Antibiotic Stewardship Metrics: How do you measure up?

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Objectives and Disclosures

1. Define metrics that can be used to measure antibiotic utilization
2. Define metrics that can be used to measure an antibiotic stewardship program’s performance
3. Describe the strengths and weaknesses of these metrics

I have no disclosures
What do the CDC Core Elements Say About Measuring Antibiotic Use?

<table>
<thead>
<tr>
<th>Category</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute care</td>
<td>Measurement is critical to identify opportunities for improvement and assess the impact of improvement efforts (87). For antibiotic stewardship, measurement may involve evaluation of both process (Are policies and guidelines being followed as expected?) and outcome (Have interventions improved antibiotic use and patient outcomes?).</td>
</tr>
<tr>
<td>Long term care</td>
<td>Provide regular feedback on antibiotic use and resistance to prescribing clinicians, nursing staff and other relevant staff</td>
</tr>
<tr>
<td>Critical access hospitals</td>
<td>Days of therapy is considered the most useful measure of antibiotic use to inform stewardship efforts. Facilities can electronically capture, analyze and benchmark days of therapy through the CDC’s AU option. Tracking adherence to treatment recommendations and performance of interventions such as antibiotic time-outs can be useful to further guide quality improvement efforts. In addition, small and critical access hospitals are well positioned to monitor antibiotic use at the provider level.</td>
</tr>
<tr>
<td>Outpatient</td>
<td>Monitor antibiotic prescribing practices and offer regular feedback to clinicians, or have clinicians assess their own antibiotic prescribing practices themselves.</td>
</tr>
</tbody>
</table>

What Do Other Organizations Say About Measuring Antibiotic Use?

<table>
<thead>
<tr>
<th>Organization</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDSA/SHEA (2016)</td>
<td>We recommend measuring antibiotic costs based on prescriptions or administrations instead of purchasing data (good practice recommendation).</td>
</tr>
<tr>
<td>Joint Commission</td>
<td>The organization collects and analyzes data on its antimicrobial stewardship program, including antimicrobial prescribing and resistance patterns</td>
</tr>
<tr>
<td>DNV</td>
<td>No info available</td>
</tr>
<tr>
<td>Leap Frog</td>
<td>Does your facility monitor antibiotic use (consumption) at the unit, service, and/or facility wide?</td>
</tr>
<tr>
<td>US News and World Report [Children’s Hospital Ranking]</td>
<td>At least 0.2 FTE support for a dedicated analyst to support ASP program</td>
</tr>
</tbody>
</table>


Antibiotic Metrics 101
Measuring antibiotic use

Financial Metrics

Defined daily dose per 1,000 patient days

Days of therapy per 1,000 patient days

Days of therapy per 1,000 days present (AU – CDC)

Accurate reflection of actual antibiotic utilization
Financial Metrics

- Antibiotic cost per patient day (inpatient only)
- Antibiotic cost per adjusted patient day (inpatient + outpatient)
- Antibiotic cost (%) to total drug budget
- Total spend
- Wastage - % wastage for specific drugs
- Antibiotic cost per discharge
- CMI adjusted __fill in the blank __
- Cost per MS DRG (ID related)
- Cost per length of stay
- Cost due to readmissions
Financial Metrics

COST = UTILIZATION X PRICE

Cost influencers
- Inventory builds or burns
- DSH (inpatient)
- 340B (outpatient)
- Generic launches
- Drug shortages

<table>
<thead>
<tr>
<th>Year</th>
<th>Price per dose</th>
<th>Total Spend</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>$335</td>
<td>$335,000</td>
</tr>
<tr>
<td>2012</td>
<td>$300</td>
<td>$300,000</td>
</tr>
<tr>
<td>2013</td>
<td>$200</td>
<td>$200,000</td>
</tr>
<tr>
<td>2014</td>
<td>$125</td>
<td>$125,000</td>
</tr>
<tr>
<td>2015</td>
<td>$ 75</td>
<td>$ 75,000</td>
</tr>
</tbody>
</table>

Annual Purchases: 1000 doses
Defined Daily Dose

Standardized definition of daily antibiotic dose
Created by the World Health Organization
Correction factor: $\frac{\text{Total Units (i.e. mg) Drug}}{\text{DDD Correction Factor}}$

Pros:
- Attempts to convert raw purchasing data into utilization data
- Allows comparisons with other institutions
- Easy to calculate

Cons:
- Not everyone agrees with the DDDs – International vs US
- Many use institution-specific correction factors (prescribed daily dose)
- Not patient level information
<table>
<thead>
<tr>
<th>ATC code</th>
<th>Name</th>
<th>DDD</th>
<th>U</th>
<th>Adm.R</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>J01CR05</td>
<td>piperacillin and enzyme inhibitor</td>
<td>14</td>
<td>g</td>
<td>P</td>
<td>Refers to piperacillin</td>
</tr>
</tbody>
</table>

List of abbreviations

Last updated: 2009-10-27
Calculating the DDD

Levofloxacin

• Dose varies in US – 250mg, 500mg, or 750mg daily
• Available in IV or PO
• Let’s say you get a report of levofloxacin 750mg use for the month of January and you have given 300 doses of levofloxacin 750mg IV and 150 doses of 500mg PO

• What is the total DDD?

https://www.whocc.no/atc_ddd_index/

O= Oral ; P= Parenteral
Calculating Levofloxacin DDD

<table>
<thead>
<tr>
<th>Dose</th>
<th>Route</th>
<th>Total Dispensed</th>
<th>Total amount (mg)</th>
<th>Total amount (grams)</th>
<th>WHO DDD</th>
<th>Levo DDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>500mg</td>
<td>PO</td>
<td>150</td>
<td>75000</td>
<td>75</td>
<td>0.5</td>
<td>150</td>
</tr>
<tr>
<td>750mg</td>
<td>IV</td>
<td>300</td>
<td>225000</td>
<td>225</td>
<td>0.5</td>
<td>450</td>
</tr>
</tbody>
</table>

Typically expressed per 1000 patient days

= (DDD/pt days) x 1000

Levo- floxacin  | Route | DDD | Total patient days | DDD/1000 pt days |
----------------|-------|-----|--------------------|------------------|
500mg PO       | 150   | 7,500 | 20                |
750mg IV       | 450   | 7,500 | 60                |
Lessons learned from calculating DDDs

• It’s not perfect
• It’s not always straightforward
  • Combination products are tricky
    – Piperacillin /tazobactam = only count piperacillin (14g)
• Drugs dosed in other units besides grams can be a challenge
  – If low use, consider counting doses vs units
• Using alternate correction factors matters less if you are comparing yourself to yourself
• If all you have is purchase data, you can still calculate it – use units purchased
Days of Therapy

Aggregate sum of days for which any amount of specific antimicrobial agent was administered to individual patients

Obtained from electronic medication administration record (eMAR) or bar code medication administration (BCMA) data
Days of Therapy per 1,000 patient days

- Total days of vancomycin 1 gm every 12 hours = 20
- Total days of vancomycin 1 gm every 24 hours = 30
- Total days of vancomycin 750 mg every 24 hours = 10
- Total days of vancomycin therapy this month = 60
- Total patient days = 500

$$\text{DOT} = \frac{\text{Vancomycin days}}{\text{patient days}} \times 1000$$

$$\text{DOT} = \frac{60}{500} \times 1000$$

$$\text{DOT} = 120 \ \text{DOT/1000 patient days}$$
**DDD vs DOT**

**Pros:**
- Standard comparisons using aggregate utilization data
- Will change estimate of drug use if high doses are used, but standard is not changed

**Cons:**
- Not a surrogate for DOT when dose is different than standard:
  - Cannot be used for: children, renal dysfunction
- DDD can change with time

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**Pros:**
- Can be used in children
- Not influenced by changes in the DDD standards
- Not subject to differences in institutional preference
- Patient-specific information

**Cons:**
- Overestimates use for drugs given multiple times per day
- More difficult to measure without computerized records

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Slide courtesy of Libby Dodds Ashley, PharmD, MHS, FCCP, BCPS - DASON
DDD vs. DOT

Other Common Denominators

**Admissions**
CDC Definition: The aggregate number of patients admitted to the facility starting on the first day of each month through the end of the calendar month

**Discharges**
Excludes patients who expire in the hospital
Also should exclude healthy newborns

**Case Mix Index Adjusted**
Commonly used in hospital systems to account for variations in location acuity
Other Utilization Metrics

DOT/1000 patient days present (AU)
IV to PO Percentage or Percentage PO
LOT/1000 pt days

Number of patients on antibiotics
- Day
- Per Visit

DOT = Days of Therapy
LOT = Length of Therapy
Long Term Care

Tracking: Data Sources for Tracking Antibiotic Use

- Monitor antibiotic use and health outcomes to guide practice changes
  - Antibiotic Use Reports can be obtained from:
    - Long-term Care (LTC) Pharmacies: dispense and deliver medications, provide drug regimen reviews and clinical consulting, can provide antibiotic use reports.
    - Electronic Health Record Systems (EHR): interface and capability of different EHR systems can vary by facility, can provide accurate antibiotic use reports.
    - Manual Chart Review: may be only the possible way to collect antibiotic use data in some facilities.
Long Term Care

Tracking: Antibiotic Use Measures

- **Antibiotic starts:**
  - Many nursing home IPC programs track new antibiotic starts as part of their infection surveillance activity.
  - Antibiotic starts may be a better measure to track the effect of stewardship initiatives designed to educate prescribers on situations when antibiotics are not appropriate.

- **Antibiotic days of therapy (DOT):**
  - Multiple antibiotic orders can be found in the LTC pharmacy or EHR systems for every antibiotic course, tracking DOT may be easier and more accurate when using those data sources.
  - Antibiotic DOT may be a better measure to track changes in antibiotic use over time.
Table 1. Examples of Calculating Antimicrobial Consumption Metrics\(^a\)\(^b\)

**Hypothetical Regimens**
- Patient 1: vancomycin 1 g i.v. every 12 hr for 5 days, meropenem 1 g i.v. every 8 hr for 7 days
- Patient 2: vancomycin 500 mg i.v. every 12 hr for 10 days, meropenem 1 g i.v. every 12 hr for 10 days
- Patient 3: vancomycin 1 g i.v. every 12 hr for 7 days, meropenem 1 g i.v. every 8 hr for 14 days

<table>
<thead>
<tr>
<th>Metric</th>
<th>Equation for Calculating Consumption per 1,000 Patient-Days</th>
<th>Calculations(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defined daily doses (DDD)(^a)(^b)</td>
<td>DDD = (amount of antimicrobial used/WHO standard)/patient volume × 1,000</td>
<td>With use of WHO-defined standard DDDs (vancomycin, 2 g/day; meropenem, 2 g/day), calculations proceed as follows: Meropenem DDD = (([83 \text{ g used/2 g}/200]) × 1,000 = 207.5 DDD per 1,000 patient-days) Vancomycin DDD = (([34 \text{ g used/2 g}/200]) × 1,000 = 85 DDD per 1,000 patient-days</td>
</tr>
<tr>
<td>Days of therapy (DOT)(^a)(^b)</td>
<td>DOT = antimicrobial days/patient volume × 1,000</td>
<td>Vancomycin days = 22 Vancomycin DOT = (22/200) × 1,000 = 110 DOT per 1,000 patient-days Meropenem days = 31 Meropenem DOT = (31/200) × 1,000 = 155 DOT per 1,000 patient-days</td>
</tr>
<tr>
<td>Length of therapy (LOT)(^a)(^b)</td>
<td>LOT = duration of antimicrobial use/patient volume × 1,000</td>
<td>Patient 1 duration = 7 days Patient 2 duration = 10 days Patient 3 duration = 14 days LOT = (([7 + 10 + 14]/200]) × 1,000 = 155 LOT per 1,000 patient-days</td>
</tr>
</tbody>
</table>

\(^a\)WHO = World Health Organization.
\(^b\)Calculations are hypothetical and likely not representative of expected use values.
\(^c\)Calculations assume a patient volume during the reporting period of 200.

*Am J Health-Syst Pharm. 2018; 75:230-8*
Other Metrics

- Advanced Utilization
- Process
- Prescriber
- Outcome
- Quality/Safety
Advanced Utilization Metrics

• % admissions that received certain antibiotics
• Point prevalence study – looking at what is happening house wide at a pre-selected time
• DOT by provider
• Average LOT for specific antibiotics
• % of therapy appropriate indication or ICD9/10 codes
• % of time empiric therapy was appropriate for a certain indication
• Choice/Change/Completion – looking at empiric, narrow, complete therapy
• DOT/LOT
DOT by Service Line
MS DRG Groupings

![DOT by Service Line Graph]

Process Measures

- Interventions
  - Renal dosing
  - IV to PO
  - De escalation
  - Therapy Cessation
- Percent ordered per protocol/guidelines
- Culture collected before antimicrobial being administered
- Intervention acceptance rate
- Average number of interventions per patient reviewed
- Redundant therapy events
- % orders with start and stop date
- MSSA and receiving a beta lactam
- Compliance to best practice bundles
Prescriber Metrics

• Drug utilization by prescriber
  • Debate about whether to blind info or use name
  • Challenge when you can only get attending physician’s name. When at academic medical center, consider by service
• Percent of orders for antimicrobials that required action
• Acceptance rates
• ID physician consult rates
Outcomes Metrics

Resistance rates
Theoretical, difficult to measure short term

*Clostridium difficile* rates
Balancing measure – pts that were de-escalated that were then escalated

![MRSA Isolates per 1000 Patient Days](image)
Quality/Safety Measures

- Percent of time diseases specific order set was used
- Adverse drug events reported
- Time to appropriate therapy
- Time to therapeutic concentrations
- Adverse drug event rates
- Time to appropriate antibiotic trough levels (vancomycin)
- Time to PO conversion
- CLABSI rates
- Mortality
- PICC line complications
Sample Dashboard

- **2015 Q1 Antimicrobial Stewardship Dashboard**
  - **Top 10 Antibiotic DOT / 1000 Patient Days**
  - **Top 10 Antibiotic Spend**
  - **Cases of resistant organisms & C. diff**

- **Pharmacist ASP Intervention Frequency**
  - **Pharmacist ASP Notable Interventions**
    - Positive Cultures, No antibiotics x >24 hrs
    - Provides clinical detail and specifics about how issue(s) were resolved
    - Pt being discharged on wrong antibiotic
    - Provides clinical detail and specifics about how issue(s) were resolved
Using Your Metrics to Drive Change

Who?
What?
When?
Where?
Why?
References


Appendix

AUR/SAAR
Antibiotic Use Tracking

NHSN Antibiotic Utilization and Resistance (AUR) Module

- Module designed to capture antibiotic use data through electronic input through NHSN
- AU measures antibiotic days per 1000 days present
- AR measures resistance and resistance trends
- Standardized Antibiotic Administration Ratio (SAAR)
AU Outputs

Antimicrobial Use and Resistance Module
- Antimicrobial Use Data
- CDC Defined Output

- Line Listing - Most Recent Month of AU Data for ...more
- Line Listing - Most Recent Month of AU Data by Location
- Line Listing - All Submitted AU Data for FACWIDEIN
- Rate Table - Most Recent Month of AU Data - Antimicrobial...more
- Rate Table - All Submitted AU Data - Antimicrobial...more
- Rate Table - Most Recent Month of AU Data - Anti-influenza...more
- Rate Table - All Submitted AU Data - Anti-influenza...more
- Pie Chart - Most Recent Month of AU Data by Anti-influenza...more
- Pie Chart - All AU Data by Antibacterial Class a...more
- Pie Chart - Most Recent Month of AU Data by Anti-influenza Class and ...more
- Pie Chart - All AU Data by Anti-influenza Class and ...more
- Bar Chart - Most Recent Month of AU Data by Anti-influenza...more
- Bar Chart - All AU Data by Antibacterial Class a...more
- Bar Chart - Most Recent Month of AU Data by Anti-influenza...more
- Bar Chart - All AU Data by Anti-influenza Class and ...more
- Bar Chart - Most Recent Month of AU Data by Anti...more
- Bar Chart - All AU Data by Anti-influenza Class ...more

National Healthcare Safety Network
Rate Table - Most Recent Month of AU Data - Antimicrobial Utilization Rates for FACWIDEIN
Rate per 1,000 Days Present
As of: February 20, 2016 at 1:44 PM
Date Range: All AU_BASIC nevertheless
Facility Org ID: 13860

<table>
<thead>
<tr>
<th>Summary Year/Month</th>
<th>Antimicrobial Category</th>
<th>Antimicrobial Data</th>
<th>Days Present</th>
<th>Rate per 1000 Days Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015M01</td>
<td>Antibacterial</td>
<td>1626</td>
<td>2177</td>
<td>746.893</td>
</tr>
<tr>
<td></td>
<td>Aminoglycosides</td>
<td>22</td>
<td>2177</td>
<td>10.106</td>
</tr>
<tr>
<td></td>
<td>Carbapenems</td>
<td>101</td>
<td>2177</td>
<td>46.394</td>
</tr>
<tr>
<td></td>
<td>Cephalosporins</td>
<td>337</td>
<td>2177</td>
<td>154.8</td>
</tr>
<tr>
<td></td>
<td>Fluoroquinolones</td>
<td>244</td>
<td>2177</td>
<td>112.081</td>
</tr>
<tr>
<td></td>
<td>Folate pathway inhibitors</td>
<td>32</td>
<td>2177</td>
<td>14.699</td>
</tr>
</tbody>
</table>

National Healthcare Safety Network
Pie Chart - Current Month - Proportion of Antimicrobial Days per Antibacterial Class by Location
As of: February 20, 2016 at 1:44 PM
Date Range: All AU_BASIC nevertheless
Stratified by Location
Summary of Class Distribution

- Carapenems
- Cephalosporins
- Fluoroquinolones
- Other
Standardized Antibiotic Administration Ratio (SAAR)

- CDC’s 1st attempt at developing a quality improvement measure for antibiotic use.
- Similar in principle to the Standardized Infection Ration (SIR).
- SAAR expresses observed antibiotic use compared to predicted use.
- CDC worked with many partners to develop the SAAR measure to try and make it most useful for stewardship.
Standardized Antibiotic Administration Ratio (SAAR): Patient Location Groupings

**Adult**
Medical and Surgical ICUs
Medical and Surgical wards
All medical and surgical locations combined

**Pediatric**
Medical and Surgical ICUs
Medical and Surgical wards
All medical and surgical locations combined
Standardized Antibiotic Administration Ratio (SAAR):
Antibiotic Groupings

• **Broad spectrum agents for hospital-onset/multi-drug resistant infections**
  - Amikacin, aztreonam, cefepime, ceftazidime, ceftazidime/avibactam, ceftolozane/tazobactam, colistimethate, doripenem, gentamicin, imipenem/cilastatin, meropenem, piperacillin, piperacillin/tazobactam, polymixin B, ticarcillin/clavulanate, tigecycline, tobramycin

• **Broad spectrum agents predominantly used for community-acquired infections**
  - Cefotaxime, ceftriaxone, ciprofloxacin, ertapenem, gemifloxacin, levofloxacin, moxifloxacin

• **Anti-MRSA agents**
  - Ceftaroline, dalbavancin, daptomycin, linezolid, oritavancin, quinupristin/dalfopristin, tedizolid, telavancin, vancomycin

• **Agents for surgical site infection prophylaxis**
  - Cefazolin, cefotetan, cefoxitin, cefuroxime, cephalaxin

• **All agents**
### SAAR Report Output

**National Healthcare Safety Network**

**SAARs Table - All Standardized Antimicrobial Administration Ratios (SAARs) High-Level Indicators and High-Value Targets**

As of: November 17, 2015 at 3:10 PM
Date Range: All AU_SAAR

**All antimicrobials used in adult ICUs and wards**

<table>
<thead>
<tr>
<th>Facility Org ID</th>
<th>Summary Yr/Quarters</th>
<th>SAAR Type</th>
<th>Antimicrobial Days</th>
<th>Predicted Antimicrobial Days</th>
<th>Days Present</th>
<th>SAAR</th>
<th>SAAR p-value</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>13860</td>
<td>2014Q1 IN-D-Adult-1</td>
<td></td>
<td>4416</td>
<td>4421.364</td>
<td>6326</td>
<td>0.999</td>
<td>0.9437</td>
<td>0.970, 1.029</td>
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<tr>
<td>13860</td>
<td>2014Q2 IN-D-Adult-1</td>
<td></td>
<td>3998</td>
<td>3856.677</td>
<td>5668</td>
<td>1.037</td>
<td>0.0240</td>
<td>1.005, 1.069</td>
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<tr>
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<td></td>
<td>3668</td>
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<td>0.873, 0.933</td>
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<tr>
<td>13860</td>
<td>2014Q4 IN-D-Adult-1</td>
<td></td>
<td>6835</td>
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<td>0.0000</td>
<td>1.165, 1.221</td>
</tr>
<tr>
<td>13860</td>
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<td></td>
<td>4060</td>
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<td>5368</td>
<td>1.304</td>
<td>0.0000</td>
<td>1.264, 1.344</td>
</tr>
</tbody>
</table>

Includes data for January 2014 and forward.
Data restricted to medical, medical/surgical and surgical locations.
Source of aggregate data: 2014 NHSN AU Data

Data contained in this report were last generated on November 11, 2015 at 5:57 PM.

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Data for Example Only. Slide source: CDC
### SAAR Report Output

#### National Healthcare Safety Network

**SAARs Table - All Standardized Antimicrobial Administration Ratios (SAARs) High-Level Indicators and High-Value Targets**

As of November 18, 2015 at 3:40 PM

**Data Range: All All SAAR**

**Antimicrobials used for hospital-onset/multi-drug resistant infections in adult ICUs**

<table>
<thead>
<tr>
<th>orgID</th>
<th>summaryYO</th>
<th>SAARtype</th>
<th>antimicrobialDays</th>
<th>numAUDaysPredicted</th>
<th>numDaysPresent</th>
<th>SAAR</th>
<th>SAAR_pval</th>
<th>SAAR95CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>13860</td>
<td>2014Q1</td>
<td>TAR-Adult-1</td>
<td>931</td>
<td>676.939</td>
<td>2800</td>
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<tr>
<td>13860</td>
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<td>TAR-Adult-1</td>
<td>1065</td>
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<td>955</td>
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<tr>
<td>13860</td>
<td>2015Q1</td>
<td>TAR-Adult-1</td>
<td>265</td>
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<td>700</td>
<td>1.464</td>
<td>0.0000</td>
<td>1.396, 1.649</td>
</tr>
</tbody>
</table>

Includes data for January 2014 and forward.

Data restricted to medical, medical/surgical and surgical locations.

Source of aggregate data: 2014 HHS AIU Data

Data contained in this report were last generated on November 11, 2015 at 5:57 PM.

#### National Healthcare Safety Network

**SAARs Table - All Standardized Antimicrobial Administration Ratios (SAARs) High-Level Indicators and High-Value Targets**

As of November 18, 2015 at 3:40 PM

**Data Range: All All SAAR**

**Antimicrobials used for hospital-onset/multi-drug resistant infections in adult wards**

<table>
<thead>
<tr>
<th>orgID</th>
<th>summaryYO</th>
<th>SAARtype</th>
<th>antimicrobialDays</th>
<th>numAUDaysPredicted</th>
<th>numDaysPresent</th>
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<th>SAAR_pval</th>
<th>SAAR95CI</th>
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<tbody>
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</table>

Includes data for January 2014 and forward.

Data restricted to medical, medical/surgical and surgical locations.

Source of aggregate data: 2014 HHS AIU Data

Data contained in this report were last generated on November 11, 2015 at 5:57 PM.

Data for Example Only. Slide source: CDC