FEASIBILITY AND UTILITY OF ROBUST ANTIBIOTIC USE RISK-ADJUSTMENT IN ANTIMICROBIAL STEWARDSHIP PROGRAM ASSESSMENTS (R-SAARS): **OVERVIEW, PART 1**

Rebekah W. Moehring, MD, MPH; Michael E. Yarrington, MD, MMCI; Elizabeth Dodds Ashley, PharmD, MS; Rachel M. Addison, MT(ASCP), MPH; Whitney R. Buckel, PharmD; Sara E. Cosgrove, MD, MS; Eili Klein, PhD; Carlos A. Q. Santos, MD, MPHS; Emily S. Spivak, MD, MHS; William Trick, MD; David J. Weber, MD, MPH; Congwen Zhao, MB; Benjamin A. Goldstein, PhD; Deverick Anderson, MD, MPH

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Duke University School of Medicine

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Sharing (data) is Caring

Comparative data gets attention.

Network comparisons, even if raw, can help:

1. Engage leadership and/or clinicians
2. Better define your question for further investigation.
3. Find opportunities to intervene
4. Set a goal

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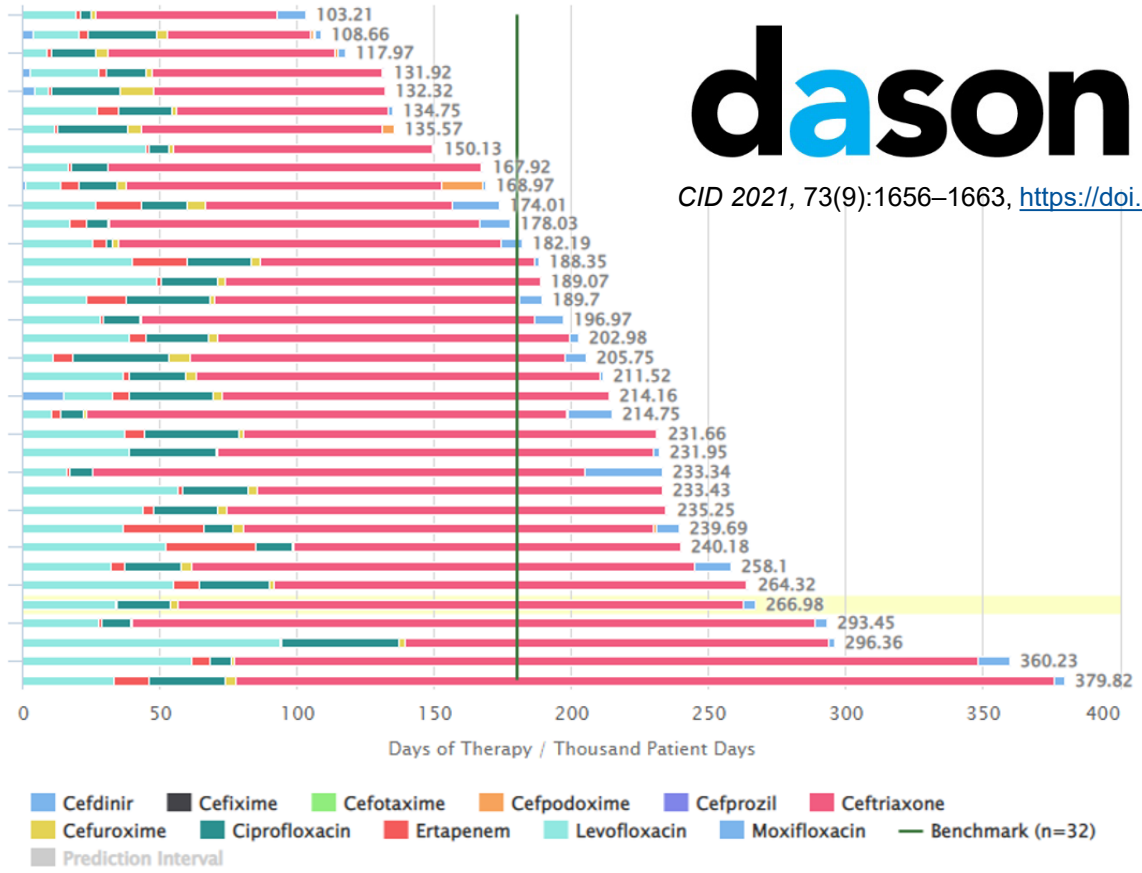
Agents for Community Acquired Infections

Figure 4c. Facility-wide Agents Community Acquired Infections Use and DASON Benchmarks (2021)



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CID 2021, 73(9):1656–1663, https://doi.org/10.1093/cid/ciab356

Table 4c. Facility-wide Agents for Community Acquired Infections Use and DASON Benchmarks (2021)

	Agents used for community-acquired infections			DASON Mean Rate	DASON Rank
	Numerator	Denominator	Rate	(95% Prediction Interval)	
Days of Therapy / Thousand Patient Days	11,163 DOT	41.81 1K Patient Days	266.97	179.97 (59.19 - 300.75)	30
Length of Therapy / Targeted Antimicrobial Use Admissions	11,009 LOT	3,447 Admissions	3.19	3.25 (2.76 - 3.74)	17
%Patient Admissions receiving selected Antimicrobial(s)			37.26%	25.47% (11.06% - 39.88%)	30
%Antimicrobial Admissions receiving selected Antimicrobial(s)			55.06%	43.22% (22.21% - 64.23%)	25

But… “My Patients are Different!”

Trying to level the playing field: Risk-adjustment methods

- Use other measured variables to create a modeled or adjusted comparison
- Used for many quality outcomes routinely (E.g. Hospital Mortality)
- Can be complex to produce, but simplified to an Observed/Expected ratio for ease of interpretation
- Requires data resource investments for longitudinal reporting, analyses

Especially important for antibiotic use, which is not a zero-goal metric

Additional Potential Benefit of Risk Adjustment = Efficiency

- Remove case mix variation + Speed efficiency of identifying practice variation =
- = Saved ASP personnel time in investigating/identifying implementation opportunities

NHSN SAAR = Standardized Antibiotic Administration Ratio

Unit of analysis: pooled AU rates by location over 1 year among 449 US Hospitals, 2156 Adult and Pediatric Locations

Model: Negative binomial regression estimating days of therapy with offset of 1,000 days present

Variables: Facility- or location-level variables collected from the NHSN annual survey and AU Option

Limitation: Minimal Risk Adjustment

- No encounter-level factors
- Structured at unit-month level
- Many other case-mix factors at play for individual hospitals and patients

	Variables used in Risk-Adjustment Models
Adult and Pediatric (N=7) 2017 baseline*	Location type Facility type Teaching status Hospital bed-size N ICU beds % ICU beds Average LOS (annual patient days/annual admissions)

*2023 is re-baseline year

O'Leary CID 2020 Dec 17;71(10):e702-e709.

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What about an R-SAAR?

R-SAAR = “Robust” SAAR models based on encounter-level electronic health record data

- 3 prior investigations of encounter-level AU risk adjustment modeling suggest **diagnosis data** can provide better model accuracy as compared with facility- or location-level data

Aim 1: Determine the feasibility of data collection, perform model validation and comparisons, and calculate robust risk-adjusted SAARs using patient encounter-level diagnosis data across a variety of hospital systems.

- Can we do it? YES (in study context)

Prior Work:

Yu et al. *CID* 2018 Nov 13;67(11):1677-1685

Goodman et al. *CID* 2021 Dec 6;73(11): e4484-e4492.

Moehring et al. *JAMA Network Open* 2021 Mar 1;4(3):e213460.

Your hospital already did it!

Aim 2: Qualitatively assess end users' perceptions of the value of robust, risk-adjusted AU data comparisons for hospital antimicrobial stewardship program assessments

- Is it helpful?

Your role as an R-SAARs participant and Steward:

Help us understand your ASP team's response to the data.

2-Part Process for Data Feedback + Response:

Receive Hospital Data Report #1, Unadjusted Comparisons and 2017 SAAR data

- You will have 1 month's time to:
  - Review the report and discuss with your ASP regarding a consensus response
  - Submit Part 1 Survey through REDCAP

Part 1: Known Methods for AU Comparisons

Receive Hospital Data Report #2, Robust Risk Adjusted SAARs

- You will have 1 month's time to:
  - Review the report and discuss with your ASP regarding a consensus response
  - Submit Part 2 Survey through REDCAP

Part 2: *NEW* Methods for AU Comparisons

R-SAARs ASP Point-of-Contact (POC) Engagement

Goals:

6-8 weeks total

~4 weeks between reports

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IF site agrees to participate, Email to POC:

- Data Report #1 (attachment)
- Link to Educational/Methods documents and webinar recording
- Email REDCAP #1 link to POC

Weekly REDCAP reminder email to POC with survey #1 link

When survey #1 is completed, Email:

- Data Report #2 (attachment)
- Email REDCAP link #2 to POC

Weekly reminder email to POC with survey #2 link

When survey 2 is completed, Email to POC

- Confirmation/Thank you

R-SAARs Resources for your team

1. R-SAARs materials: https://dason.medicine.duke.edu/research-publications

2. Site PIs:

Epicenter	Contacts
Duke-UNC DASON	Rebekah Moehring and DASON: Libby Dodds Ashley, Melissa Johnson, Angelina Davis
Utah, Intermountain	Emily Spivak and Whitney Buckel
Chicago	Carlos Santos and Bill Trick
Hopkins	Sara Cosgrove and Eli Klein

3. Duke study team contacts:

Rebekah Moehring, MD, MPH
Associate Professor of Medicine
Lead faculty and PI
rebekah.moehring@duke.edu

Duke Center for Antimicrobial Stewardship and Infection Prevention
Duke Hospital ASET, Medical Director

Rachel Addison, MT, MPH
Lead Regulatory and Clinical Research Coordinator
rachel.addison@duke.edu

Duke Center for Antimicrobial Stewardship and Infection Prevention
Regulatory Coordinator

Duke Center for Antimicrobial Stewardship and Infection Prevention

PART 1: KNOWN METHODS OVERVIEW

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Aim: Use existing methods to evaluate AU as compared to study hospitals

1) Unadjusted or “raw” AU rates

2) Existing risk-adjustment models used by National Healthcare Safety Network (NHSN) called the Standardized Antimicrobial Administration Ratio (SAAR)

Goals: Benchmarking and External Comparisons

What it’s NOT: Time trend analysis, Assessment of specific intervention impact.

Inclusion/Exclusion

50 Study hospitals with complete data

Calendar year = 2022

- For admissions that crossed over the dates, only information for calendar days in 2022 were included in estimates.

Inpatient encounters: at least 1 day present in an inpatient location.

- Excludes ED, procedural areas, observation wards

Age groups: Pediatrics [1 up to 18); Adult [18+]

- Excluded Neonates <1 year.

NHSN methods for Agents, Agent Groups (SAAR Groups), Routes and days of therapy (DOT) per 1,000 days present

Definitions (emulate NHSN methods)

Unit type – defined by local IP using NHSN methods

Facility-wide -- unit-types included in the NHSN definition of FACWIDEIN with the following exceptions:

- Maternal (e.g. Labor and Delivery), Neonatal (e.g. Well Baby Nursery), Behavioral Health

Observed to Expected (O:E) Ratio: The O:E is the ratio of observed DOT to the calculated, expected DOT values using 1-year of 2022 data for that hospital unit.

Expected DOT values were calculated using 2017 model parameters provided by the NHSN, answers to the 2022 NHSN annual survey, and days present during 2022.

$$SAAR = \frac{\textbf{Observed}\ antimicrobial\ days\ of\ therapy}{\textbf{Predicted}\ antimicrobial\ days\ of\ therapy}$$

https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/aur/au-saar-guide-508.pdf

Example SAAR calculation

NHSN uses negative binomial regression for AU risk adjustment. The model uses a set of fixed parameters (adjustment variables) for each SAAR type to predict the risk of AU in a set of SAAR-locations. Below is the general formula for a negative binomial model:

$log\ (\lambda) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i$, where:

α = Intercept

β_i = Parameter estimate

X_i = Value of risk factor (categorical variables: 1 if present, 0 if not present)

i = Number of predictors

Exponentiating the solution (specifically, $e^{\log(\lambda)}$), and multiplying by the number of days present provides an estimate for predicted antimicrobial days.

Table 1. Risk factors used in the 2017 baseline adult SAAR predictive model for broad-spectrum antibacterial agents predominantly used for hospital-onset infections.

Factor	Parameter Estimate	P-value
Intercept	-2.3357	<.0001
Location type = Medical ICU	1.0084	<.0001
Location type = Medical-Surgical ICU, Surgical ICU	0.8825	<.0001
Location type = General Hematology-Oncology Ward	0.3795	<.0001
Location type = Step down Unit	0.2197	<.0001
Location type = Medical Ward	0.0781	0.0041
Veteran's Affairs hospital (facility type = HOSP-VA)	-0.1821	<.0001
Critical access hospital (facility type = HOSP-CAH)	-0.2465	0.0049
Military hospital (facility type = HOSP-MIL)	-0.6278	<.0001
Women's hospital (facility type = HOSP-WOM)	-1.1920	0.0003
≥8 ICU beds	0.1734	0.0003
≥3.6 average length of stay, facility-wide (in days)	0.1091	<.0001

Output: 2017 SAAR for a Unit
>1.0 AU Higher than Expected
<1.0 AU Lower than Expected

Example: MICU; Military Hospital; 16 hospital ICU beds; average hospital LOS = 3.2

-2.3357 + 1.0084*1 + -0.6278*1 + 0.1734*1 = -1.8
Exp (-1.8) = 0.168352
Multiply by days present in 2022: 0.168352*934 = 157.24

Observed DOT in 2022 = 187
O:E = 187/157 = 1.19

Percentile Scores of O:E Ratios or SAARs

Provides a more updated Benchmark for 2022

https://www.cdc.gov/nhsn/datastat/aur-reports.html

Adult SAAR antimicrobial agent categories

In 2022, 2,007 facilities reported ≥9 months of AU data from adult SAAR patient care locations (AU Report Excel Data Table 1a). The pooled mean SAAR values differ across location type and SAAR category (Table 3).

Table 3. Pooled mean SAAR values by adult location type and SAAR antimicrobial agent category

Adult SAAR Location Type	Adult SAAR Antimicrobial Agent Categories						
	All Antibacterial	BSHO	BSCA	GramPos	NSBL	CDI	Antifungal
Medical ICUs	0.998	1.023	0.935	0.977	1.016	1.243	0.974
Medical-Surgical ICUs	0.952	1.013	0.893	0.846	0.953	1.043	0.908
Surgical ICUs	0.939	0.985	0.956	0.834	0.780	1.169	1.063
Medical Wards	0.909	0.918	0.897	0.829	1.016	0.950	0.803
Medical-Surgical Wards	0.944	1.058	0.897	0.856	1.005	0.965	0.875
Surgical Wards	0.951	1.079	0.997	0.933	0.796	1.059	0.980
Step Down Units	0.925	0.943	0.911	0.836	0.954	0.991	0.839
General Hematology-Oncology Wards	0.989	0.974	1.034	0.858	1.066	1.087	0.834

Abbreviations: Standardized Antimicrobial Administration Ratio (SAAR), intensive care unit (ICU) All antibacterial agents (All Antibacterial), Broad spectrum antibacterial agents predominantly used for hospital-onset infections (BSHO), Broad spectrum antibacterial agents predominantly used for community-acquired infections (BSCA), Antibacterial agents predominantly used for resistant Gram-positive infections (GramPos), Narrow spectrum beta-lactam agents (NSBL), Antibacterial agents posing

MICU SAAR for BSHO: 1.19

2022 Pooled MICU Mean: 1.023

2022 MICU Percentile: 75th

Table 2b. Adult broad spectrum antibacterial agents predominantly used for hospital-onset infections (Adult BSHO)

Table 2b1: Adult broad spectrum antibacterial agents predominantly used for hospital-onset infections SAAR distributions, by SAAR location type

			Antimicrobial days		SAAR and 95% confidence limits (CL)			Percentile distribution of location-specific SAARs																				
Adult SAAR location type	No. of locations[1]	Days present	Observed	Predicted	SAAR	Lower CL	Upper CL	No. of locations with ≥1 predicted antimicrobial day[2]	5th	10th	15th	20th	25th	30th	35th	40th	45th	50th	55th	60th	65th	70th	75th	80th	85th	90th	95th
Medical ICUs	574	2,813,057	1,005,282	982,201.47	1.023	1.021	1.026	574	0.464	0.594	0.659	0.726	0.793	0.823	0.867	0.903	0.948	0.995	1.028	1.073	1.117	1.148	1.195	1.252	1.312	1.394	1.513
Medical-surgical ICUs	1,357	6,463,794	2,039,019	2,012,580.37	1.013	1.012	1.015	1,357	0.470	0.599	0.685	0.749	0.802	0.843	0.882	0.927	0.965	0.995	1.040	1.082	1.123	1.166	1.222	1.277	1.361	1.433	1.577
Surgical ICUs	263	1,351,019	412,185	418,284.79	0.985	0.982	0.988	263	0.426	0.539	0.632	0.705	0.734	0.784	0.827	0.865	0.905	0.955	0.993	1.036	1.083	1.145	1.206	1.275	1.351	1.447	1.527
Medical wards	1,936	18,809,903	2,377,540	2,590,301.77	0.918	0.917	0.919	1,936	0.283	0.411	0.495	0.562	0.609	0.656	0.704	0.758	0.821	0.874	0.934	0.988	1.051	1.107	1.175	1.257	1.364	1.485	1.687
Medical-surgical wards	2,788	26,685,983	3,573,745	3,379,087.83	1.058	1.057	1.059	2,788	0.295	0.445	0.560	0.648	0.722	0.791	0.854	0.921	0.982	1.043	1.105	1.165	1.222	1.296	1.367	1.450	1.550	1.680	1.915
Surgical wards	871	8,911,788	1,228,374	1,138,951.94	1.079	1.077	1.080	871	0.305	0.466	0.565	0.672	0.735	0.788	0.851	0.917	0.978	1.036	1.093	1.149	1.215	1.281	1.355	1.432	1.558	1.682	1.922
Step down units	1,184	9,985,708	1,515,123	1,607,531.02	0.943	0.941	0.944	1,184	0.319	0.401	0.500	0.575	0.646	0.706	0.761	0.813	0.869	0.933	0.991	1.045	1.108	1.177	1.256	1.354	1.454	1.590	1.791
General hematology-oncology wards	299	2,806,923	513,742	527,243.97	0.974	0.972	0.977	299	0.472	0.566	0.627	0.681	0.756	0.797	0.829	0.864	0.909	0.952	0.981	1.020	1.068	1.108	1.158	1.220	1.331	1.409	1.532

Drugs in adult broad spectrum antibacterial agents predominantly used for hospital-onset infections SAAR agent category: Amikacin (IV only), Aztreonam (IV only), Cefepime, Ceftazidime, Doripenem, Gentamicin (IV only), Imipenem with Cilastatin, Meropenem, Piperacillin with Tazobactam, Tobramycin (IV only)

1. The number of SAAR locations reporting at least 9 months of data in 2022. Values may differ by SAAR agent category and from values listed in Table 2b2 due to exclusion criteria used to produce SAARs and calculate percentages.
2. The number of SAAR locations reporting at least 9 months of data in 2022 with ≥1.0 predicted antimicrobial day. Locations with <1.0 antimicrobial day predicted for the entirety of 2022 are not included in SAAR distributions.

RESULTS: PART 1

Section 1: Table 1 Descriptive

Compare your hospital's characteristics to Study Hospitals

Emulates publicly available data from NHSN and includes SAAR variables

Is my hospital unique?

	Study Hospitals N=50	Your Hospital
Facility Type	Acute Care 43 (84%) Critical Access 7 (14%) Children's 1 (2%)	Acute Care
Teaching status	None 25 (49%) Major Teaching 14 (27%) Graduate 6 (11%) Undergraduate 6 (11%)	Major Teaching
Bed Size	181 (37-369)	450
Number of ICU Beds	20 (4-66)	138
% ICU Beds	11.6% (6-18.9%)	30.67
Calculated Avg LOS	4.1 (2.4-4.8)	4.66
Unit Summary	(SAAR eligible units)	

Section 2: Unadjusted, Facility-wide Rates

Histograms, by Adult Agent Group

Is my hospital's AU rate an outlier?

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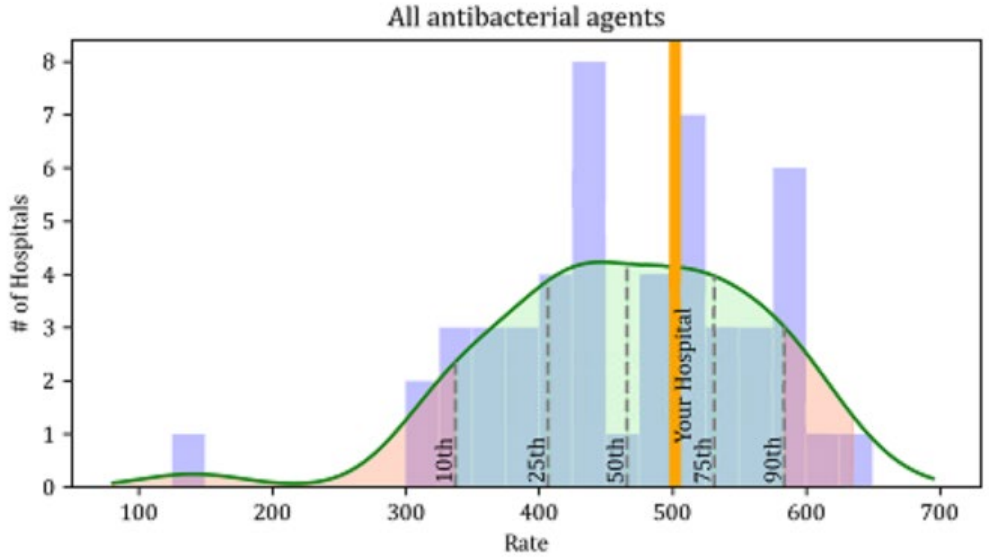


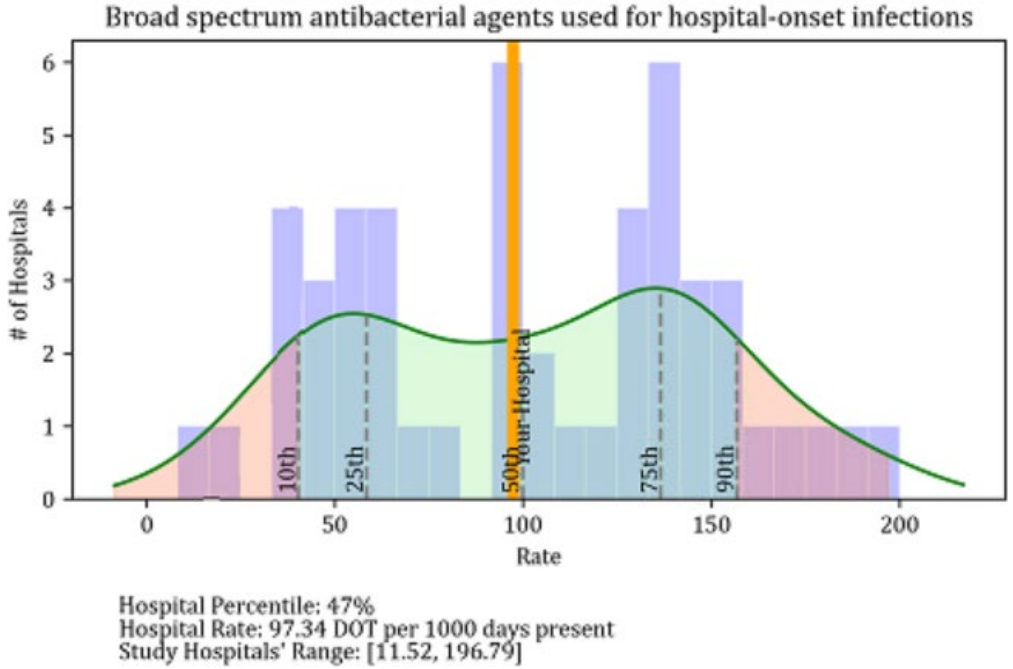


Table 2: Top 10 Agents' Rates

Compare your Hospital's Facility-Wide Agent Use to Study Hospitals

Top Antimicrobial by Rate	N	Hospital Rate (DOT/1000dp*)	Study Hospital Cohort Median [25%, 75%] (DOT/1000dp*)	Percentile
Ceftriaxone	1	65.8	73.0, (61.3,88.7)	36
Vancomycin	2	65.6	50.9, (30.2,73.3)	66
Cefazolin	3	46.3	44.6, (28.9,59.8)	60
Metronidazole	4	41.8	30.7, (25.8,37.6)	86
Cefepime	5	38.1	34.5, (20.4,46.6)	60
AmpicillinSulbactam	6	36.7	7.7, (4.5,11.5)	100
PiperacillinTazobactam	7	30.0	36.3, (23.6,66.6)	38
Meropenem	8	23.6	8.8, (5.0,13.7)	90
Levofloxacin	9	21.6	9.2, (5.8,20.1)	78
SulfamethoxazoleTrimethoprim	10	20.9	6.7, (4.6,10.9)	94

Section 3: Unit-Level AU, O:E (SAAR)

By Unit and Agent Group

Observed and Expected AU Rate

O:E Ratio (2017 SAAR on 2022 data)

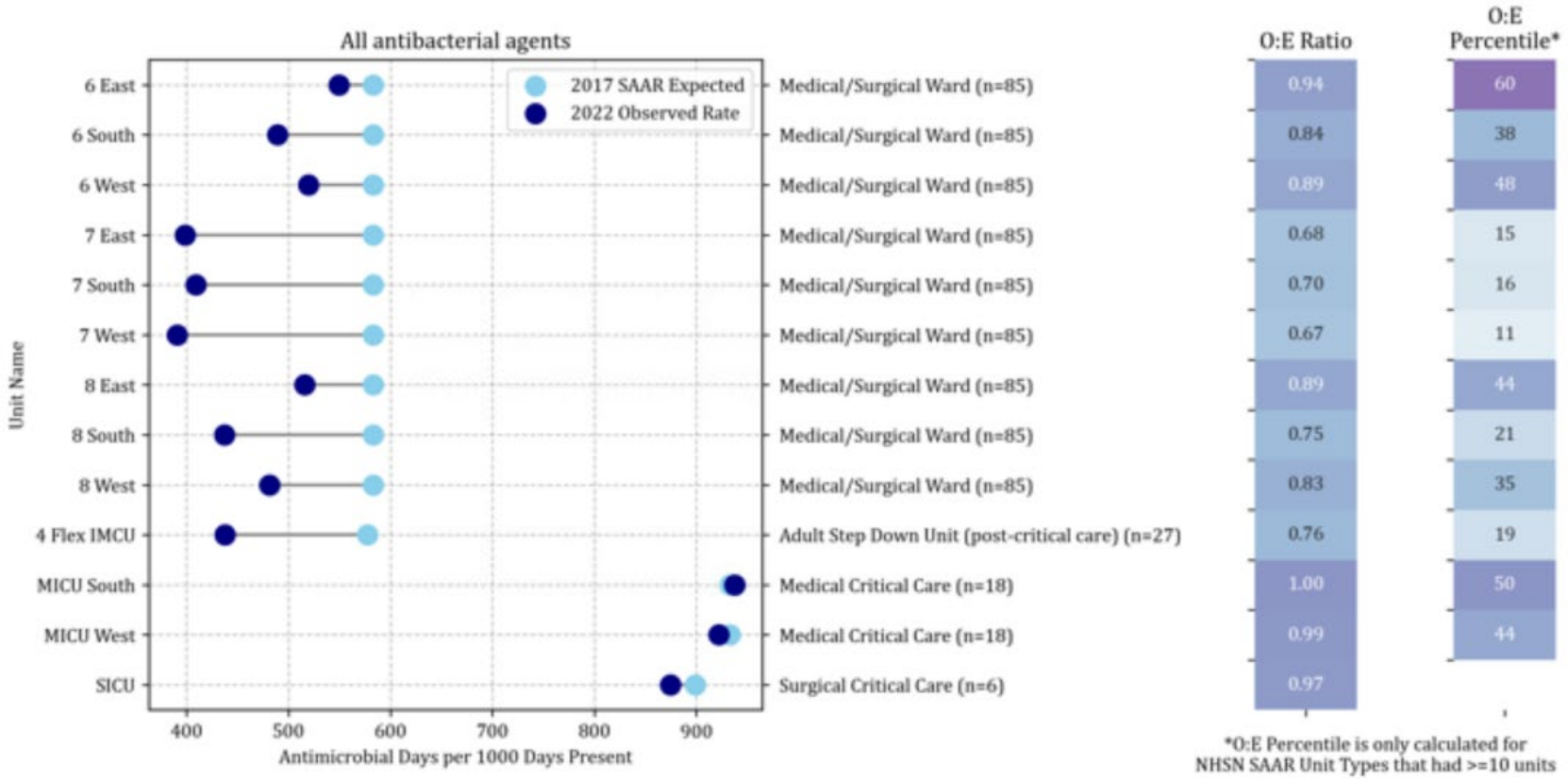
Percentile: O:Es among all units of that type in the study

- Not calculated if <10 units of that type in the study

Only units eligible for SAARs

Is my UNIT's SAAR an outlier?

Figure 2A. Adult SAAR Categories



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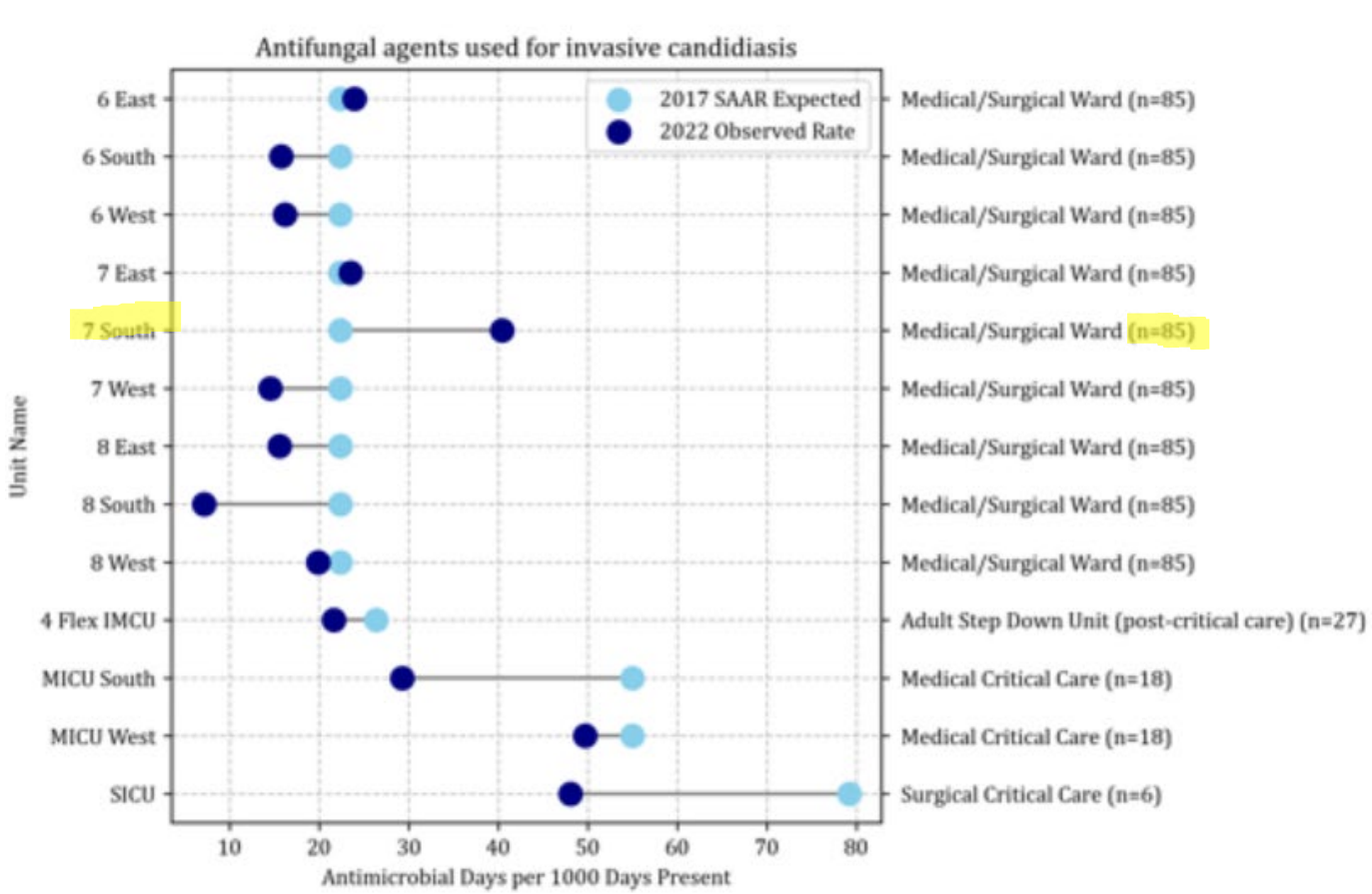
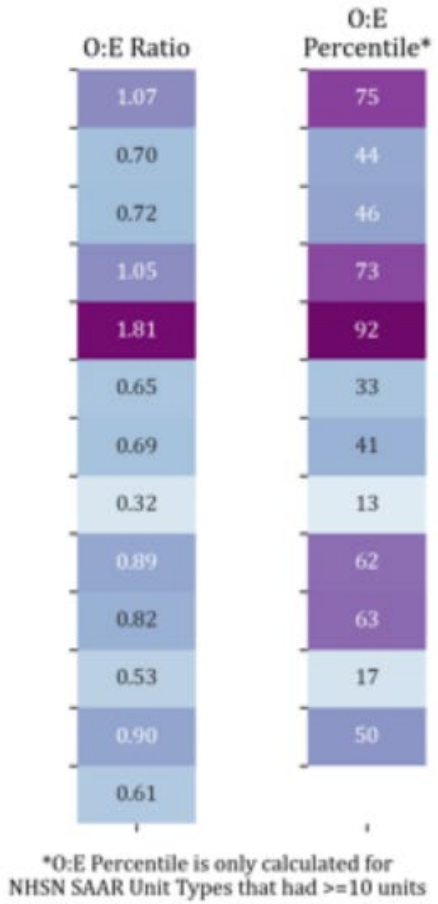
Anti-fungal Agents Group





7 South:

O:E Ratio: 1.81
as compared with 2017 SAAR model expected value

O:E percentile: 92%
Among 85 other Med/Surg Wards in Study Hospitals, 2022

Appendix: Data Points in the Reports

For those of you who need Excel sheets

Next Steps: Survey Questions

If your ASP can't come up with 3 Target Areas for each response, it's ok.

Select N/A.

This requires PRIORITIZATION.

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POC: Take a look through the Survey Questions

Review Part 1 Data with your ASP Team

As you review:

- Identify Top 3 Focus Areas for 3 Possible ASP Responses
- Combo of Location + Agent Group (Adult and Pediatrics separated)

Possible ASP Responses
Known problem area/Action Needed
Possible opportunity/Investigate Further
Doing well/ Provide positive feedback + Highlight performance

POC: Provide REDCAP Survey Response

R-SAARs Resources for your team

1. R-SAARs materials: https://dason.medicine.duke.edu/research-publications

2. Site PIs:

Epicenter	Contacts
Duke-UNC DASON	Rebekah Moehring and DASON: Libby Dodds Ashley, Melissa Johnson, Angelina Davis
Utah, Intermountain	Emily Spivak and Whitney Buckel
Chicago	Carlos Santos and Bill Trick
Hopkins	Sara Cosgrove and Eli Klein

3. Duke study team contacts:

Rebekah Moehring, MD, MPH
Associate Professor of Medicine
Lead faculty and PI
rebekah.moehring@duke.edu

Duke Center for Antimicrobial Stewardship and Infection Prevention
Duke Hospital ASET, Medical Director

Rachel Addison, MT, MPH
Lead Regulatory and Clinical Research Coordinator
rachel.addison@duke.edu

Duke Center for Antimicrobial Stewardship and Infection Prevention
Regulatory Coordinator

Duke Center for Antimicrobial Stewardship and Infection Prevention