MEASURING ANTIMICROBIAL USE

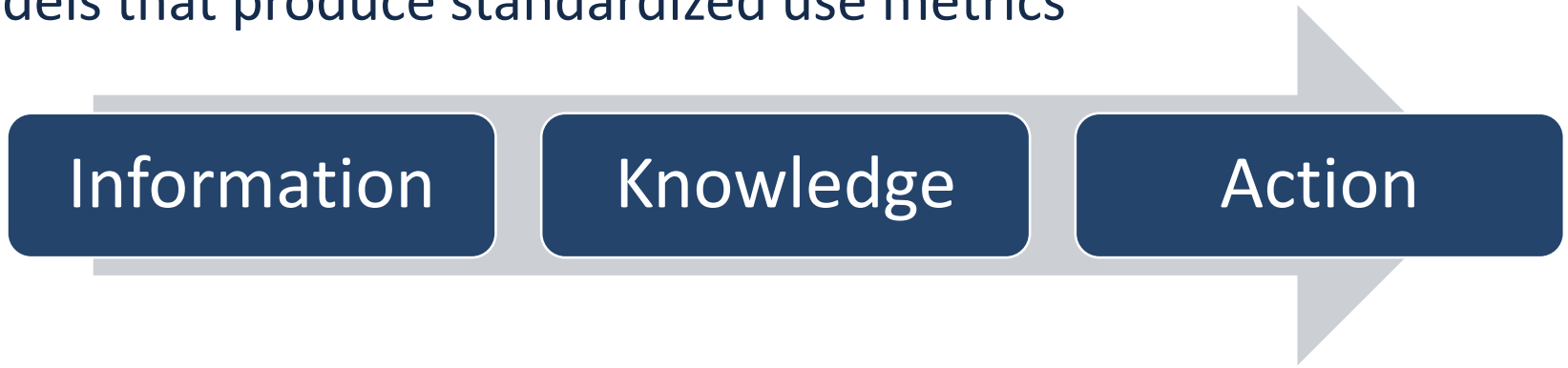
November 16, 2017
SHEA ASRW

Whitney R. Buckel, PharmD, BCPS-AQ ID
System Antimicrobial Stewardship Pharmacist Manager

LEARNING OBJECTIVES

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

- Define common or standard antimicrobial use metrics for your stewardship research project
- Identify likely sources of variation when comparing antimicrobial use between institutions
- Indicate the role of risk adjustment when comparing facilities
- Describe predictive models that produce standardized use metrics



Define common or standard antimicrobial use metrics for your stewardship research project

REVIEW OF CONSENSUS STATEMENTS

Included in four consensus statements:

1) Days of therapy (DOT) per 1,000 patient days
    - Or Defined Daily Doses (DDD)

Included in one or more consensus statements:

1) Days of excess or avoidable antibiotic use
2) Days of therapy per admission

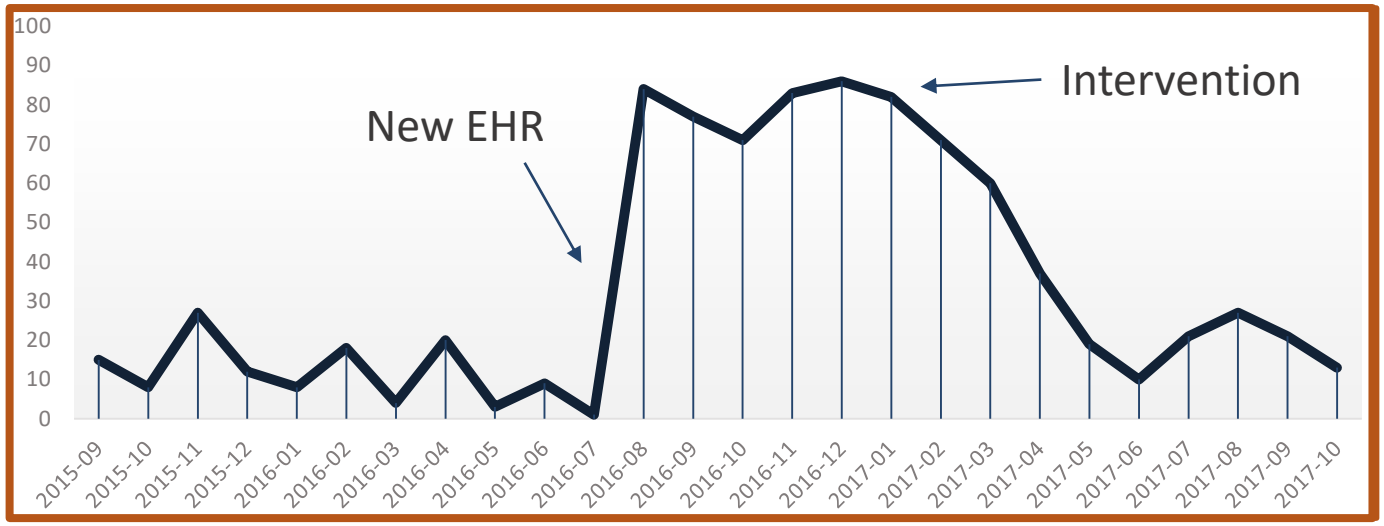
Morris AM et al. *Infect Control Hosp Epidemiol* 2012;33(5):500-6. Pollack LA, et al. *Infect Control Hosp Epidemiol* 2016;37(10)1201-11. Moehring RW, et al. *Clin Infect Dis* 2016;64(3):377-83. Thern J et al. *Infection* 2014;42;351-62. Van den Bosch et al. *Clin Infect Dis* 2015;60:281-91.

ANTIMICROBIAL DOSES

If it's simple, and it works, don't overcomplicate it.

Very effective stewardship interventions can occur by measuring number of doses.

Number of Clindamycin Doses Before and After Switching EHRs



Data courtesy of Laurie Blankenship, PharmD

ANTIMICROBIAL DEFINED DAILY DOSE (DDD)

"the assumed average maintenance dose per day for a drug used for its main indication in adults" found in the Anatomical Therapeutic Chemical Classification System and DDD index

- For example, for ceftriaxone this is 2 grams per day

Calculation: Sum of [Total grams of each antibiotic ÷ DDD for each antibiotic]

Strengths

- Promoted by the World Health Organization
- Original metric
- Easy to calculate

Limitations

- Not applicable to pediatric patients
- Dose adjustments skew the data
- Certain drugs have very inaccurate estimates of days of therapy

ANTIMICROBIAL DAYS OF THERAPY (DOT)

A day of therapy is any day in which at least one dose is received

For example:

- Cefazolin 1 g x1 = 1 DOT cefazolin
- Cefazolin 2 g IV q8h = 1 DOT cefazolin
- Vancomycin plus ceftriaxone = 2 DOT (1 for vancomycin, 1 for ceftriaxone)

Strengths

- Promoted by the Centers for Disease Control and Prevention
- Applicable to pediatric patients
- Less between drug discrepancies

Limitations

- More difficult to calculate
- Overestimates true days of therapy for drugs dosed multiple times per day
- Unrelated to total grams of antibiotic

DEFINED DAILY DOSE VS DAYS OF THERAPY

Comparison of values between 130 different U.S. hospitals

Mean number of hospital beds: 288 +/- 176 (range 20 – 1020)

	Hospitals	DDD/1,000 PD	DOT/1,000 PD	Difference	DDD g/day	Actual g/day
Total	130	792 ± 147	776 ± 120	p=0.137; 60% correlation		
Ceftriaxone	130	45 ± 28	63 ± 36	- 29*	2	1.46
Pip-tazo	127	30 ± 20	43 ± 29	- 41*	14	10.1
Levofloxacin	123	76 ± 58	75 ± 56	0.7	0.5	0.51
Ciprofloxacin	123	18 ± 22	14 ± 16	+ 25*	0.5	0.72

*Statistically significant

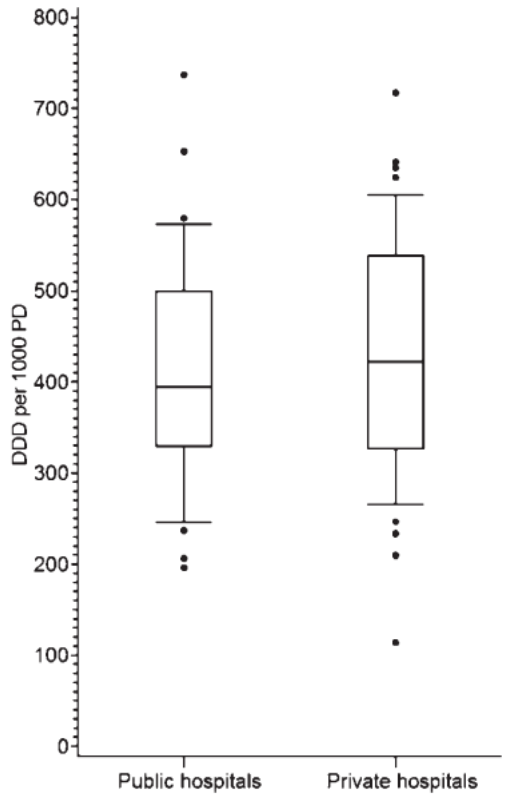
Polk et al. *Clin Infect Dis* 2007; 44:664–70

NORMALIZATION PER 1,000 PT DAYS or 100 ADMISSIONS

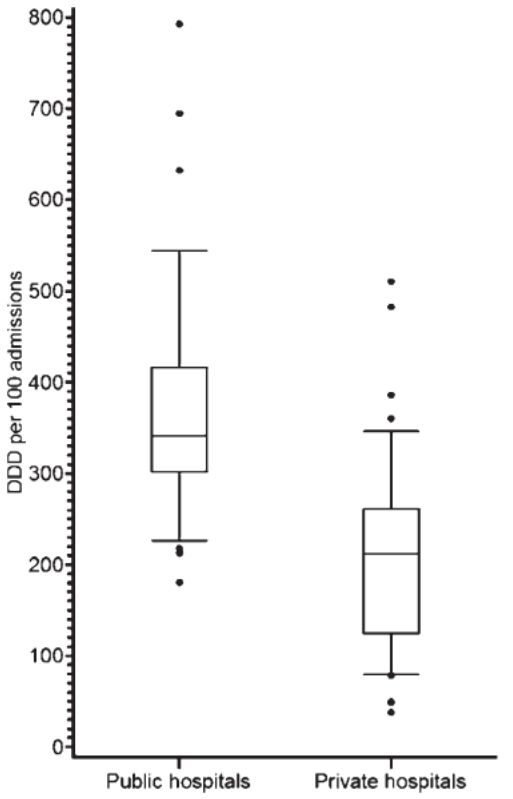
Evaluation of 77 (36%) hospitals in south-western France

FIG. 1. Distribution of total antibiotic consumption in public and private hospitals, expressed as defined daily doses (DDD)/1000 patient-days and 100 admissions. The box stretches from the lower hinge (the 25th percentile) to the upper hinge (the 75th percentile). The median is shown as a line across the box. Therefore, a quarter of the distribution is between this line and the top of the box. The line above the upper hinge is the 90th percentile and the line below the lower hinge is the 10th percentile. Filled circles represent hospitals which have a total consumption superior at the 90th percentile or inferior at the 10th percentile.

DDD per 1,000 PDs



DDD per 100 Adm



The median length of stay in private hospitals was shorter than in public hospitals (4 vs 8 days)

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Amadeo et al. *Clin Microbiol Infect* 2010;16:735-41

OTHER

Length of antimicrobial therapy

Antimicrobial-free days

Proportion of admissions receiving specific antimicrobial

Antimicrobial de-escalation rate

Antimicrobial cost of therapy

Antimicrobial prevalence (point-prevalence surveys)

Morris A. *Curr Treat Options Infect Dis* 2014;6:101-12

Identify likely sources of variation when comparing antimicrobial use between institutions

Both warranted and unwarranted variations in antibiotic use exist.

Both random and assignable variations in antibiotic use exist.

The goal is to understand the variation and reduce unwarranted variation.

SOURCES OF VARIATION IN ANTIBIOTIC USE

Differences in the patients being cared for

- Rate and types of infection
- Antimicrobial resistance rates
- Percent with high severity of illness

Differences in clinical practice patterns

- Local infectious diseases guidelines (and associated adherence rates)
- Changes in prescribing due to drug shortages
- Lack of evidence or disagreement among experts

DETERMINING CAUSE OF VARIATION

Ask clinicians

Medication use evaluation

} Small Scale

Statistical evaluation

Risk adjustment

Benchmarking

} Large Scale

CLINICAL SERVICE LINES AND FLOOR TYPE

Clinical service line impacts the percent of patients receiving antibiotics

- Among 70 academic medical centers, 14% of psychiatry patients received an antibiotic, while 100% of liver transplant patients received an antibiotic

Intensive care unit floor type also significantly contributes to antimicrobial use

- Proportion of patient days with an ID diagnosis code and hospital location (ICU versus other) explained 46-51% of the variation in over 500 U.S. hospitals

Polk et al. *Clin Infect Dis* 2011;53(11):1100-10. Baggs J, Fridkin S, Pollack L, Srinivasan A, Jernigan J. Oral abstract #685 IDWeek 2015

CASE MIX INDEX

The sum of the total cost weights of all inpatients per a defined time period divided by the number of admissions.

- The cost weight of a diagnosis-related group (DRG) X is defined by dividing the average cost per case of DRG X by the mean cost per case on a nationwide level.

Switzerland example

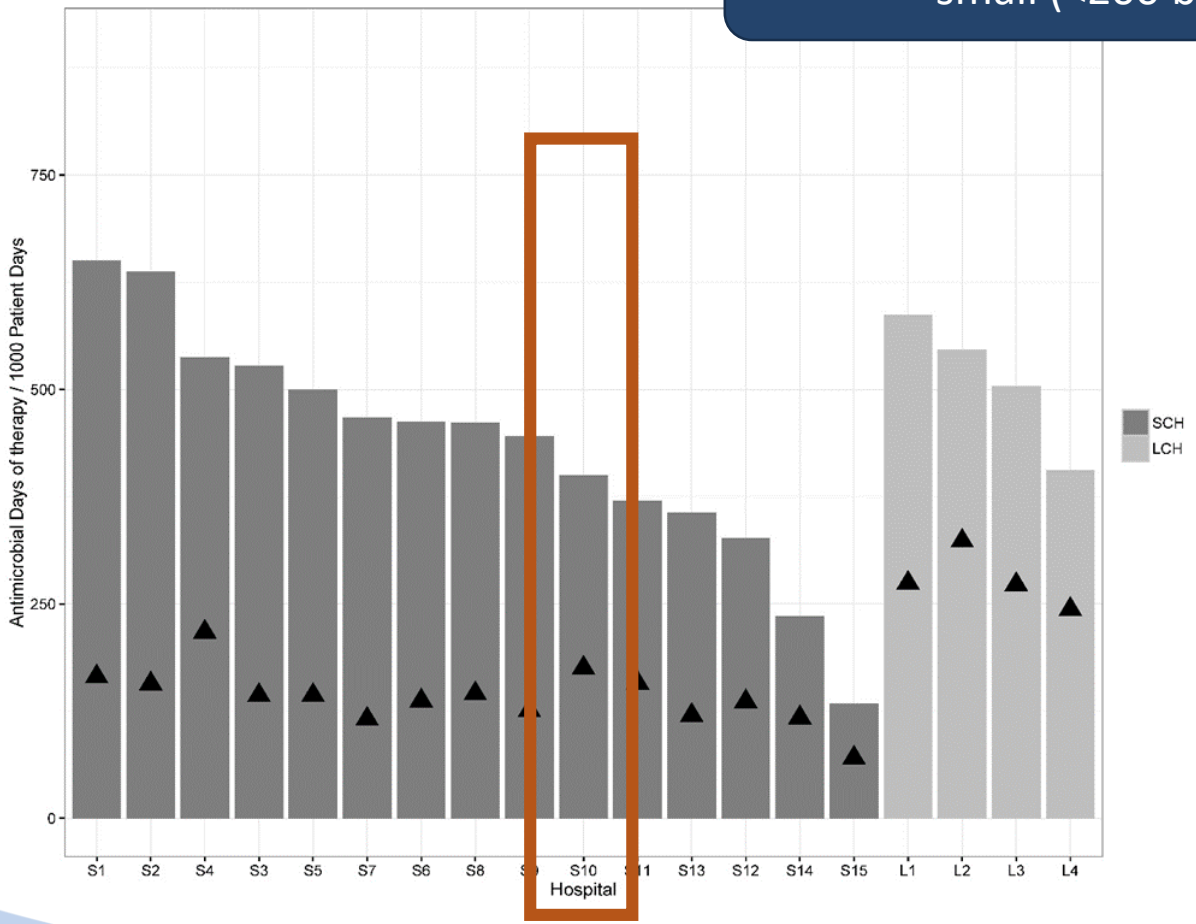
- CMI significantly correlated with DDD/100 bed-days
  - Explained 57% of the variation between units at a tertiary care university hospital
  - Explained 46% of the variation between 13 acute care hospitals

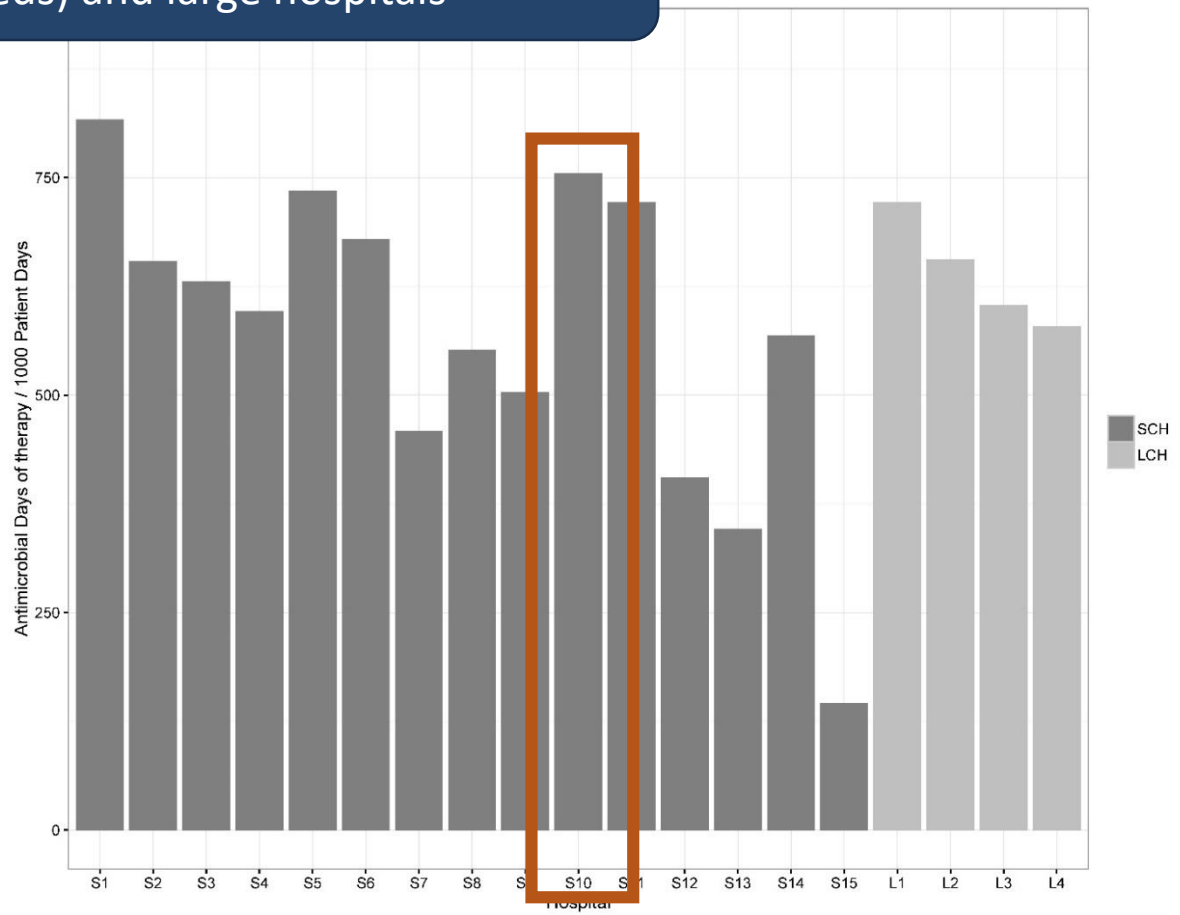
Big limitations: (1) divided by number of admission, not patient-days
(2) definitions and variables change over time

Kuster et al. *J Antimicrob Chemother* 2008;62:837-42

HOSPITAL SIZE

DOT per 1,000 patient days present similar between small (<200 beds) and large hospitals





▲ case-mix index

Excluding labor & delivery, maternity, nursery, psychiatry units

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Stenehjem et al. *Clin Infect Dis* 2016;63(10):1273-80

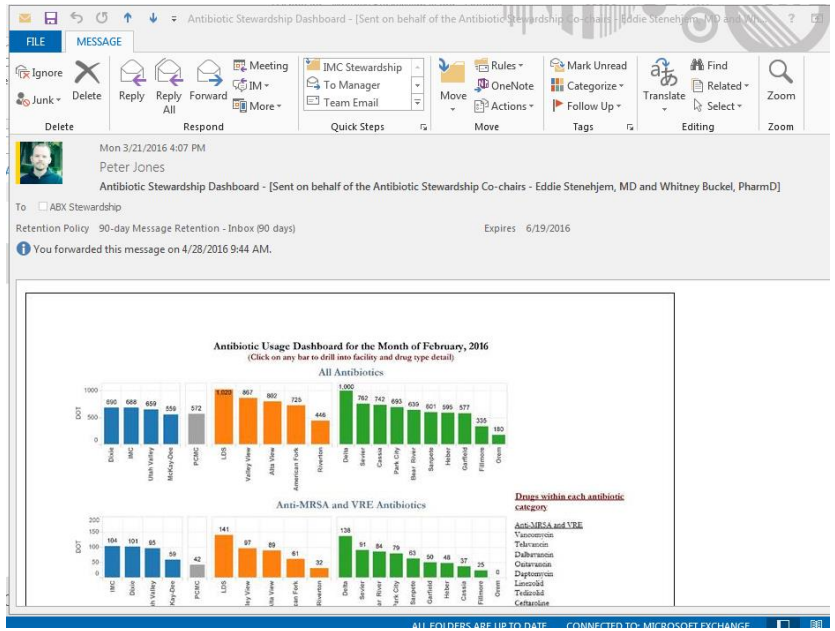
OTHER CHARACTERISTICS

- Surgical volume
- Proportion patients surgical DRG
- No. cases of pneumonia
- No. cases of UTI
- No. cases of bacteremia
- Teaching status
- Proportion ID ICD-9/10 codes
- Rates of resistant organisms
- Average patient age
- Average patient comorbidity score
- Urban or rural location

MacDougall C et al. *Infect Control Hosp Epidemiol* 2008;29(3):203-11.
Baggs J, Fridkin S, Pollack L, Srinivasan A, Jernigan J. Oral abstract #685 IDWeek 2015

Indicate the role of risk adjustment when comparing facilities

YOUR ADMINISTRATOR



Thanks for sending the antibiotic use report my way. To me, this looks like our DOT is pretty good. Is that accurate?

CHOICE, CHANGE, COMPLETION (CCC)

The Veteran Affairs Health Care System has developed a novel approach

Look at antimicrobial use and spectrum as a proportion of admissions

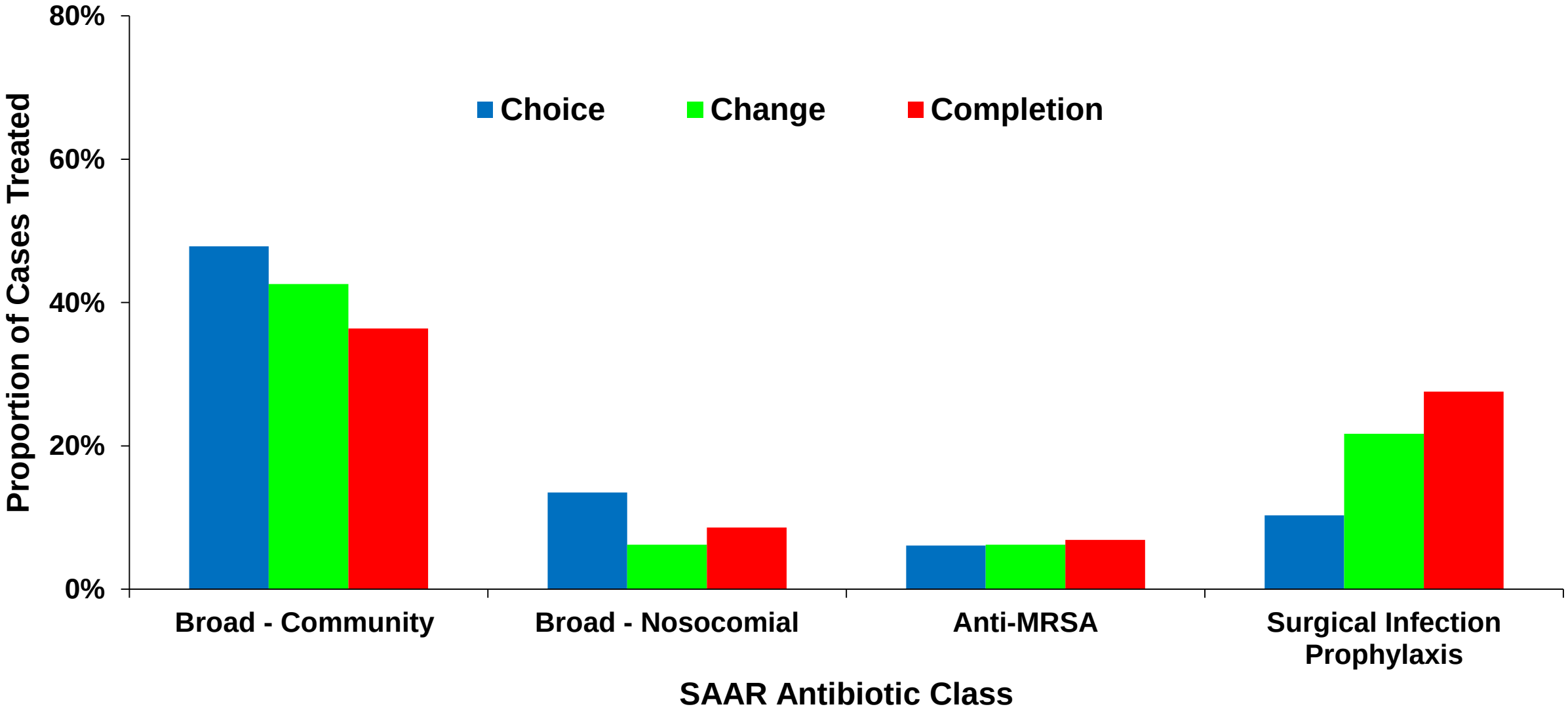
- At Choice (0 – 2 days)
- At Change (3 – 4 days)
- At Completion (5+ days or discharge)

Proportion may add up to > 1 as patients may receive more than one drug class within the specified time-frame

The next 3 slides are courtesy of Jesse Sutton, PharmD, Salt Lake City VA

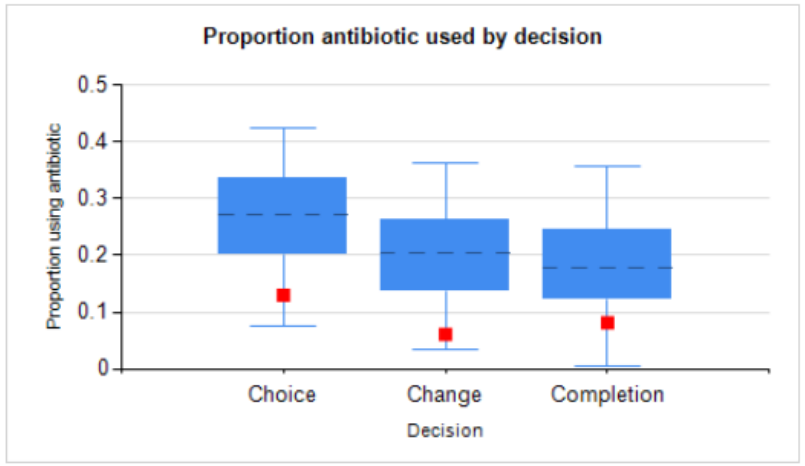
Pneumonia Antibiotic Use by Choice Change Completion

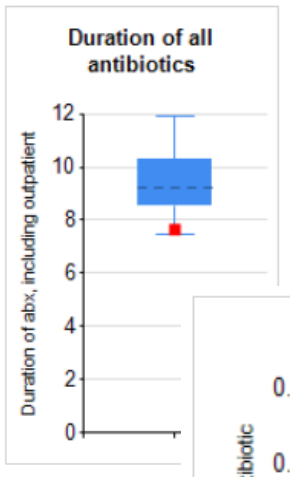
Hospital F: Acute Medical & Surgical Wards (2016)

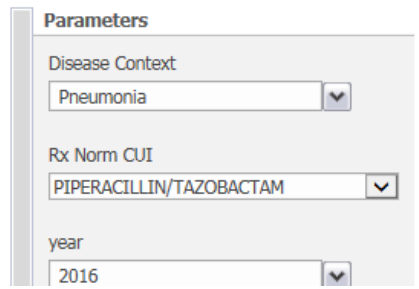


Indication-Specific Antibiotic Use by Choice Change Completion

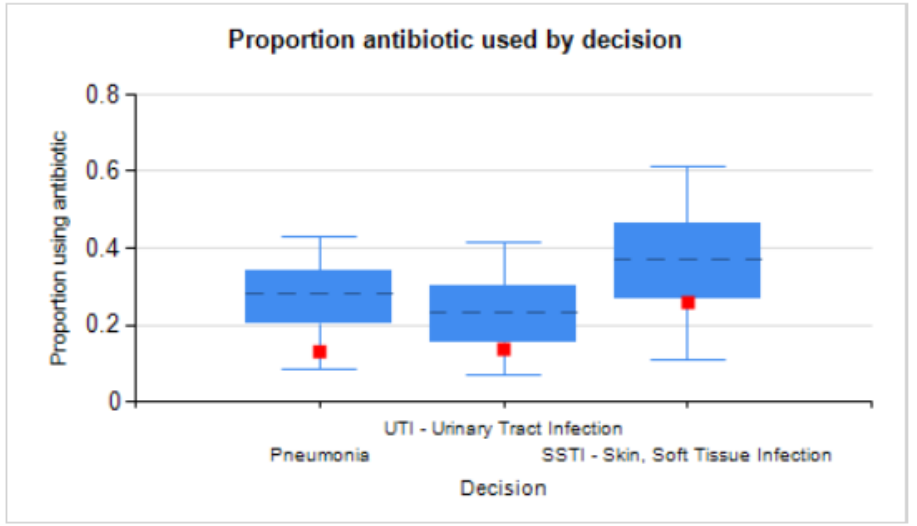
Single Hospital Comparison to Other Sites







whiskers: 5th and 95th percentile
box IQR
dotted line: median
Red dot: your facility



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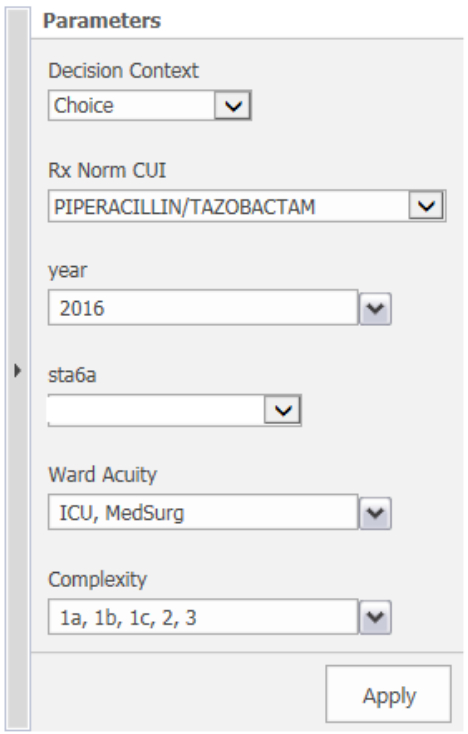


ANTIBIOTIC USE RISK ADJUSTMENT

No external goal for antibiotic use exists

- However, we know the goal *cannot* be zero

Metric benchmarking of antibiotic use can compare hospitals

- Helps when you cannot compare yourself to another hospital “exactly like you”
- 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

ANTIBIOTIC USE ADJUSTMENT

Modifiable

- Implementation of guidelines
- Adherence to guidelines
- Antibiotic use policies
- Prescriber education
- Patient expectations

Non-modifiable (at least not easily)

- Hospital bed-size
- ICU-beds
- Infectious diseases diagnoses
- Antibiotic resistance rates
- Case-mix index

Focus of benchmarking

THE ROLE OF BENCHMARKING, AND ITS BARRIERS

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

Ibrahim & Polk. *Expert Rev Anti Infect Ther*. 2012;10(4):445-57.

Describe predictive models that produce standardized use metrics

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 (retroactively 2011)

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 to the AU Module

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
- Expresses observed antibiotic use compared to predicted use

The SAAR is risk adjusted based only on facility and location characteristics

- E.g. presence of ICUs, hospital size, teaching status, ward type
- Indirect standardization via negative binomial regression

In January, 2016 The Standardized Antibiotic Administration Ratio was endorsed by the National Quality Forum

- For public health surveillance and quality improvement only

CDC SPECTRUM DEFINITIONS

Broad spectrum agents predominantly used for		Anti-MRSA agents	Agents predominantly used for surgical site infection prophylaxis
hospital-onset/ multi-drug resistant bacteria	community-acquired infection		
aminoglycosides imi/meropenem cefepime/cefazidime β-lactam/βLIs (PsAr) aztreonam colistin/polymyxin tigecycline	ertapenem cefotaxime ceftriaxone ciprofloxacin levofloxacin moxifloxacin	ceftaroline dalba/oritavancin daptomycin line/tidezolid quinu/dalfopristin, telavancin vancomycin IV	cefazolin cefotetan cefoxitin cefuroxime IV

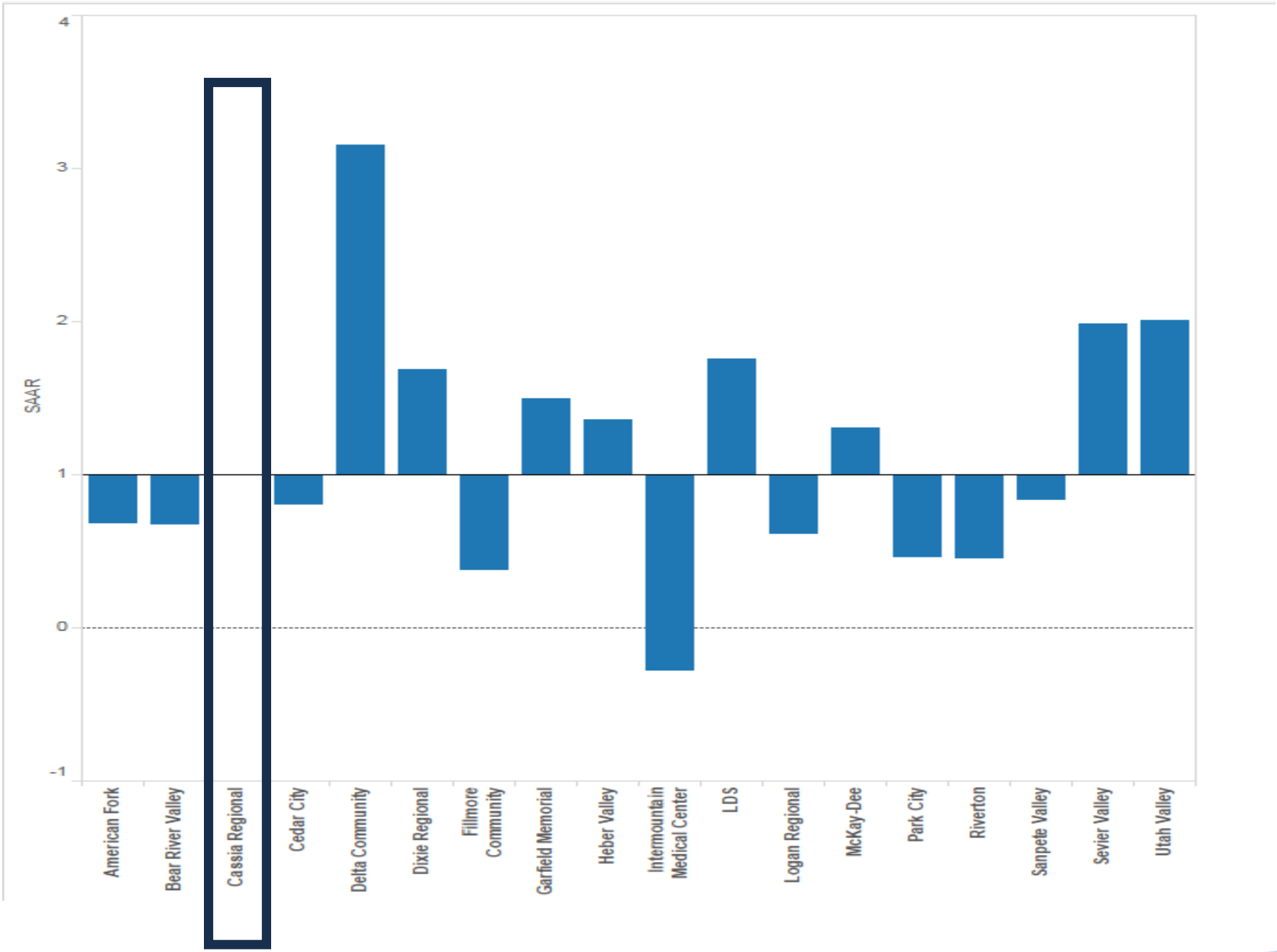
SAARs CURRENTLY AVAILABLE

All antimicrobials	Medical and surgical ICUs and wards	
Antimicrobials for hospital-onset/ multi-drug resistant infections	M/S ICUs	M/S wards
Antimicrobials used for community-onset infections	M/S ICUs	M/S wards
Anti-MRSA antimicrobials used	M/S ICUs	M/S wards
Antimicrobials used for surgical site infection prophylaxis	Medical and surgical ICUs and wards	

EXAMPLE SAARs

Facility-wide

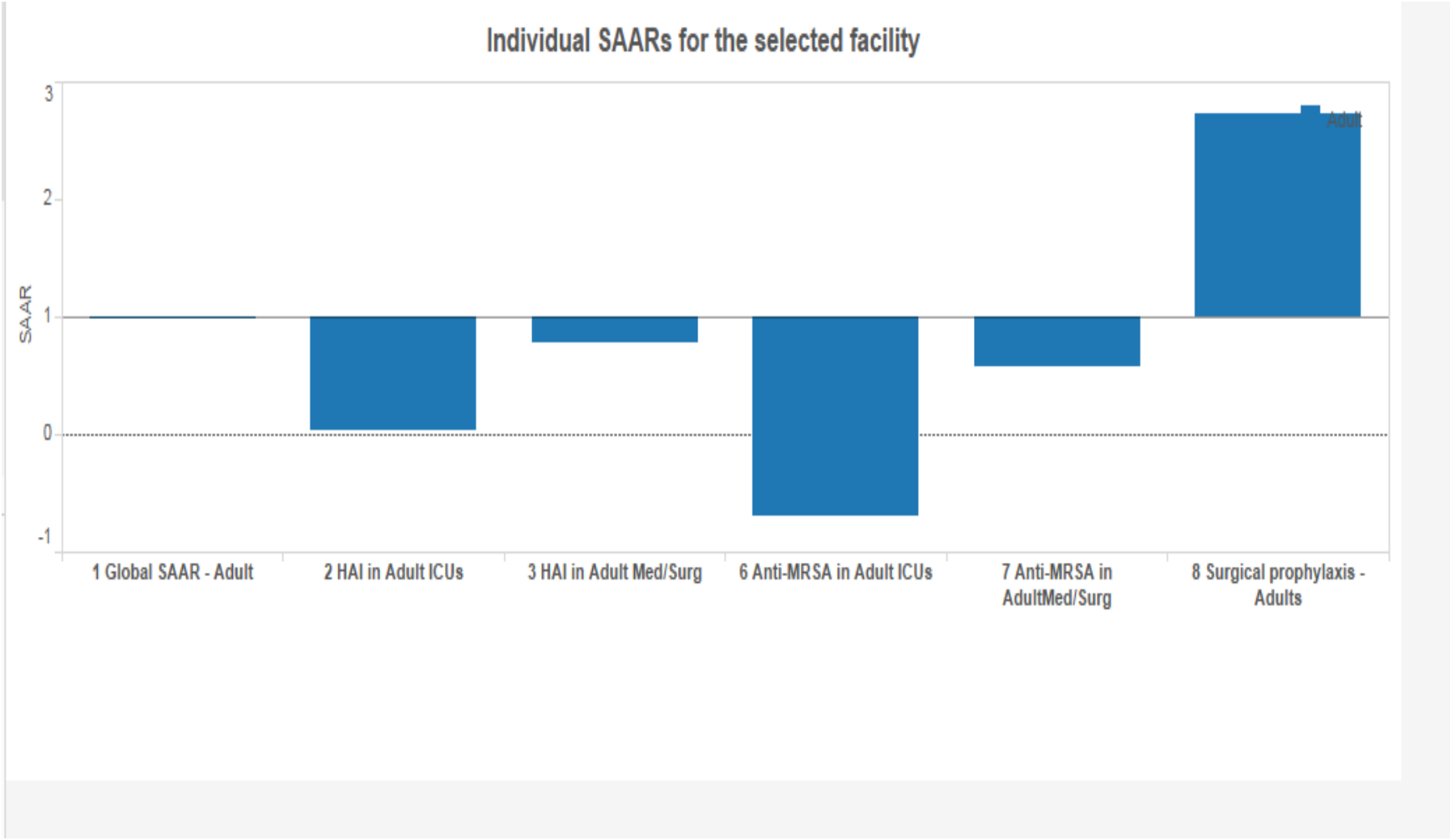
System-view



EXAMPLE SAAR

Single Hospital

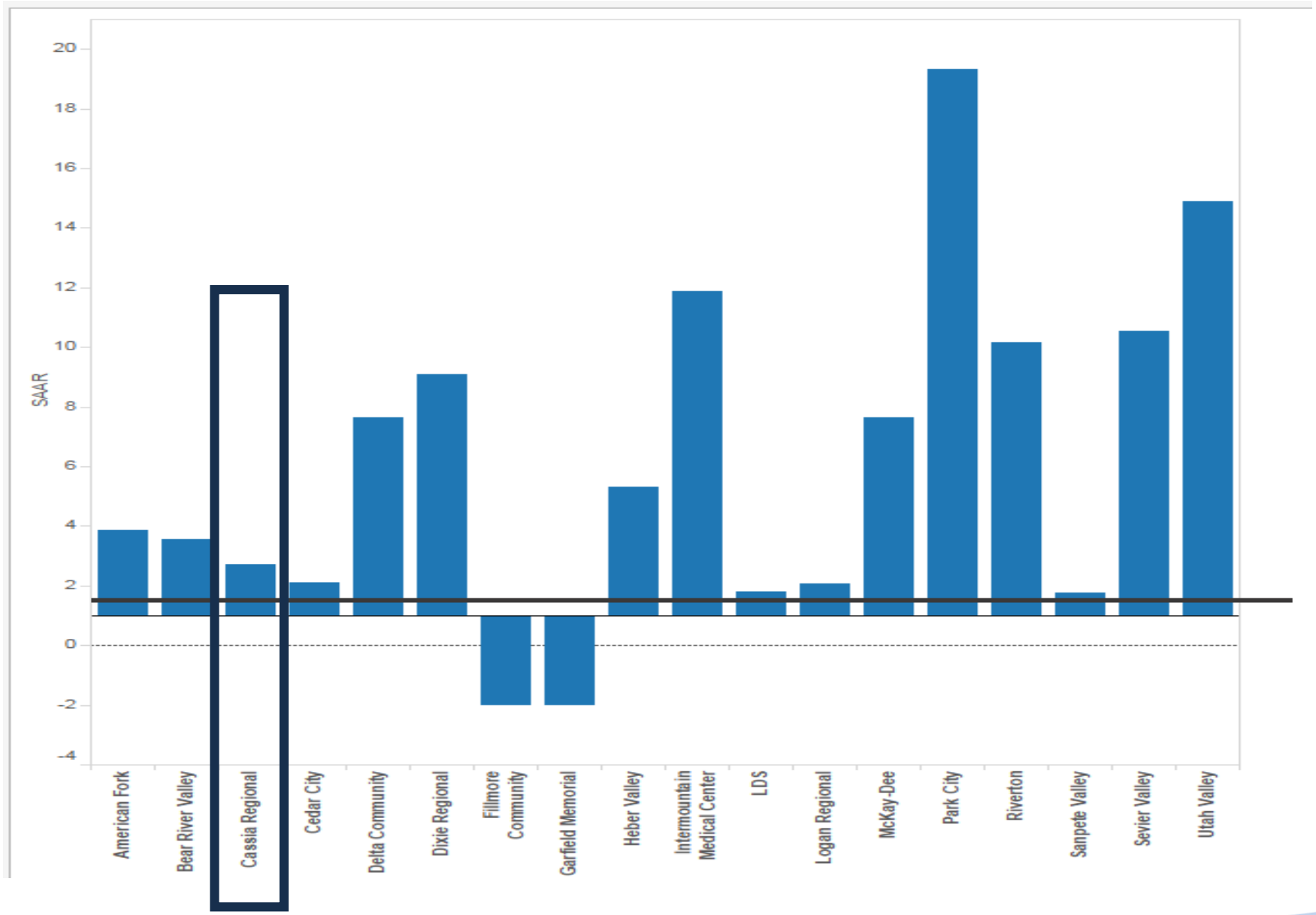
Unit-level View



EXAMPLE SAAR

Surgical prophylaxis

- cefazolin
- cefotetan
- cefoxitin
- cefuroxime IV



THE SAAR

Strengths

- Largest comparison of antibiotic use across hospitals
- Adjustment for hospital-level characteristics
- Large denominator increases ability to detect statistically significant differences

Limitations

- Floor type classifications
- No patient level diagnostic or microbiologic data in risk adjustment
- More hospitals needed
- Not linked to appropriateness

→ which may not be clinically meaningful

Image: https://www.pinterest.de/explore/indiana-jones-holy-grail/

CONCLUSION

Tailor your antimicrobial use metric to your intervention

- If general intervention, consider DOT per 1,000 patient days present

Consider benchmarking in the evaluation of your stewardship program

- Either with SAAR or other measures of antimicrobial use
- To assess new areas for potential intervention or evaluate the impact of an occurring intervention, realizing that in some cases high use may be justified

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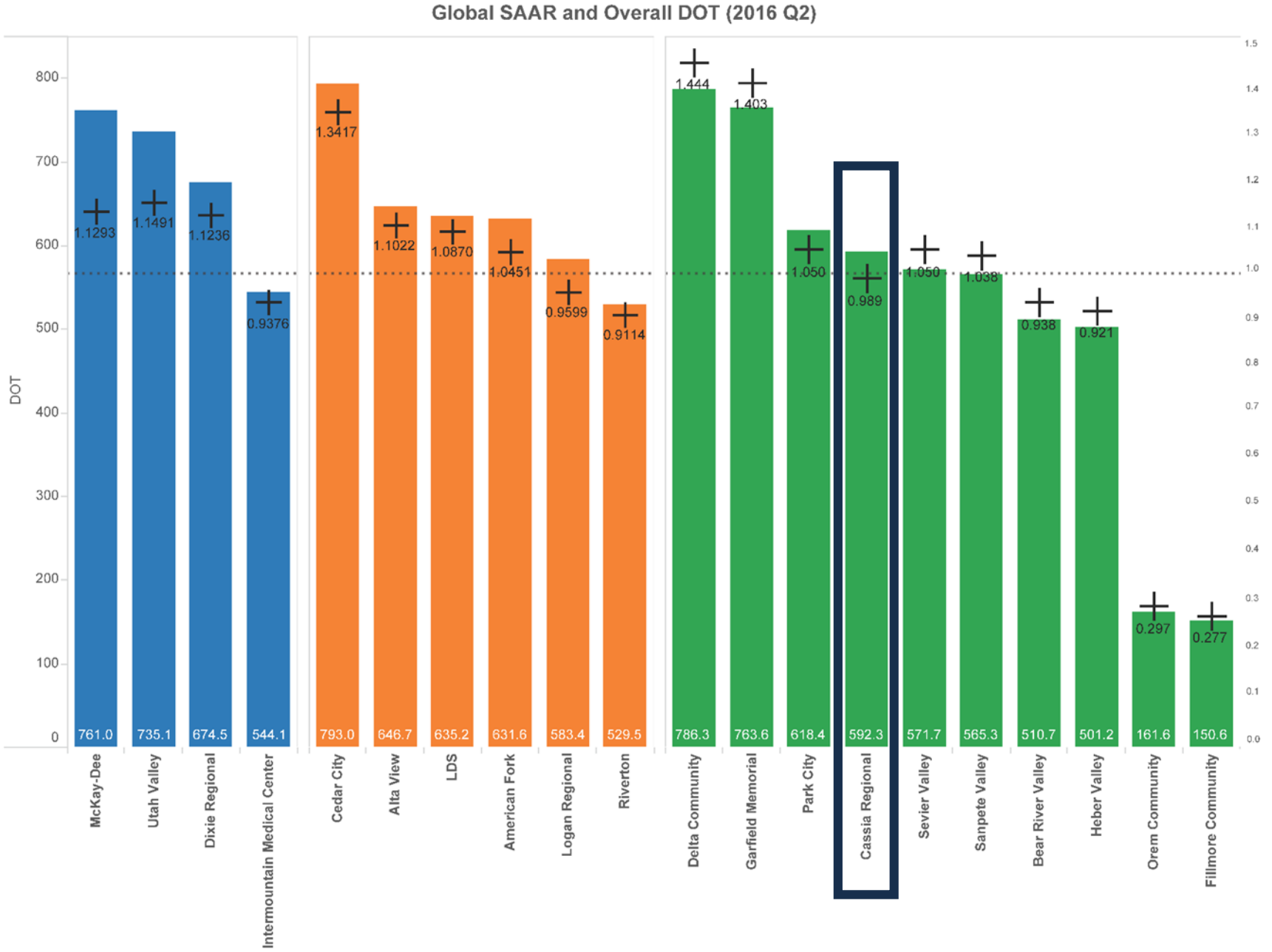

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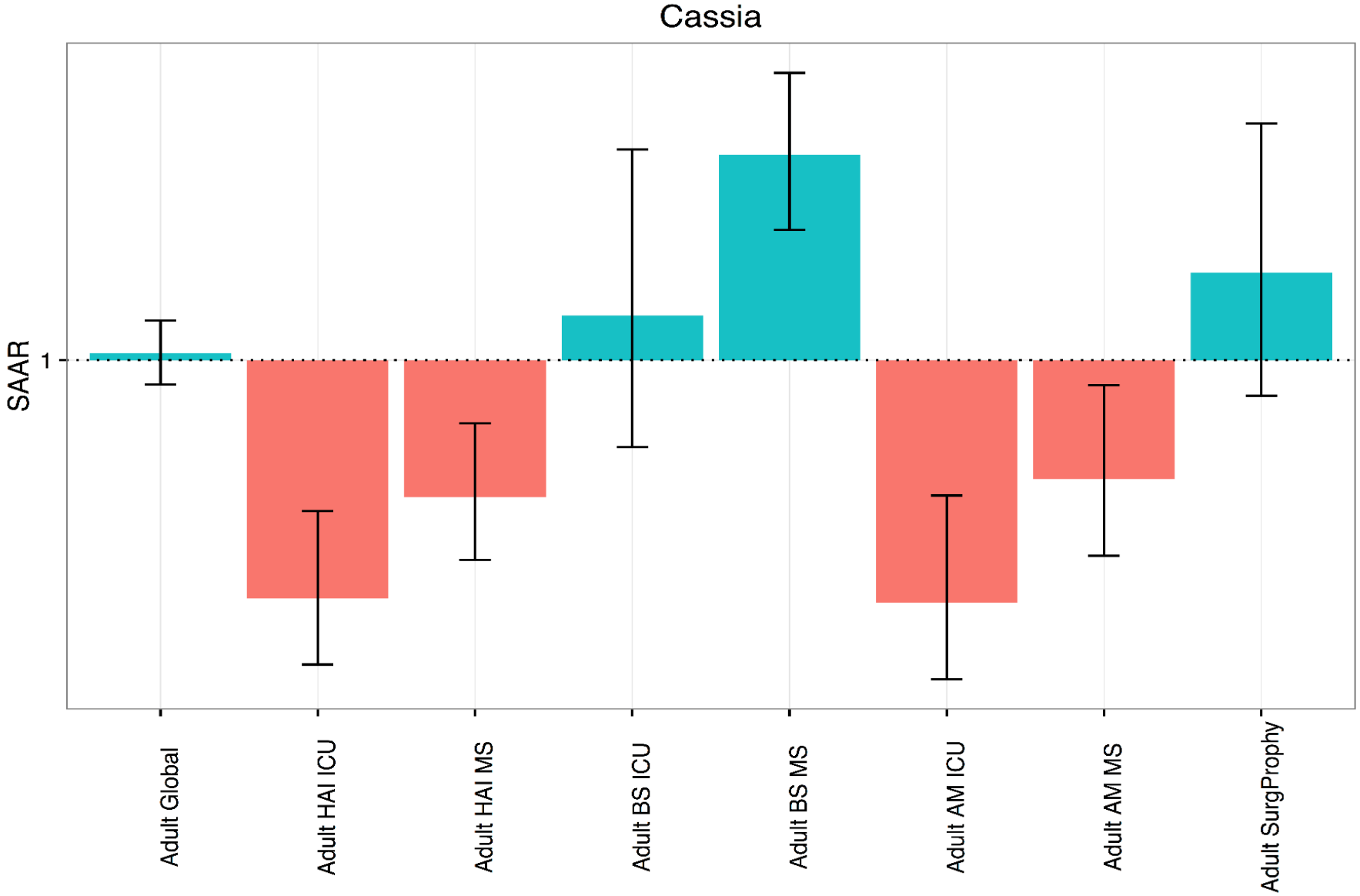

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