinuation of antibiotic therapy if infection is not confirmed
- Presence of a local guide

Limitations

• **Interventions assessed separately**
  – Interventions are generally bundled (in practice)
  – Combined effect of meeting several interventions could be greater than that of meeting one

*Randomized* multi-hospital trials needed:

Test the effectiveness of interventions on achieving **meaningful** stewardship outcomes

Comprehensive summary

- **Interventions** likely to be good starting points for any healthcare system:
  - adherence to guidelines
  - de-escalation of therapy

- Identified **gaps in data** linking interventions to practical outcomes

C. difficile infection
(Lancet Infect Dis; 2017)

Process

Demonstrating linkage to outcome

Outcomes
Effects of control interventions on *Clostridium difficile* infection in England: an observational study

**Conclusion:**

...restriction of fluoroquinolone prescribing, above other interventions

...appears to explain the decline in incidence of *C. difficile* infections
National incidence of *C. difficle* infections and FQ prescribing

**National recommendation (2007)**
- Avoid clindamycin and cephalosporins
- Minimize use of fluoroquinolone, carbapenem and aminopenicillin
- Improved infection prevention and control activities

Why did *C. difficile* infection decrease? (Two hypotheses)

1. If declines were driven by reductions in use of particular antibiotics then:
   then the incidence of *C difficile* infection caused by resistant isolates should decline faster than that caused by susceptible isolates across several genotypes.

2. If declines were driven by improvements in hospital infection control then:
   transmitted (secondary) cases should decline regardless of susceptibility.

Methods /definitions

• **Whole genome sequences:**
  – clinical *C. difficile* isolates from symptomatic, unique patients during 2006-2013, (n=2021)
  – only sequence type, (n=261 isolates)

• **Nosocomial transmission = subsequent infections from closely genetically related isolates**

Whole genome sequence data suggests:

- FQ restriction plausibly played the most important part in the decline of *C. difficile* infection
Incidence of *C. difficile* infection only fell for secondary cases caused by FQ-resistant isolates.
Limitations

• Retrospective, quasi-experimental study

Nevertheless, these findings are compelling, and consistent with other data....

Antimicrobial Optimization Reduces *C. difficile* infection

Quality Improvement

Processes

**Value in healthcare**
- Better quality *plus*
- Lower costs

Demonstrated linkage to improve outcome

Outcomes

• 57% fewer bloodstream infections
• Net savings in the millions…. 

...can be of high value

• Reimbursement based on *quality* of care

• **ASPs must:**
  - expand beyond measures linked to cost and utilization

Regulatory of Quality Improvement Organizations

ASPs can demonstrate value to administrators by:

Optimizing their hospital’s compliance with relevant national quality indicators

• **Aggregate NHSN antibiotic measures** can be used by hospitals to:
  
  – identify antibiotics (or classes) that are outliers (compared to similar organizations)
  
  – does not inform on the quality of antibiotic use
Performance metrics

Identify important/problematic areas...

- **WHAT** are we trying to accomplish?
- **WHY** is it important?
- **WHO** is the specific target population?
- **WHAT** are our measurable goals?
- **HOW** will we know our changes are working?
- **HOW** do we know if the intervention is harmful?
- **HOW** completely was intervention implemented?
- **VALIDITY** of data - alternate reasons for results

Summary...for now....
Finally, more studies....

• Link between ASP interventions (processes) and improved patient outcomes

• Value of ASPs
  – Health outcomes achieved per dollar spent

11 years after infection control programs were mandated by the Joint Commission.....

Editorial
INFECTION CONTROL 1987/Vol. 8, No. 6

Peter C. Fuchs, MD, PhD

Will the Real Infection Rate Please Stand?
Acknowledgements

- Onofre Donceras, RN (Infection Control) ¹
- David Schwartz, MD (Infectious Diseases) ¹

¹ John H. Stroger Jr. Hospital of Cook County
Questions / comments?

Your experiences with:
Joint Commission Survey?
NHSN usage measures?