

Measuring Antibiotic Use in NHSN

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SHEA Antimicrobial Stewardship Research Workshop
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Learning Objectives

- ❑ Identify analytical methods for measuring antibiotic use**
- ❑ Indicate the role of risk adjustment when analyzing antibiotic stewardship and use data**
- ❑ Describe predictive models that produce the Standardized Antimicrobial Administration Ratio (SAAR), which is NHSN's new AU clinical quality measure**

Antimicrobial Use and Resistance (AUR) Module – The Basics

- ❑ Designed to support healthcare and public health efforts to:
 - (1) Monitor and improve antimicrobial prescribing
 - (2) Identify, understand, and respond to antimicrobial resistance patterns or trends
- ❑ Provides a common set of technical specifications and a single surveillance platform for hospitals to report AU and AR data
- ❑ All data must be submitted electronically to the AUR Module
- ❑ Data that are successfully transmitted are available immediately to NHSN users for analysis and visualization
- ❑ Summary data provide AU and AR benchmarks that hospitals, healthcare systems, and public health agencies can use for comparative purposes and as a guide for further analysis and action

AU Data Flow From Bedside to NHSN



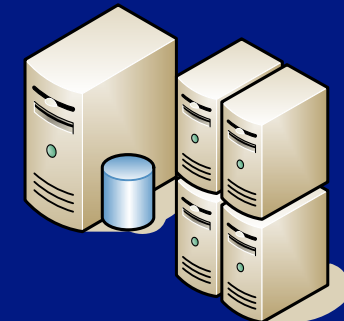
**eMAR/BCMA
and ADT
Systems**

**Extract, transform and load
AU data by means of a vendor
or homegrown IT solution**

- Monthly summary data
- 89 antimicrobials
- Location specific
- Days present and admissions



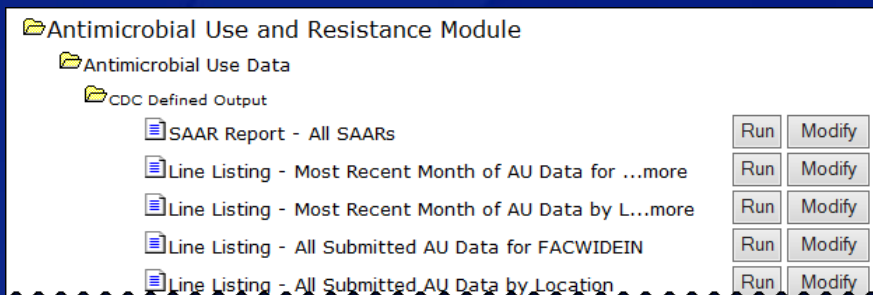
**Submit AU data
using standard
file format**



**NHSN
Servers**



**Local AU data access via
NHSN's web interface**



**Analysis, visualization,
and reporting AU data**

NHSN AU Reporting Option: Operational Overview

❑ Data Sources:

- Numerator: Electronic Medication Administration Record (eMAR) or Bar Coding Medication Administration (BCMA) systems for AU data
- Denominator: Admission/Discharge/Transfer (ADT) systems for patient location data

❑ Participation:

- General acute care hospitals, long-term acute care hospitals, inpatient rehabilitation facilities, oncology hospitals, critical access hospitals
- Locations/units in which numerator & denominator can be accurately electronically captured
 - All NHSN-defined inpatient locations
 - Select outpatient locations: Emergency Department, Pediatric Emergency Department, 24-hour Observation Unit

NHSN AU Reporting Option: Operational Overview (continued)

❑ Monthly Numerator Data:

- Antimicrobial days – Days of therapy for a specified antimicrobial agent administered in a patient care location
- 89 antimicrobials are in scope - Antibacterial, antifungal, and anti-influenza agents,
 - Stratified by route of administration: intravenous, intramuscular, digestive, and respiratory

❑ Monthly Denominator Data:

- Days present – Number of patients in a specific location or facility, per day, aggregated for a monthly total
- Admissions – Number of patients admitted to the hospital

NHSN AU Option Submission Metrics

- ❑ 146 facilities submitted at least 1 month of data
 - From 31 states: AZ, CA, CO, CT, FL, IA, ID, IL, IN, KS, KY, MA, MI, MN, MO, NC, ND, NE, NM, NY, OH, OK, OR, PA, RI, SD, TN, TX, UT, VA, WI
 - Bed size:
 - Average = 233
 - Median = 217
 - Min/Max = 11,919
 - 59% teaching hospitals
 - 57% major teaching
 - Majority submission part of health system submission or large academic medical center
 - Using 6 vendors and 'homegrown' systems
- ❑ Data from 77 hospitals for 2014 were used for the NHSN AU measure submission to the National Quality Forum (NQF) in 2015

Standardized Antimicrobial Administration Ratio (SAAR) – The Basics

- ❑ The SAAR is the quantitative linchpin of the NHSN AU Measure; it summarizes AU in the form of an observed-to-predicted ratio:
 - Numerator – Observed days of therapy reported by a healthcare facility for a specified category of antimicrobial agents used in a patient care location or group of locations
 - Denominator – Days of therapy predicted for a healthcare facility's use of a specified category of antimicrobial agents in a patient care location or group of locations, calculated by applying negative binomial regression modeling to nationally aggregated AU data
- ❑ SAAR values can serve as a starting point for medication use evaluations by antimicrobial stewardship programs, but SAAR values are not definitive measures of judiciousness or appropriateness



NHSN Antimicrobial Use Measure – NQF 2720 – Endorsed in January 2016

Current and Planned Use of the Measure:

- ☒ Public health/disease surveillance
- ☒ Quality improvement (internal to the specific organization)
- ☒ Quality improvement (external benchmarking involving multiple organizations)
- ☐ Public reporting
- ☐ Payment program
- ☐ Regulatory and accreditation programs
- ☐ Professional certification or recognition program

Interpreting SAAR Values

SAAR values are always greater than 0, and a value of 1.0 suggests equivalency between observed and predicted antibiotic use.

- ❑ A SAAR that is not statistically different from 1.0 indicates antibiotic use is equivalent to the referent population's antibiotic use
- ❑ A high SAAR (above 1.0) that achieves statistical significance (i.e., different from 1.0) may indicate excessive antibiotic use
- ❑ A low SAAR (below 1.0) that achieves statistical significance (i.e., different from 1.0) may indicate antibiotic under use

Note: A SAAR above 1.0 that does not achieve statistical significance may still be associated with excessive AU and warrant further investigation. Also, a SAAR that differs statistically from 1.0 does not assure that further investigation will be productive.

NHSN Patient Care Locations for SAAR Calculations

The NHSN AU Measure is comprised of 16 SAARs, each of which summarizes AU for a specified combination of patient care locations and antimicrobial agents. SAARs are generated for six specified groupings of adult and pediatric patient care locations:

1. Adult medical, surgical, and medical/surgical intensive care units
2. Adult medical, surgical, and medical/surgical wards
3. Pediatric medical, surgical, and medical/surgical intensive care units
4. Pediatric medical, surgical, and medical/surgical wards
5. All adult medical, medical/surgical, and surgical intensive care units and wards
6. All pediatric medical, medical/surgical, and surgical intensive care units and wards

Antimicrobial Agent Categories Used for SAARs Metrics

High value targets for antimicrobial stewardship programs:

1. **Broad spectrum agents predominantly used for hospital-onset/multi-drug resistant bacteria** – aminoglycosides, 4th and 5th gen. cephalosporins, penicillin B-lactam/b-lactamase inhibitor combinations, carbapenems (except ertapenem)
2. **Broad spectrum agents predominantly used for community-acquired infection** – ertapenem, some cephalosporins, and fluoroquinolones
3. **Anti-MRSA agents** – ceftaroline, dalbavancin, daptomycin, linezolid, oritavancin, quinupristin/dalfopristin, tedizolid, telavancin, and vancomycin
4. **Agents predominantly used for surgical site infection prophylaxis** – cefazolin, cefotetan, cefoxitin, cefuroxime

High level indicators for antimicrobial stewardship programs:

5. **All antibiotic agents** – All agents included in NHSN AUR protocol

Predictive Modeling

□ Data:

- 2014 NHSN AU data
- 77 hospitals: 350 adult locations, 33 pediatric locations
- Each Antimicrobial SAAR category was modeled separately
- Patient care location and facility-level data, no patient level data

□ Modeling details:

- Forward stage-wise Negative Binomial Regression
- Binary or Nominal variables
- Estimates the number of predicted antimicrobial days

SAAR Predictive Models Include Hospital and Patient Location Variables

Broad Spectrum Agents Predominantly Used for Hospital-Onset/multi-drug resistant infections

ICU, 4-way location-type variable (Levels: Medical Unit, Medical/Surgical Unit, Surgical Unit, Pediatric Unit*)

Broad Spectrum Agents Predominantly Used for Community Acquired infections

Teaching Status, ICU, Pediatric Location

Anti-MRSA Agents

ICU, 4-way location-type variable (Levels: Medical Unit, Medical/Surgical Unit, Surgical Unit, Pediatric Unit*), Interaction Term: ICU and 4 way location-type variable

Agents Predominantly Used for Surgical Site Infection Prophylaxis

ICU, Surgical Location

All Agents

ICU, 4 way location-type variable (Levels: Medical Unit, Medical/Surgical Unit, Surgical Unit, Pediatric Unit*)

**Referent group in a multi-way variable*

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Model 1: Broad Spectrum HO/MDRO

Parameter	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-square	Chi square p-value
Intercept	-2.669	0.081	-2.827	-2.511	1092.18	<.0001
ICU	0.971	0.052	0.868	1.074	343.77	<.0001
Location Type: MEDICAL UNIT	0.522	0.088	0.349	0.695	34.98	<.0001
Location Type: MEDICAL/SURGICAL UNIT	0.444	0.090	0.266	0.621	24.05	<.0001
Location Type: SURGICAL UNIT	0.406	0.098	0.213	0.598	17.02	<.0001
Location Type: PEDIATRIC UNIT	REF	--	--	--	--	--

SAAR Distributions

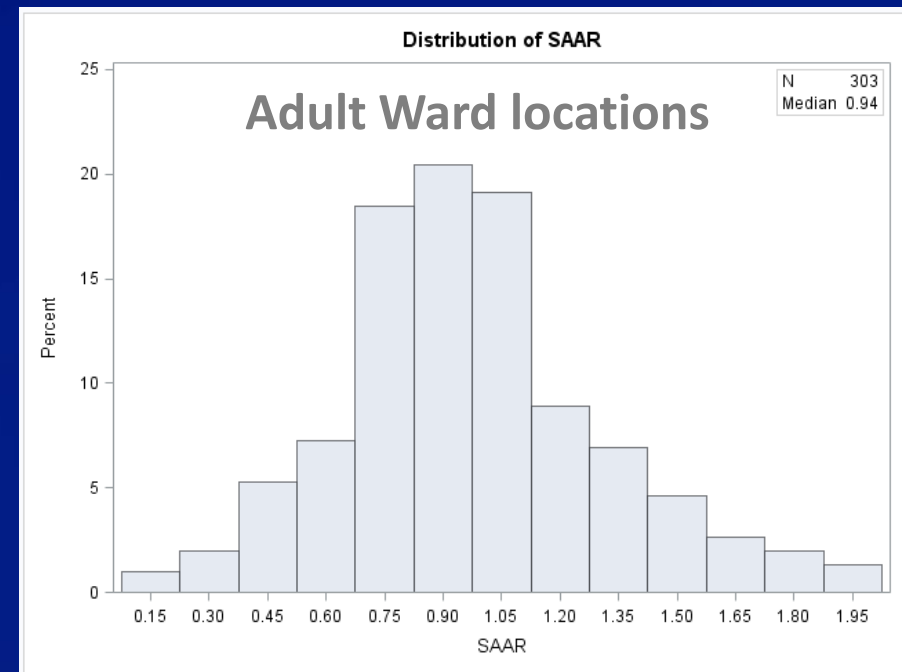
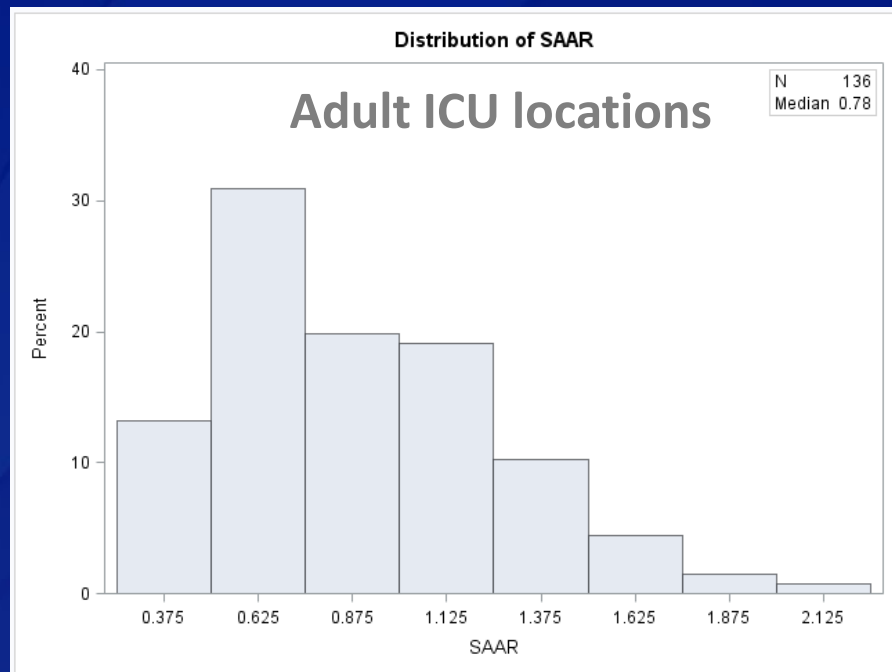
Broad Spectrum for HO/MDR Infections Category

NQF Reporting Measure	N*	Median SAAR	SAAR statistically lower than 1 N (%)	SAAR statistically higher than 1 N (%)
Adult ICUs	100	0.914	52 (52%)	37 (37%)
Adult Wards	250	0.983	108 (43%)	99 (40%)
Pediatric ICUs	7	0.881	4 (57%)	1 (14%)
Pediatric Wards	26	1.119	13 (50%)	8 (31%)

* Locations

SAAR Distributions—ICUs vs. Wards

- Median SAAR values differ greatly between ICUs and wards for broad spectrum community onset agents (ICU median=0.78, Ward median=0.94). This may relate to the spread and skew of predicted DOT.



SAAR Output in NHSN*

National Healthcare Safety Network

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

As of: April 18, 2016 at 4:14 PM

Date Range: All AU_SAAR

SAAR Title

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

orgID	summaryYQ	SAARType	antimicrobialDays	numAUDaysPredicted	numDaysPresent	SAAR	SAAR_pval	SAAR95CI
13860	2014Q1	TAR-Adult-2	151	381.046	3526	0.396	0.0000	0.337, 0.463
13860	2014Q2	TAR-Adult-2	175	373.157	3453	0.469	0.0000	0.403, 0.542
13860	2014Q3	TAR-Adult-2	131	370.239	3426	0.354	0.0000	0.297, 0.418
13860	2014Q4	TAR-Adult-2	580	518.920	4751	1.118	0.0089	1.029, 1.212
13860	2015Q1	TAR-Adult-2	789	512.183	4658	1.540	0.0000	1.436, 1.651
13860	2015Q2	TAR-Adult-2	60	122.332	1132	0.490	0.0000	0.378, 0.627

Observed Use

Predicted Use
(SAAR Denominator)

Rate
Denominator

Calculated
SAAR Values

Includes data for January 2014 and forward.

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

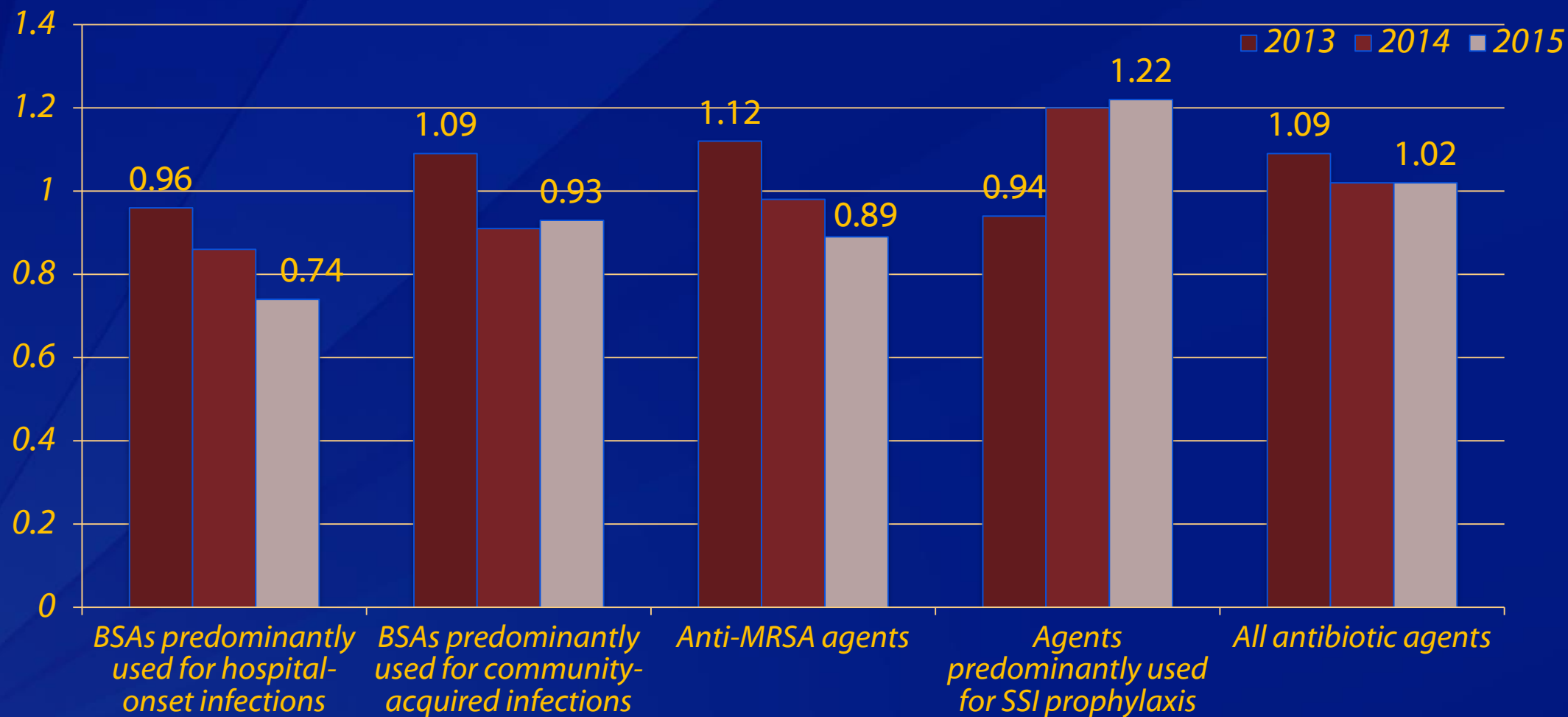
Source of aggregate data: 2014 NHSN AU Data

Data contained in this report were last generated on March 15, 2016 at 10:33 AM.

*Synthetic data, for example only

Using the SAAR to Evaluate Stewardship

Facility-level Standardized Antimicrobial Administration Ratios (SAAR), 2013-2015



Summary

- ❑ **SAAR is new and unlike any AU measure currently available**
- ❑ **Takes into account some but not all factors that are known sources of variability in antimicrobial use.**
 - Next steps: continued risk adjustment and patient level factors
- ❑ **Provides benchmarks that antibiotic stewardship programs can use in their efforts to monitor and improve the use of antibiotics in acute care hospitals**
 - Next steps: SAAR assessment tool
 - Relationship of the SAAR with stewardship practices

ADDITIONAL METHODS AND RESULTS

Spectrum of Agents

Narrower

Broader

1

- Penicillin G
- Penicillin V
- Oxacillin
- Dicloxacillin
- Ampicillin
- Amoxicillin
- Cefazolin
- Cephalexin
- Nitrofurantoin
- Metronidazole

2

- Tetracycline
- Doxycycline
- Minocycline
- Azithromycin
- Clarithromycin
- Erythromycin
- Sulfamethoxazole/
Trimethoprim
- Cefoxitin
- Cefuroxime
- Clindamycin

3

- Amoxicillin/
Clavulanate
- Ampicillin/
Sulbactam
- Ceftriaxone

4

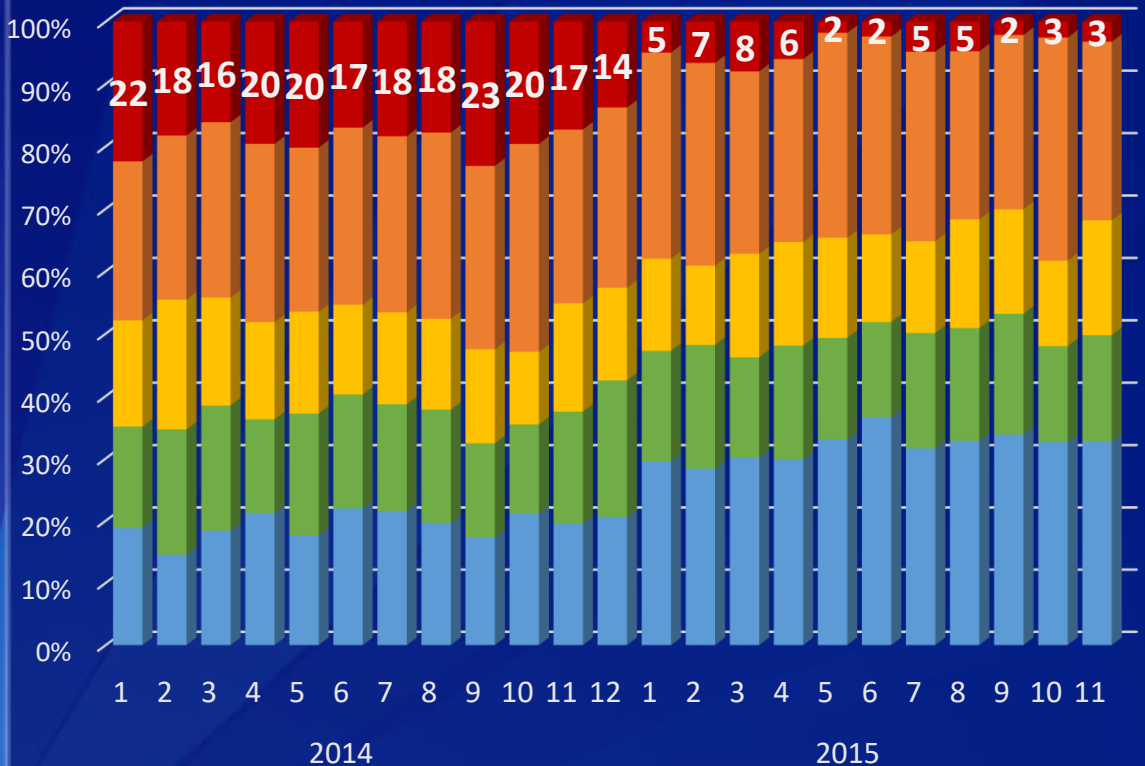
- Amikacin
- Gentamicin
- Tobramycin
- Ciprofloxacin
- Gemifloxacin
- Levofloxacin
- Moxifloxacin
- Aztreonam
- Ceftazidime
- Ertapenem
- Vancomycin
- Ceftaroline

5

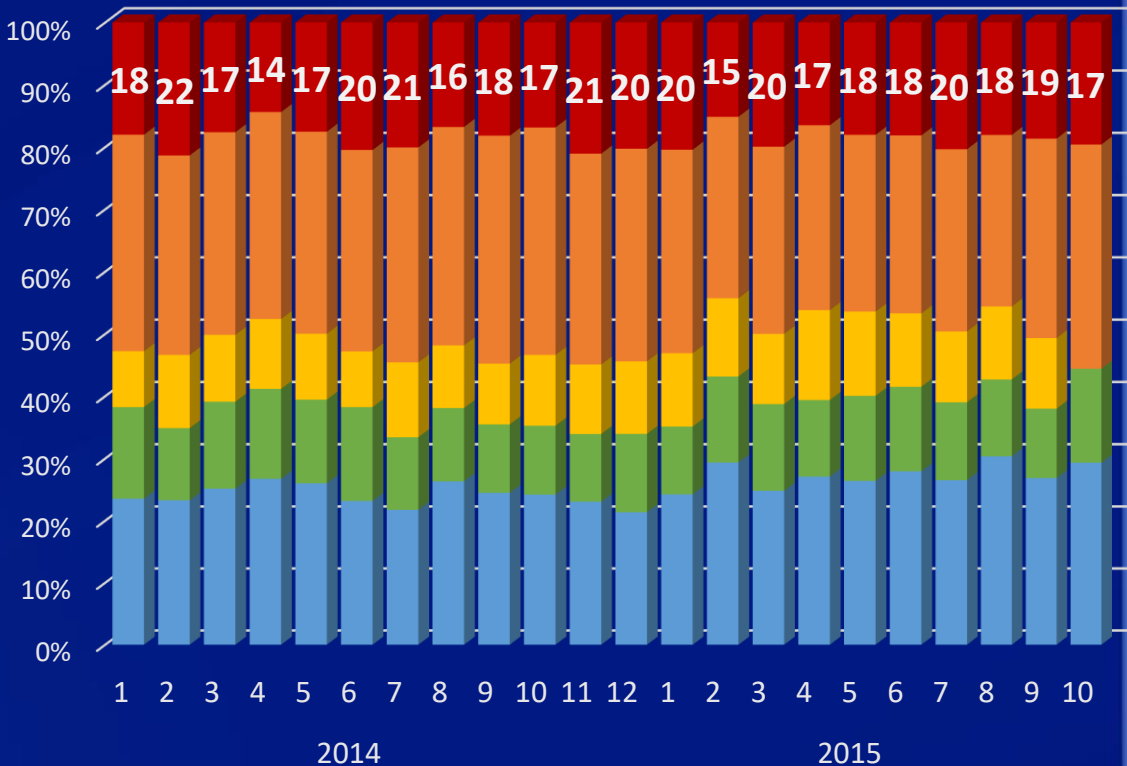
- Imipenem/Cilastatin
- Meropenem
- Piperacillin/Tazobactam
- Ticarcillin/Clavulanate
- Daptomycin
- Linezolid
- Tigecycline
- Colistimethate

Spectrum Analysis

Most significant (Hospital A)

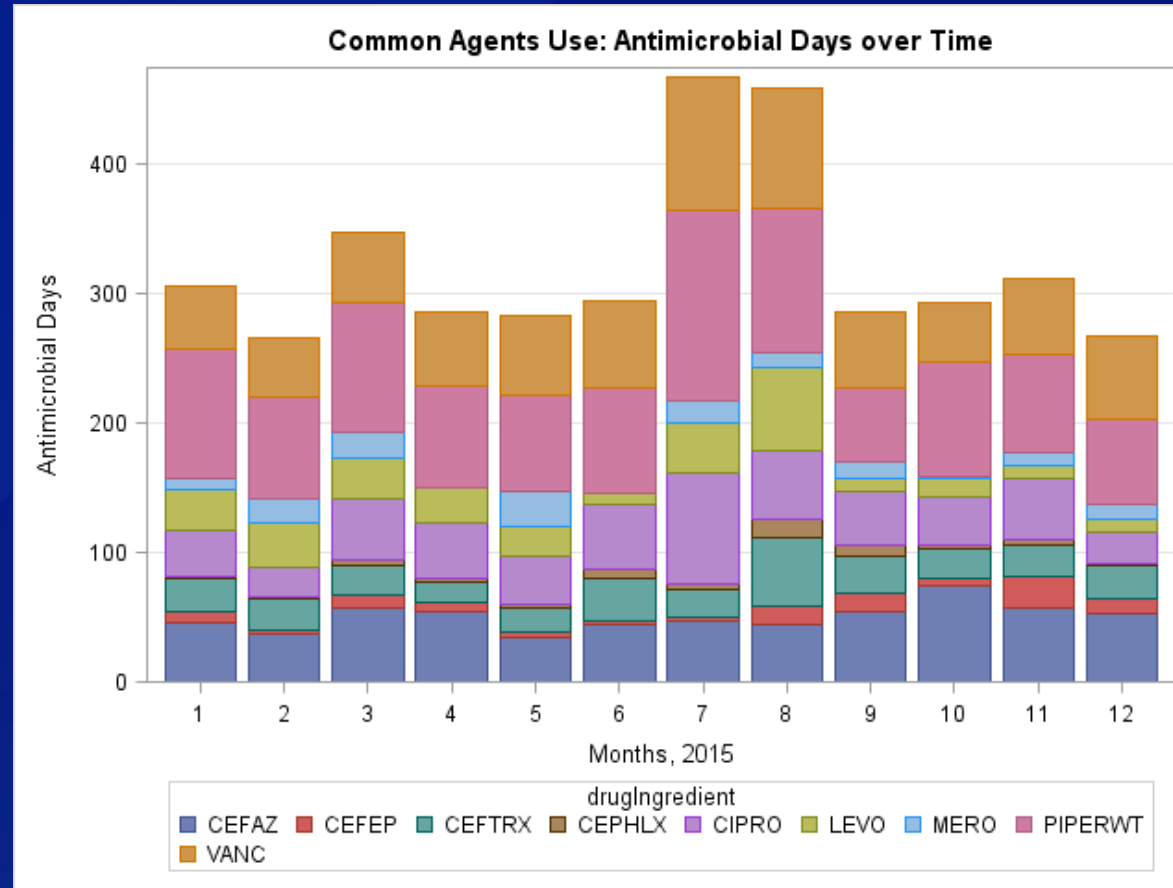


Least significant (Hospital Z)



SAAR Visual Output* (Coming January 2017)

DOTs per
1,000 patient
days

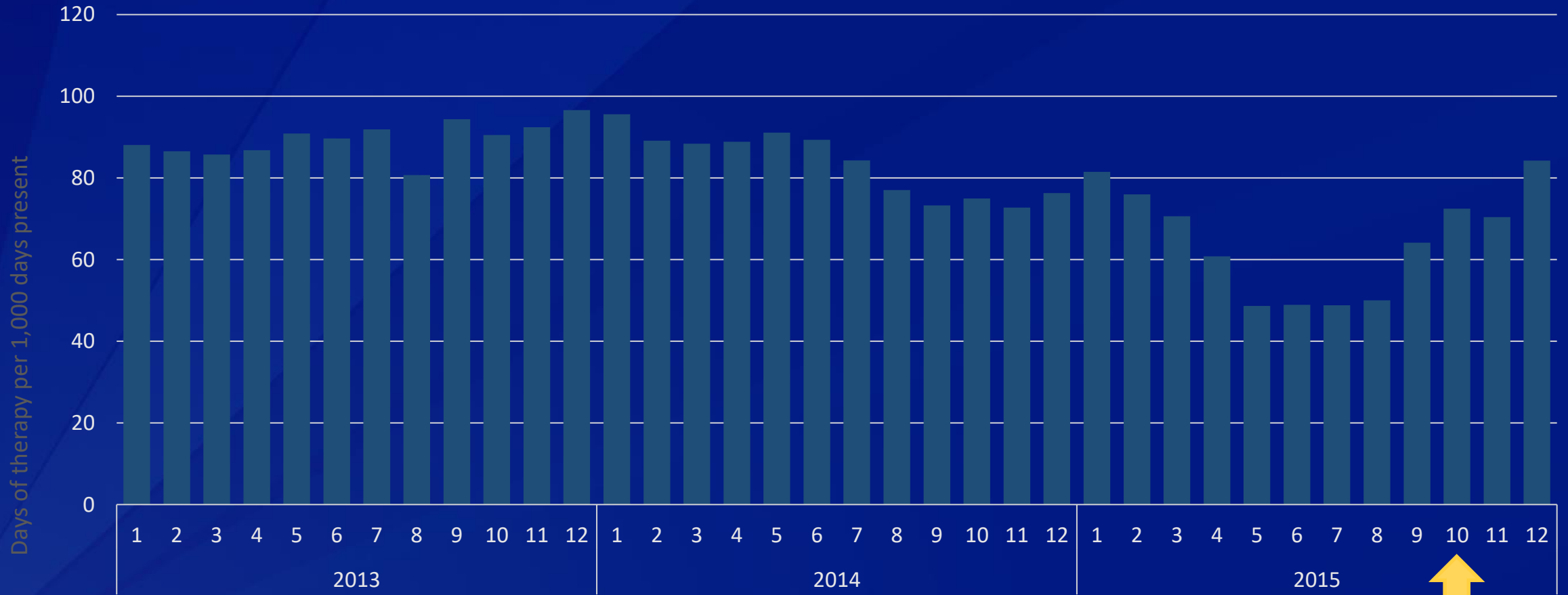


Customizable
agents list

*Synthetic data, for example only

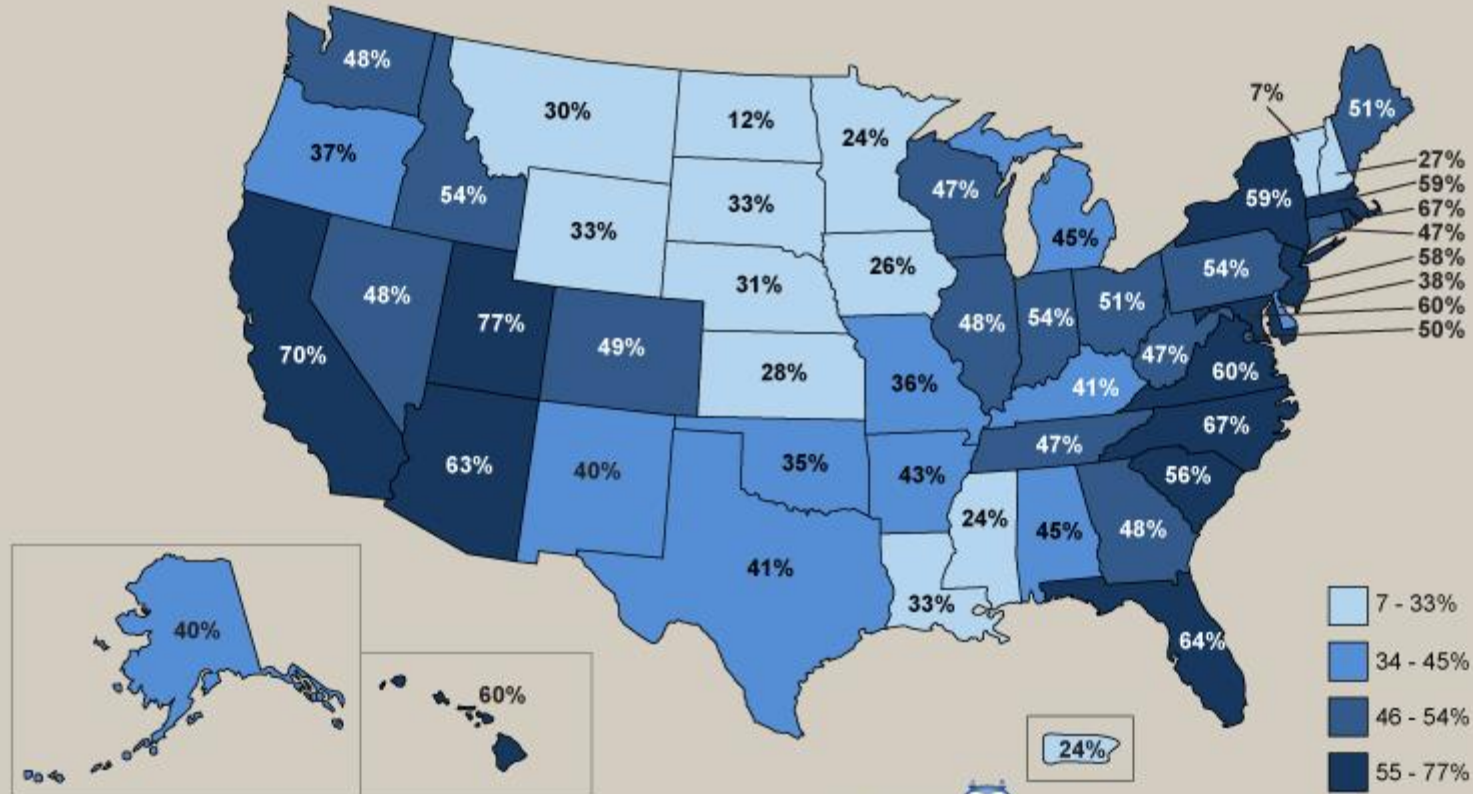
Does Cefepime, Vancomycin, and
Piperacillin/Tazobactam use increase
following October 1, 2015 Sepsis Measure?

Piperacillin/Tazobactam Use (Days of Therapy per 1000 day present)



Sepsis measure took
effect

Percent of Hospitals with Antibiotic Stewardship Programs by State, 2015*



*A hospital stewardship program is defined as a program following all 7 of CDC's Core Elements of Hospital Antibiotic Stewardship Programs.

Source: CDC's National Healthcare Safety Network (NHSN) Survey



Nationally, 48.1% of all hospitals have stewardship programs (2,199 of 4,549); the national goal is 100% of hospitals by 2020.

Next Steps for the NHSN AU Measure

- ❑ Maintain collaborations—and develop additional partnerships—with hospitals and healthcare systems that submit AU data to NHSN and use the data in their antimicrobial stewardship programs**
- ❑ Participate in AU and antimicrobial stewardship studies that use AU data and stewardship survey data submitted to NHSN**
- ❑ Use field experience with the SAAR, additional AU data collection and analysis, and other studies to enhance the SAAR predictive models**
- ❑ Work on a second iteration of the NHSN AU Measure that will enable the measure to be used for public reporting and other accountability purposes**

Thank You!



NHSN@cdc.gov

<http://www.cdc.gov/nhsn/acute-care-hospital/AUR/>

For more information please contact Centers for Disease Control and Prevention

1600 Clifton Road NE, Atlanta, GA 30333

Telephone, 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348

E-mail: cdcinfo@cdc.gov Web: www.cdc.gov

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.

Division of Healthcare Quality Promotion

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EXTRA SLIDES

Available SAARs

- ❑ **16 specific SAARs can be generated in NHSN**
 - Specific location types
 - Specific antimicrobial groups
 - Broad Spectrum Agents Predominantly Used for Hospital Onset/MDRO infections
 - Broad Spectrum Agents Predominantly Used for Community Onset infections
 - Anti MRSA Agents
 - Agents Predominantly Used for Surgical Site Prophylaxis Agents
 - All Antibiotics
- ❑ **Complete details found in NHSN AUR Protocol:**
<http://www.cdc.gov/nhsn/pdfs/pscmanual/11pscaurcurrent.pdf>

NHSN AU Measure - SAARs for High Value Targets

SAARs for broad spectrum antibacterial agents predominantly used for hospital-onset/multidrug resistant infections:

1. Adult medical, medical/surgical, and surgical ICUs
2. Adult medical, medical/surgical, and surgical wards
3. Pediatric medical, medical/surgical, and surgical ICUs
4. Pediatric medical, medical/surgical, and surgical wards

SAARs for broad spectrum antibacterial agents predominantly used for community-acquired infections:

5. Adult medical, medical/surgical, and surgical ICUs
6. Adult medical, medical/surgical, and surgical wards
7. Pediatric medical, medical/surgical, and surgical ICUs
8. Pediatric medical, medical/surgical, and surgical wards

Note: All patient care locations are according to CDC location definitions

NHSN AU Measure - SAARs for High Value Targets (continued)

SAARs for anti-MRSA antibacterial agents:

9. Adult medical, medical/surgical, and surgical ICUs
10. Adult medical, medical/surgical, and surgical wards
11. Pediatric medical, medical/surgical, and surgical ICUs
12. Pediatric medical, medical/surgical, and surgical wards

SAARs for antibacterial agents predominantly used for surgical site infection prophylaxis:

13. Adult ICUs and wards (medical, medical/surgical, and surgical)
14. Pediatric ICUs and wards (medical, medical/surgical, and surgical)

Note: All patient care locations are according to CDC location definitions

NHSN AU Measure - High Level Indicator SAARs

SAARs for all antibacterial agents:

15. Adult ICUs and wards (medical, medical/surgical, and surgical)
16. Pediatric ICUs and wards (medical, medical/surgical, and surgical)

Note: All patient care locations are according to CDC location definitions