The Short and Long of Measurement in Antibiotic Stewardship

Whitney Buckel, PharmD, BCPS-AQ ID
Infectious Diseases/Antimicrobial Stewardship
Intermountain Medical Center

Disclosures

• No relevant disclosures
• Planning committee member for the Society of Healthcare Epidemiology of America’s Antimicrobial Stewardship Research Workshop with honoraria from Merck
Objectives

By the end of this presentation, the learner should be able to:

• Categorize quality measures into structure, process, and outcome metrics
• Design a plan to measure your antimicrobial stewardship intervention by following the main steps in collecting, analyzing, and utilizing data
• Propose two different approaches to viewing antibiotic use data to assess your antibiotic stewardship program

What is Measurement?

Merriam-Webster insight

measure
:to find out the size, length, or amount of (something)
:to judge the importance, value, or extent of (something)
Why Measure?

Intrinsic
- Am I making a difference?
- Has my intervention “worked”?
- Are there additional areas for improvement?

Extrinsic
- Justification for current or additional resources
- Documentation for The Joint Commission

“Measures are not definitive but act as a focus for the commencement of review and should act as a stimulus for change.”

Types of Quality Measures

- **Structure measures**
  - Definition: assess the characteristics, components and activities of the stewardship program
  - Examples:
    - Designation of an antibiotic stewardship program leader
    - Implementation of policies and procedures
    - Tracking of antibiotic use
    - Provision of antibiotic education
In-Depth Example

The Joint Commission Medication Management Standard

https://www.jointcommission.org/assets/1/6/New_Antimicrobial_Stewardship_Standard.pdf

Types of Quality Measures

• Process measures
  – Definition: surrogate endpoints in the treatment of infectious diseases, or data describing the activities of a stewardship program
  – Examples:
    • Adherence to institution-specific guidelines or bundle
    • Duration of antimicrobial therapy
    • Number of blood cultures reviewed by the ASP
    • Approval rate of requests for restricted antibiotics
    • Days of therapy per 1,000 patient days present
In-Depth Example

Prospective Audit and Feedback Documentation

Auto-calculated percentages in summary section
• For feasibility and ongoing sustainability, decided to only list specific interventions
• Accepted interventions: need to decide if this is a verbal acceptance, or if follow up is done to confirm intervention carry through

Types of Quality Measures

• Outcome measures
  – Definition: patient outcomes, unintended consequences/adverse effects, and the emergence of antibiotic resistance
  – Examples:
    • Infection-related mortality
    • *Clostridium difficile* rates
    • Antibiotic resistance rates
    • Length of hospital stay
    • Drug and hospitalization costs
In-Depth Example

Evaluation of a new protocol for acute ruptured appendicitis one-year after implementation

<table>
<thead>
<tr>
<th></th>
<th>Prior Protocol N=154</th>
<th>New Protocol N=152</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of stay, hours, mean (SD)</td>
<td>134 (66) hours</td>
<td>95 (62) hours</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cost of care, US dollars, mean (SD)</td>
<td>13,610 (6859)</td>
<td>9,879 (5,670)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Inpatient readmission, n (%)</td>
<td>13 (8%)</td>
<td>9 (6%)</td>
<td>NS</td>
</tr>
<tr>
<td>Observation readmission, n (%)</td>
<td>3 (2%)</td>
<td>15 (10%)</td>
<td>0.003</td>
</tr>
<tr>
<td>Reoperation, n (%)</td>
<td>3 (2%)</td>
<td>4 (3%)</td>
<td>NS</td>
</tr>
<tr>
<td>Abdominal abscess, n (%)</td>
<td>8 (5%)</td>
<td>2 (1%)</td>
<td>NS</td>
</tr>
</tbody>
</table>


Quiz Question

Which of the following pairs is correct?
A. Antibiotic use trends :: Outcome measure
B. Treatment guideline :: Process measure
C. Clostridium difficile rates :: Structure measure
D. Duration of therapy :: Process measure
Quiz Question

Which of the following pairs is correct?

A. Antibiotic use trends :: Outcome Process measure
B. Treatment guideline :: Process Structure measure
C. Clostridium difficile rates :: Structure Outcome measure
D. Duration of therapy :: Process measure

Process for Measuring Your Stewardship Program

General approach (not disease-specific)
Process Overview

• Collecting Data
• Analyzing Data
• Utilizing Data

For every minute spent organizing, an hour is earned.
~ Benjamin Franklin

You will never be completely ready. Start from wherever you are.
~ C.J. Hayden, MCC

NEDARC.org (Tutorials)

Collecting Data

1. Define your needs

Ask yourself:
• Who is your audience?
• Which quality measures?

Check Out: The Improvement Guide by Gerald Langley, Ronald Moen, Kevin Nolan, Thomas Nolan, Clifford Norman and Lloyd Provost

NEDARC.org (Tutorials)
### Review of Consensus Statements

<table>
<thead>
<tr>
<th>Intent</th>
<th>Criteria</th>
<th>Metrics</th>
<th>Ref</th>
</tr>
</thead>
</table>
| External accountability and internal quality improvement efforts | (1) Scientific merit  
(2) Burden and impact  
(3) Accountability | Accountability: 2  
Quality improvement: 5 | 1 |
| Structure and process indicators to assess and compare stewardship programs across hospitals | (1) Feasibility  
(2) Clinical importance  
(3) Relevance to minimizing antimicrobial resistance | Infrastructure: 7  
Policy and practice: 4  
Monitoring and feedback: 6 | 2 |
| Metrics most pertinent for internal ASP decisions | (1) Improved prescribing  
(2) Improved patient care  
(3) Targeting efforts  
(4) Feasibility | Clinical outcomes: 0  
Unintended consequences: 3  
(4) Utilization: 2  
Process measures: 1 | 3 |


### Review of Consensus Statements

<table>
<thead>
<tr>
<th>Intent</th>
<th>Criteria</th>
<th>Metrics</th>
<th>Ref</th>
</tr>
</thead>
</table>
| Internal quality management and external quality assessment | (1) Relevance  
• Clinical  
• Economical  
(2) Presumed practicality  
• 6 subcategories | Structure: 21  
Process: 21 | 1 |
| Develop generic indicators for appropriate antibiotic use for all hospitalized patients with bacterial infections | (1) Health gain, care efficiency or less resistance  
(2) Generalizable to all adults with infections  
(3) Sufficient scientific evidence or expert consensus | Structure: 2  
Process: 9 | 2 |

Review of Consensus Statements
Process and Outcome Measures

Included in four consensus statements:
1) Days of therapy (DOT) per 1,000 patient days
   – Or Defined Daily Doses (DDD)

Included in more than one consensus statements:
1) Rate of drug-resistant infections
2) *Clostridium difficile* infection incidence
3) Appropriate blood culturing prior to systemic antibiotics
4) Frequency of prompt dose adaptation for renal dysfunction
5) Percent initial therapy in accordance with local guidelines
6) 30-day readmission rates
7) Days of excess or avoidable antibiotic use

Consensus Statements
My Take Home

Antimicrobial Stewardship Program Strategy

<table>
<thead>
<tr>
<th>Program Age</th>
<th>Goals</th>
<th>Metrics (S: structure; P: process; O: outcome)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3 years</td>
<td>• Small wins</td>
<td>• S: Infrastructure</td>
</tr>
<tr>
<td></td>
<td>• Demonstrate value</td>
<td>• P: Antibiotic use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• O: <em>C. difficile</em> incidence</td>
</tr>
<tr>
<td>3 – 6 years</td>
<td>• Sustainability</td>
<td>• S: Guideline development</td>
</tr>
<tr>
<td></td>
<td>• New areas of impact</td>
<td>• P: Guideline adherence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• O: 30-day readmission</td>
</tr>
<tr>
<td>7+ years</td>
<td>• Advanced interventions</td>
<td>• S: Annual report</td>
</tr>
<tr>
<td></td>
<td>• Validate new metrics</td>
<td>• P: Appropriateness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• O: Adverse events</td>
</tr>
</tbody>
</table>
Collecting Data

1. Define your needs
2. Clearly define the project

Ask yourself:
• Which units/locations do you want to include?
• Which patient populations are your focus?
• What are your current baseline rates?
• How much time do you have to spend on this?
• What is your data hypothesis?

Collecting Data

2. Clearly define the project
3. Identify the data sources

Ask yourself:
• How is this information coded?
• How can you retrieve this data?
• Is it a manual or automated process?
Collecting Data

3. Identify the data sources

4. Plan how to store the data
   • Create a data dictionary
   • Choose a storage method
     – e.g. Excel, Access, REDCap, Tableau, paper
   • Ensure HIPAA compliance
   • Invest in a way to backup your data
   • Create quality control and edit checks

Collecting Data

4. Plan how to store the data

5. Choose your project design

Ask yourself:
• Descriptive or predictive?
• Retrospective or prospective?
• What is the timeline of your project?
• If it’s pre-intervention, plan staged roll out?
• Any pre-intervention education required?
Collecting Data

5. Choose your project design
6. How to collect the data
   • Who will collect the data? How often?
   • Develop your data collection tool
   • Balance completeness with essentialism
   • If this is a manual process, less is more

NEDARC.org (Tutorials)

Collecting Data

6. How to collect the data
7. Consult experts & test data collection tool
   • Consult with colleagues and experts
   • Pilot your tool or run a test data query
   • If multiple data collectors, educate on, assess for, and ensure similar processes

NEDARC.org (Tutorials)
Collecting Data

1. Define your needs
2. Clearly define the project
3. Identify the data sources
4. Plan how to store the data
5. Choose your project design
6. How to collect the data
7. Consult experts & test data collection tool

8. Start collecting your data!

NEDARC.org (Tutorials)

Analyzing Data

1. Assess your data

   • Check for consistency
   • Check for completeness
   • Check for duplications
   • Request data dictionary
   • Save original file in a safe place

NEDARC.org (Tutorials)
Analyzing Data

1. Assess your data
2. Validate the data
   - Ask yourself, does this make sense?
   - Check min, max, mean, median for continuous variables
   - Check for non-acceptable or missing answers for categorical variables

NEDARC.org (Tutorials)

Analyzing Data

1. Assess your data
2. Validate the data
3. Clean the data
   - Discover the scope of the problem
   - Fix errors
   - Prevent future errors, if possible

NEDARC.org (Tutorials)
Analyzing Data

1. Assess your data
2. Validate the data
3. Clean the data
4. Plan your analysis
   • Pre/post analysis
   • Trend lines, interrupted time series analysis
   • Aggregate data monthly vs quarterly
   • Are there important subgroups to analyze?

NEDARC.org (Tutorials)
Analyzing Data

1. Assess your data
2. Validate the data
3. Clean the data
4. Plan your analysis
5. Do your analysis
6. Create the initial report

- Did you find what you expected?
- Anything jump out?
- Initial interpretation?

NEDARC.org (Tutorials)
Utilizing Data

1. Define your goal for communicating

Ask yourself:
• What did I learn?
• What is my primary message?
• What would I like to see happen?

2. Determine your target audience

Likely multiple targets for stewardship:
• Those on your stewardship team
• Those impacted by your stewardship program, such as frontline clinicians
• Those who financially support you (grants and/or your local administration)
Utilizing Data

2. Determine your target audience

3. Choose the communication method(s)

- Different audience needs different approach
  - How much detail would your audience want?
  - What’s the easiest way to communicate?
  - What does your audience care most about?
- Options include: fact sheets, newsletter, reports, online summaries, presentations

The Stewardship Audience

Perceived Most Important by Position

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Hospital Administrator</th>
<th>Pharmacy Director</th>
<th>P&amp;T Committee</th>
<th>ID Physician</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibiotic Use</td>
<td>1 (2)</td>
<td>9 (22)</td>
<td>13 (32)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Antibiotic Cost</td>
<td>17 (42)</td>
<td>23 (56)</td>
<td>6 (15)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Appropriateness</td>
<td>2 (5)</td>
<td>2 (5)</td>
<td>6 (15)</td>
<td>11 (27)</td>
</tr>
<tr>
<td>Infection-related mortality</td>
<td>1 (2)</td>
<td>2 (5)</td>
<td>1 (2)</td>
<td>15 (37)</td>
</tr>
<tr>
<td>Infection or antibiotic-related length of stay</td>
<td>2 (5)</td>
<td>0 (0)</td>
<td>1 (2)</td>
<td>3 (7)</td>
</tr>
</tbody>
</table>

Utilizing Data

3. Choose the communication method(s)

4. Adopt good communication principles
   - Write for your audience
   - Make it visually appealing (font, space, color)
   - Make it readable (clear and concise)
   - Make it credible (organization logo, contact information, references, honest, accurate)

NEDARC.org (Tutorials)

Utilizing Data

4. Adopt good communication principles

5. Communicate numbers effectively
   - Include titles, legends, and labels for charts
   - Simplify images as much as possible
   - Convert numbers into words
   - Don’t overstate your results

Some tips (NOTE: these are challenging!):

Check Out: Show Me the Numbers by Stephen Few

NEDARC.org (Tutorials)
Utilizing Data

5. Communicate numbers effectively

6. Provide a take home message
   • State the conclusion
   • Provide possible recommendations based on your findings
   • Suggest an action, if appropriate

NEDARC.org (Tutorials)
Quiz Question

Which of the following should be considered when designing your antibiotic stewardship measurement plan?

A. Relevance to your target audience
B. Feasibility to collect and analyze
C. Impact on antibiotic resistance
D. All of the above!
Approaches to Antibiotic Use Data

Highlighting Specific Examples

Aggregated Antibiotic Data (Pre/Post)

Comprehensive evaluation pre and post full ASP implementation in February 2010 at a 39-bed Veterans Affairs Health Care System in Fargo

Table 1. Usage of the top five antibiotics: 2008 vs 2010

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>2008 (N=1,432)</th>
<th>2010 (N=1,935)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total no. of patients on specific antibiotic (%)</td>
<td>DDD/ 1,000 patient bed days</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>149 (10.4)</td>
<td>75.9</td>
</tr>
<tr>
<td>Piperacillin/tazobactam</td>
<td>118 (8.2)</td>
<td>92.1</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>122 (8.5)</td>
<td>80.5</td>
</tr>
<tr>
<td>Ciprofloxacine</td>
<td>95 (6.6)</td>
<td>38.6</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>26 (1.8)</td>
<td>22.3</td>
</tr>
</tbody>
</table>

Note: DDD = defined daily dose; N = number of patients admitted during interval.
*Statistically significant, P < .05, chi-square test.

Antibiotic Use Pre/Post: Things To Know

- Less information available to understand the impact of the intervention
  - E.g., if antibiotic use was increasing prior to ASP implementation, and decreased after ASP implementation, a pre/post assessment may falsely conclude the ASP had no intervention
- Other considerations:
  - Unable to tell if effect was immediate or gradual
  - Unable to tell if effect has been sustained
  - Was there an outbreak impacting antibiotic use?
  - What was the fidelity to the stewardship intervention?

Antibiotic Use Trends Over Time

Time series analysis before and after ASP implementation in July 2008 at a 525-bed teaching hospital in Denver

Figure 3: Use of agents with activity against *Pseudomonas aeruginosa* before (closed markers) and after (open markers) implementation

Antibiotic Use Trends: Things To Know

- The trend cannot continue to go down
  - We know the goal cannot be zero
  - Therefore, the slope cannot indefinitely decline
- This has statistical and practical implications
- Other considerations:
  - Unit of time? (depends on the event frequency)
  - How far back to collect data? (time = power)
  - Is there a lagged effect?
  - Is the intervention constant?
  - Have methods changed over time?
  - Are there confounders? E.g., drug shortages?
  - Can you find a control group?

Antibiotic Use Benchmarking

- 70 academic medical centers
- Broad range of antibiotic use (days of therapy = DOT)
  - Observed: 600 – 1100 DOT per 1,000 patient days
  - Example O:E ratio of 1.44
    - Observed 1101 DOTs/1,000 patient-days
    - Expected 763 DOTs/1,000 patient-days
- Clinical service line impacts antibiotic use
  - 14% of psychiatry patients received an antibiotic
  - 100% of liver transplant patients received an antibiotic

Antibiotic Use Benchmarking

LOT = length of therapy

Antibiotic Use Benchmarking: Things To Know

- No external goal for antibiotic use exists
  - However, we know the goal cannot be zero
- Metric benchmarking of antibiotic use can compare hospitals
  - Does not determine appropriateness of antibiotic use
  - Provides information on outliers
    - Outliers may represent inappropriate prescribing
    - High performers can be used to identify best practices
    - Need to adjust for confounding factors using statistical procedures to be most useful
### Advantages and Barriers to Benchmarking

#### Advantages
- Identify strengths and weaknesses
- Realize what level(s) of performance is possible
- Establish new standards and goals
- Stimulate continuous quality improvement
- Drive innovative ideas and practical solutions

#### Barriers
- Time and cost constraints
- Competitive barriers
- Lack of management commitment and professional human resources
- Resistance to change
- Short-term expectations


---

### NHSN AUR Option Overview

The Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN) Antibiotic Use and Resistance (AUR) Option

#### National Objectives
1. Monitor and improve antimicrobial prescribing
2. Identify, understand, and respond to antimicrobial resistance patterns or trends

- First real AU data uploaded into NHSN in July 2012
- As of June 2017, 314 facilities submitted at least 1 month of data
NHSN AU Option Details

- Currently voluntary participation
- Data are based on:
  - Medication administration data (not billing data) and
  - Admission/Discharge/Transfer (ADT) systems
- All data must be submitted electronically
- Metric:
  - Numerator: Days of Therapy per
  - Denominator: 1,000 Patient Days Present

Standardized Antibiotic Administration Ratio (SAAR)

- First attempt at antibiotic use benchmarking
  - Similar to the Standardized Infection Ratio
  - Observed antibiotic use compared to predicted use
- Risk adjusted by facility and location characteristics
  - Presence of ICUs, hospital size, teaching status, ward type
- Endorsed by the National Quality Forum
  - For public health surveillance and quality improvement
**CDC Spectrum Definitions**

<table>
<thead>
<tr>
<th>Broad spectrum agents predominantly used for</th>
<th>Anti-MRSA agents</th>
<th>Agents predominantly used for surgical site infection prophylaxis</th>
</tr>
</thead>
<tbody>
<tr>
<td>hospital-onset/ multi-drug resistant bacteria</td>
<td>community-acquired infection</td>
<td>ceftaroline dalba/oritavancin daptomycin line/tidezolid quinu/dalfopristin, telavancin vancomycin IV</td>
</tr>
<tr>
<td>aminoglycosides imi/meropenem cefepime/cefazidime β-lactam/βLis (PsAr) aztreonam colistin/polymyxin tigecycline</td>
<td>ertapenem cefotaxime ceftriaxone ciprofloxacin levofloxacine moxifloxacine</td>
<td>cefazolin cefotetan cefotaxime IV</td>
</tr>
</tbody>
</table>

**The SAARs Currently Available**

<table>
<thead>
<tr>
<th>All antimicrobials</th>
<th>Medical and surgical ICUs and wards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimicrobials for hospital-onset/ multi-drug resistant infections</td>
<td>M/S ICUs</td>
</tr>
<tr>
<td>Antimicrobials used for community-onset infections</td>
<td>M/S ICUs</td>
</tr>
<tr>
<td>Anti-MRSA antimicrobials used</td>
<td>M/S ICUs</td>
</tr>
<tr>
<td>Antimicrobials used for surgical site infection prophylaxis</td>
<td>Medical and surgical ICUs and wards</td>
</tr>
</tbody>
</table>

SAAR: Standardized Antibiotic Administration Ratio
Three-Year Facility-wide Antibiotic Use within Intermountain

![Graph showing antibiotic use across different hospitals and years.]

Floor Types in Small Hospitals

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Licensed Beds</th>
<th>Total Patient Days</th>
<th>Medical/Surgical Days</th>
<th>Intensive Care Unit Days</th>
<th>Pediatric Days</th>
<th>Other Days*</th>
</tr>
</thead>
<tbody>
<tr>
<td>S11</td>
<td>146</td>
<td>44,174</td>
<td>13,976 (32%)</td>
<td>3,351 (8%)</td>
<td>4,619 (10%)</td>
<td>22,228 (59%)</td>
</tr>
<tr>
<td>S14</td>
<td>97</td>
<td>33,319</td>
<td>8,082 (24%)</td>
<td>802 (2%)</td>
<td>8,609 (10%)</td>
<td>21,435 (64%)</td>
</tr>
<tr>
<td>S6</td>
<td>89</td>
<td>27,491</td>
<td>11,363 (41%)</td>
<td>1,895 (7%)</td>
<td>4,677 (17%)</td>
<td>9,556 (35%)</td>
</tr>
<tr>
<td>S10</td>
<td>71</td>
<td>23,448</td>
<td>8,913 (38%)</td>
<td>933 (4%)</td>
<td></td>
<td>13,625 (58%)</td>
</tr>
<tr>
<td>S1</td>
<td>48</td>
<td>13,642</td>
<td>7,785 (57%)</td>
<td>1,591 (13%)</td>
<td></td>
<td>2,346 (20%)</td>
</tr>
<tr>
<td>S25</td>
<td>24</td>
<td>10,118</td>
<td>6,991 (69%)</td>
<td>4,827 (40%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- A significant proportion of patient days present were in labor & delivery, maternity, nursery and psychiatry units (Other Days*)
Facility Level – Excluding “Other”

Baseline Trend in 15 Small Hospitals
Baseline Trends in 4 Large Hospitals

Monthly Antimicrobial Usage Rate
Hospital-Large

Intermountain AU Dashboard

- We send out NHSN AU data which allows comparisons between facilities
- Monthly email to physician, pharmacist and business administrators
- Goal: “To keep you better informed and provide data that you can use to identify areas within your hospitals that may need further assessment of antibiotic prescribing.”
Survey of Our Dashboard

- Randomly selected recipients of our antibiotic use dashboard invited for a 20-minute telephone or in-person interview
- Administrators, physicians, and pharmacists
- Examples of great feedback we received:
  - Add note that data do not include the emergency department
  - Change the color scheme to a value neutral set
  - Include raw numerator and denominator data
  - Create a training asset or guidance document on how to use
  - Add cost data to panel or dashboard (administrator request)
  - Is there a way to display what the target is (plan to add SAAR data)
Limitations of Antibiotic Use

• NOT outcome measure
• Does not address number or percent of patients treated
• Surrogate endpoint
  — Is it ‘irrational’ or ‘inappropriate’ antibiotic prescribing?
• Benchmarking antibiotic use data
  — Attempts to adjust for known variables that influence use
    • High level data – teaching status, presence of an ICU
    • More challenging to account for diagnostic or microbiologic differences between hospitals
  — Helps identify outlier areas for further investigation

“Put simplistically, the DDDs [or DOTs] per 1000 bed days unit is unable to distinguish between a few patients getting a lot of antibiotic and a lot of patients getting a little antibiotic, nor between a small number of long-stay patients and a large number of short-stay patients.”

Antibiotic Appropriateness

• No standard exists
• Significant reviewer variability
• The need is there – the next frontier
• European Consensus Statements
• CDC resources available:
  – Inpatient assessment tools for UTI, CAP, resistant gram-positive infections and inpatient antibiotics
  – [www.cdc.gov/getsmart/healthcare/implementation.html](http://www.cdc.gov/getsmart/healthcare/implementation.html)

Conclusion

• Measure the impact of your stewardship program
• Choose structure, process and outcome measures
• Feasibility should be a main consideration
• Regularly assess and validate your data
• Communicate your findings, tailor your message
• Consider different approaches for displaying antibiotic use data
Additional Reading

Show Me the Numbers by Stephen Few

The Improvement Guide by Gerald Langley, Ronald Moen, Kevin Nolan, Thomas Nolan, Clifford Norman and Lloyd Provost

The Short and Long of Measurement in Antibiotic Stewardship

Whitney Buckel, PharmD, BCPS-AQ-ID
Infectious Diseases/Antimicrobial Stewardship
Intermountain Medical Center