

# Standardized Antimicrobial Administration Ratio (SAAR)

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# Outline

- SAAR overview
- 2017 baseline adult and pediatric SAAR models
- 2018 baseline neonatal SAAR models
- The SAAR and antimicrobial stewardship
- Next Steps

# SAAR Overview

# Overview

## ■ What is the SAAR?

- The SAAR, or Standardized Antimicrobial Administration Ratio, is a standardized metric of antimicrobial use (AU) available to facilities reporting data to NHSN's AU Option from specified patient care locations
- Observed-to-Predicted Ratio (similar to the SIR)
- First developed in 2015 using data reported to the AU Option in 2014
- Provides the quantitative foundation for the NHSN antimicrobial use clinical quality measure endorsed by the National Quality Forum (NQF)

# Overview

- As an Observed-to-Predicted Ratio, the SAAR allows facilities to compare their AU to the AU of a standard referent population (i.e., NHSN baseline)
  - **Observed AU:** antimicrobial days of therapy reported by a hospital for a specified group of antimicrobial agents used in a specified patient care location or group of locations
  - **Predicted AU:** antimicrobial days of therapy predicted for a hospital for a specified group of antimicrobial agents used in a specified patient care location or group of locations on the basis of negative binomial regression modeling applied to nationally aggregated AU data

# Overview

- **Why was the SAAR developed?**
  - Enable antimicrobial stewardship programs and other users to measure and track antimicrobial use
  - Facilities can monitor antimicrobial days of therapy (DOT) and rates of use, which are measurements of AU that do not take differences in risk between populations into account and should not be used for comparisons of AU over time or across reporting entities
  - The SAAR was developed to enable risk-adjusted comparisons of AU over time and across entities

# Overview

## ■ Interpreting SAAR values

- As a ratio, SAAR values are always greater than or equal to 0
  - A SAAR value  $<1$  indicates antimicrobial use was less than predicted
  - A SAAR value  $=1$  indicates observed AU is equivalent to predicted AU
  - A SAAR value  $>1$  indicates antimicrobial use was greater than predicted
- 
- **Note:** A SAAR alone is not a definitive measure of the appropriateness or judiciousness of antimicrobial use, and any SAAR may warrant further investigation. For example, a SAAR above 1.0 that does not achieve statistical significance may be associated with meaningful excess of antimicrobial use and further investigation may be needed. Also, a SAAR that is statistically different from 1.0 does not mean that further investigation will be productive.

# SAAR development process

- Determine eligible SAAR patient care locations
- Finalize SAAR antimicrobial agent categories
- Identify factors to consider as risk-adjustments in SAAR models
  - \*\*Reminder: no patient level data available
- Validate data
  - AU data reported from eligible patient care locations for referent year
  - NHSN annual hospital survey data from referent year
  - Validation conducted through internal analyses, outreach to facilities, and facilities voluntarily completing AU Option validation protocols



# SAAR predictive modeling process

- Model each SAAR antimicrobial category separately
- Use negative binomial regression to assess which location- and facility-level factors are statistically significantly associated with rates of antimicrobial use for each SAAR agent category
- Factors found to be predictive of AU are included in final models as risk-adjustments

# SAAR predictive modeling process

- Final risk-adjusted SAAR models are used to predict days of therapy (DOT) for a specified location or group of locations for a specified time period
- All predictions take into account the number of days present for a given time period
- More information about eligible SAAR patient care locations, SAAR antimicrobial groupings and SAAR types available in SAAR reports can be found in the AUR Module Protocol
  - <https://www.cdc.gov/nhsn/PDFs/pscManual/11pscAURcurrent.pdf>

# National Quality Forum Endorsement

- The SAAR was originally endorsed by the National Quality Forum in 2015 and updated 2017 baseline models were re-endorsed in 2019
- 2018 neonatal SAARs will be submitted for endorsement in a future cycle

- ☒ 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

# **2017 Baseline Adult and Pediatric SAARs**

# 2017 baseline referent populations

- Locations reporting  $\geq 9$  months of validated AU data were included in SAAR predictive models; these locations make up our adult and pediatric referent populations
- SAAR locations were reported from a diverse group of hospitals
  - **Facility types represented:** children's, critical access, general acute care, military, oncology, surgical, Veterans Affairs, women's, women and children's
  - **Teaching statuses represented:** none, undergraduate, graduate, major
  - **Hospital sizes represented:** hospitals ranged in size from 8 beds to 1,287 beds
  - **States represented:** hospitals from 49 U.S. states and territories are represented in adult referent population and hospitals from 29 states are represented in pediatric referent population

# 2017 baseline referent populations

- **Adult referent population:** 2156 patient care locations from 449 facilities
- **Pediatric referent population:** 170 patient care locations from 106 facilities

| Location type                        | Adult locations | Pediatric locations |
|--------------------------------------|-----------------|---------------------|
| Medical intensive care unit          | 131             | 4                   |
| Medical-surgical intensive care unit | 318             | 46                  |
| Surgical intensive care unit         | 73              | .                   |
| Medical ward                         | 472             | 21                  |
| Medical-surgical ward                | 554             | 94                  |
| Surgical ward                        | 247             | 5                   |
| General hematology-oncology ward     | 68              | .                   |
| Step-down unit                       | 293             | .                   |
| Total                                | 2156            | 170                 |

# 2017 baseline adult and pediatric SAAR antimicrobial agent categories

- Broad spectrum antibacterial agents predominantly used for hospital-onset infections
- Broad spectrum antibacterial agents predominantly used for community-acquired infections
- Antibacterial agents predominantly used for resistant gram-positive infections (e.g., MRSA)
- Narrow spectrum beta-lactam agents
- Azithromycin (pediatrics only)
- Antifungal agents predominantly used for invasive candidiasis
- Antibacterial agents posing the highest risk for CDI
- All antibacterial agents

## 2017 baseline adult SAAR model risk-adjustment summary

| Factor                                         | BSHO | BSCA | GramPos | NSBL | Fungal | CDI | All |
|------------------------------------------------|------|------|---------|------|--------|-----|-----|
| Location type                                  | ✓    | ✓    | ✓       | ✓    | ✓      | ✓   | ✓   |
| Facility type                                  | ✓    | ✓    | ✓       |      | ✓      | ✓   | ✓   |
| Medical school affiliation                     | ✓    |      |         |      |        | ✓   |     |
| Total number of hospital beds                  |      | ✓    | ✓       | ✓    | ✓      | ✓   |     |
| Total number of hospital ICU beds              | ✓    |      |         |      | ✓      | ✓   |     |
| Percentage of hospitals beds that are ICU beds |      | ✓    |         | ✓    |        |     |     |
| Average hospital length of stay                | ✓    | ✓    | ✓       | ✓    | ✓      | ✓   | ✓   |

## 2017 baseline pediatric SAAR model risk-adjustment summary

| Factor                                         | BSHO | BSCA | GramPos | NSBL | Azithro | Fungal | CDI | All |
|------------------------------------------------|------|------|---------|------|---------|--------|-----|-----|
| Location type                                  |      | ✓    | ✓       |      | ✓       | ✓      | ✓   |     |
| Facility type                                  |      | ✓    |         |      |         |        | ✓   |     |
| Location type with facility type               | ✓    |      |         | ✓    |         |        |     |     |
| Medical school affiliation                     |      |      |         |      |         |        |     |     |
| Total number of hospital beds                  |      | ✓    |         | ✓    | ✓       |        | ✓   | ✓   |
| Total number of hospital ICU beds              |      |      |         |      |         |        |     |     |
| Percentage of hospitals beds that are ICU beds | ✓    |      |         |      |         | ✓      |     | ✓   |
| Average hospital length of stay                |      |      |         |      |         |        | ✓   | ✓   |



# Adult/Pediatric rate report

- Antibacterial agents used to treat extensively antibiotic resistant infections were removed from the broad spectrum hospital-onset SAAR agent category
  - Ceftazidime/avibactam
  - Ceftolozane/tazobactam
  - Colistimethate
  - Polymyxin B
  - Tigecycline
- Rates of use for these agents are extremely low in SAAR patient care locations
  - Adult SAAR locations: pooled mean rate = 1.21 DOT/1,000 days present
  - Pediatric SAAR locations: pooled mean rate = 0.65 DOT/1,000 days present

## Adult/Pediatric rate report

- Because use is so low, and there is little variation in use (majority of locations report 0 DOT), SAARs for this group of agents would not be particularly useful to most antibiotic stewardship programs (ASPs)
- With that said, because of their ability to treat extensively antibiotic resistant infections, these antimicrobials are often protected and of interest to ASPs
- Therefore, it was decided that rate reports would be included in AU output analysis options to provide facilities with their pooled rates for adult SAAR locations and pediatric SAAR locations, along with the pooled rate distributions using data from the 2017 baseline SAAR referent populations

# Adult/Pediatric rate report

- Example pediatric pooled rate report (data in white were made up for explanatory purposes, but data in yellow reflect true values)

Pooled rate- across the 5 antibacterial agents  
and eligible pediatric SAAR locations

P-value to indicate whether your  
hospital's pooled rate is significantly  
different from the pooled rate of the  
referent population

| summaryYM | SAARRateType_2017 | antimicrobialDays | numDaysPresent | RateDaysPresent | RateDaysPresent95CI | pooled_mean_AUrate | SAAR_pval | p25th | p50th | p75th | p90th |
|-----------|-------------------|-------------------|----------------|-----------------|---------------------|--------------------|-----------|-------|-------|-------|-------|
| 2018M07   | Ped_EARB_2017     | 110               | 2219           | 49.57           | 40.936, 59.511      | 0.65               | 0.0000    | 0.00  | 0.00  | 0.00  | 0.29  |

National pooled pediatric mean rate  
(from 2017 baseline pediatric SAAR  
referent population) displayed as DOT  
per 1,000 days present

Pooled rate distribution  
from 2017 baseline  
pediatric SAAR referent  
population

# 2018 Baseline Neonatal SAARs

# 2018 baseline referent populations

- Locations reporting  $\geq 9$  months of validated neonatal AU data were included in SAAR predictive models; these locations make up our neonatal referent population
- SAAR locations were reported from a diverse group of hospitals
  - **Facility types represented:** children's, general acute care, military, women's, women and children's
  - **Teaching statuses represented:** none, undergraduate, graduate, major
  - **Hospital sizes represented:** hospitals ranged in size from 32 beds to 1,455 beds
  - **States represented:** hospitals from 45 U.S. states and territories are represented in the neonatal referent population

# 2018 baseline referent populations

- **Neonatal referent population:** 324 patient care locations from 304 facilities

| Location type                          | Neonatal locations |
|----------------------------------------|--------------------|
| Special Care Nurseries                 | 56                 |
| Level II/III intensive care units      | 152                |
| Level III (Or IV) intensive care units | 116                |
| Total                                  | 324                |

- Level I units were not included in the referent population for neonatal SAARs due to very low AU rates and high rates of missing survey data
- The Fluconazole model does not include special care nurseries

# 2018 baseline neonatal SAAR antimicrobial agent categories

- Vancomycin predominantly used for treatment of late-onset sepsis
- Broad spectrum antibacterial agents predominantly used for hospital-onset infections
- 3rd generation cephalosporins
- Ampicillin predominantly used for treatment of early-onset sepsis
- Aminoglycosides predominantly used for treatment of early- and late-onset sepsis
- Fluconazole predominantly used for candidiasis
- All antibacterial agents

## 2018 baseline neonatal SAAR model risk-adjustment summary

| Factor                                                                           | VANC | BSHO | 3rd CEPHS | AMP | AMINO | FLUCO | ALL |
|----------------------------------------------------------------------------------|------|------|-----------|-----|-------|-------|-----|
| Location type                                                                    | ✓    | ✓    |           |     |       |       |     |
| Facility type                                                                    |      |      | ✓         |     |       |       |     |
| Teaching status                                                                  |      |      | ✓         |     |       |       |     |
| Total number of hospital beds                                                    |      |      | ✓         |     |       |       |     |
| Total annual admissions                                                          |      |      |           |     |       |       | ✓   |
| Total annual inborn admissions                                                   |      |      |           |     |       |       |     |
| Total annual outborn admissions                                                  |      |      |           | ✓   | ✓     |       | ✓   |
| Percentage outborn admissions                                                    |      |      |           |     |       |       |     |
| All levels of care provided by facility                                          |      |      |           |     |       |       | ✓   |
| Facility provides Level III care                                                 |      |      |           |     |       |       |     |
| Facility accepts neonates as transfers for various specified complex procedures  | ✓    | ✓    |           |     |       |       |     |
| Percentage of admissions of infants with birthweight ≤750g (A)                   |      |      |           |     |       | ✓     |     |
| Percentage of admissions of infants with birthweight 751-1000g (B)               |      |      |           |     |       |       |     |
| Percentage of admission of infants with birthweight 1001-1500g (C)               |      |      |           |     |       |       |     |
| Percentage of admissions of infants that are very low birthweight ≤1500g (A,B,C) | ✓    | ✓    |           | ✓   | ✓     |       |     |
| Percentage of admissions of infants that are low birthweight 1501-2500g (D)      |      |      |           |     |       |       |     |
| Percentage of admissions of infants that are normal birthweight >2500g (E)       |      |      |           |     |       |       | ✓   |

\*Some variables are combined in models, such as location type and neonatal transfer



# Neonatal rate reports

- Rates of use are extremely low for the following antibiotics and levels of neonatal care
  - Ampicillin in level I units to treat early onset sepsis
  - Aminoglycosides (Gentamicin, Tobramycin, Amikacin) in level I units to treat early or late onset sepsis
  - Fluconazole in level II (special care) units predominantly used for candidiasis
- Tracking of these antimicrobials in level I or II units can provide neonatal ASPs with valuable information, and new rate reports allow for tracking of use and for an unadjusted comparison to national AU rates

# Example neonatal rate report

- Example neonatal pooled rate report (data in white were made up for explanatory purposes, but data in yellow reflect true values)

Pooled rate- aminoglycoside usage across level 1 neonatal units



P-value to indicate whether your hospital's pooled rate is significantly different from the pooled rate of the referent population



| orgID | summaryYM | SAARRateType_Neo_2018       | antimicrobialDays | numDaysPresent | RateDaysPresent | RateDaysPresent95CI | pooled_mean_AUrate | SAAR_pval | p25th | p50th | p75th | p90th |
|-------|-----------|-----------------------------|-------------------|----------------|-----------------|---------------------|--------------------|-----------|-------|-------|-------|-------|
| 10021 | 2018M07   | Level1_Aminoglycosides_2018 | 42                | 587            | 71.55           | 52.232, 95.802      | 5.23               | 0.0000    | 0.00  | 2.34  | 10.15 | 23.55 |
| 10021 | 2018M08   | Level1_Aminoglycosides_2018 | 32                | 645            | 49.61           | 34.516, 69.200      | 5.23               | 0.0000    | 0.00  | 2.34  | 10.15 | 23.55 |



National pooled neonatal mean rate (from 2018 baseline pediatric SAAR referent population) displayed as DOT per 1,000 days present



Pooled rate distribution from 2018 baseline neonatal SAAR referent population

# The SAAR and Antimicrobial Stewardship

# How can the SAAR help with stewardship efforts?

- The SAAR can help hospitals determine where to focus antimicrobial stewardship efforts
- The SAAR can be used to assess the impact of specific interventions targeted at improving AU
- Facilities can use the SAAR to compare AU in a specific location or group of locations across two points in time

# Assessing where to focus ASP efforts

- Hospital A notices higher than normal rates of azithromycin the past few months
- The ASP team suspects overuse may be occurring in one of their pediatric units but want to be sure before dedicating the additional ASP resources needed to intervene
- In order to investigate where potential overuse of azithromycin is occurring, the team runs the All SAARs by Location report in NHSN

# Assessing where to focus ASP efforts

## Azithromycin used in pediatric SAAR ICUs

| Facility Org ID | SAAR Type 2017 Baseline | Location | Summary Yr/Qtr | CDC Location       | Antimicrobial Days | Predicted Antimicrobial Days | Days Present | SAAR  | SAAR p-value | 95% Confidence Interval |
|-----------------|-------------------------|----------|----------------|--------------------|--------------------|------------------------------|--------------|-------|--------------|-------------------------|
| 13860           | Ped_Azith_ICU_2017      | PMICU    | 2018Q3         | IN:ACUTE:CC:M_PED  | 8                  | 5.650                        | 187          | 1.416 | 0.3282       | 0.658, 2.689            |
| 13860           | Ped_Azith_ICU_2017      | PMSICU   | 2018Q3         | IN:ACUTE:CC:MS_PED | 11                 | 9.185                        | 304          | 1.198 | 0.5315       | 0.630, 2.082            |

## Azithromycin used in pediatric SAAR wards

| Facility Org ID | SAAR Type 2017 Baseline | Location | Summary Yr/Qtr | CDC Location        | Antimicrobial Days | Predicted Antimicrobial Days | Days Present | SAAR   | SAAR p-value | 95% Confidence Interval |
|-----------------|-------------------------|----------|----------------|---------------------|--------------------|------------------------------|--------------|--------|--------------|-------------------------|
| 13860           | Ped_Azith_Ward_2017     | PEDMED   | 2018Q3         | IN:ACUTE:WARD:M_PED | 9                  | 5.453                        | 264          | 1.650  | 0.1531       | 0.805, 3.029            |
| 13860           | Ped_Azith_Ward_2017     | PEDSURG  | 2018Q3         | IN:ACUTE:WARD:S_PED | 39                 | 3.343                        | 1160         | 11.666 | 0.0000       | 8.411, 15.788           |
| 13860           | Ped_Azith_Ward_2017     | PEDSURG  | 2018Q4         | IN:ACUTE:WARD:S_PED | 34                 | 3.314                        | 1150         | 10.260 | 0.0000       | 7.219, 14.174           |

- The ASP team assesses SAAR values for their 4 pediatric locations and sees their PEDSURG unit is using azithromycin at >10x the predicted rate
- The team decides to further investigate azithromycin use in this ped surgical ward to determine if use is appropriate and if there are opportunities for improvement

# Comparing SAAR values across two points in time

- Hospital A has been working to decrease use of broad spectrum antibacterial agents for hospital-onset infections in their adult medical ICU
- To assess the impact of their efforts, they want to compare SAAR values for this antimicrobial category across two points in time:

1.

| orgID | summaryYQ | antimicrobialDays | numAUDaysPredicted | SAAR  |
|-------|-----------|-------------------|--------------------|-------|
| 13860 | 2014Q2    | 714               | 431.792            | 1.654 |
| 13860 | 2014Q3    | 926               | 697.668            | 1.327 |

Is this a statistically significant decrease?

2.

## NHSN Statistics Calculator: Comparing Two SIRs

|          | 2014Q2  | 2014Q3  |
|----------|---------|---------|
| Observed | 714     | 926     |
| Expected | 431.792 | 697.668 |
| SIR      | 1.654   | 1.327   |

Relative ratio of SIRs (data column 2 / data column 1):  $1.327/1.654 = 0.802$  (80.2%)

Two-tailed p-value **<0.05**

95% Conf. Interval: 0.728, 0.885

Yes, it is!

However, SAARs typically have large denominators and large statistical power to find differences statistically significant. Statistical significance is important but does not automatically mean the findings are clinically significant or meaningful.

# AU Option Case Examples

- <https://www.cdc.gov/nhsn/au-case-examples/index.html>

## Targeting a Reduction in Fluoroquinolone Use within a Community Hospital

### Key Take Away Points

- A community hospital was able to identify an area of high drug use using NHSN Antimicrobial Use (AU) Option Standardized Antimicrobial Administration Ratio (SAAR) data.
- Once the area of high use and hospital locations were identified, appropriate empiric treatment guidelines promoting use of more narrow-spectrum agents where appropriate were developed and implemented.
- Ongoing tracking of SAAR data allowed the facility to assess the intervention and also monitor for unintended consequences (i.e. squeezing the balloon).



# Using the SAAR for stewardship

## STRATEGIES TO ASSESS ANTIBIOTIC USE TO DRIVE IMPROVEMENTS IN HOSPITALS



U.S. Department of  
Health and Human Services  
Centers for Disease  
Control and Prevention



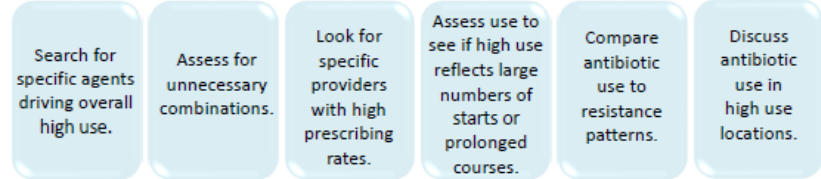
THE PEW CHARITABLE TRUSTS

- <https://www.cdc.gov/antibiotic-use/healthcare/pdfs/strategies-to-assess-antibiotic-use-in-hospitals-508.pdf>

SAAR or other indicators of antibiotic use show higher than expected values



### General Assessments

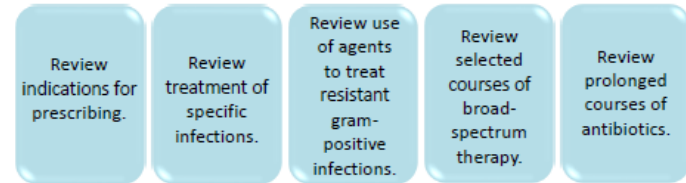


Narrow investigation targets



Medication use evaluations

### Detailed Reviews



### Stewardship Actions



**Next Steps for the SAAR**

## Next steps for the SAAR

- In the process of publishing manuscript describing 2017 baseline SAAR models
- Continue assessing new locations for which SAARs can be calculated
  - Potential next step: SAAR for emergency departments

# For more information on the SAAR

- SAAR publication, 2018, Clinical Infectious Diseases
  - <https://academic.oup.com/cid/advance-article/doi/10.1093/cid/ciy075/4835069>
- Training materials
  - <https://www.cdc.gov/nhsn/acute-care-hospital/aur/index.html>

## EDITOR'S CHOICE

### The Standardized Antimicrobial Administration Ratio: A New Metric for Measuring and Comparing Antibiotic Use FREE

Katharina L van Santen ✉, Jonathan R Edwards, Amy K Webb, Lori A Pollack, Erin O'Leary, Melinda M Neuhauser, Arjun Srinivasan, Daniel A Pollock

*Clinical Infectious Diseases*, Volume 67, Issue 2, 2 July 2018, Pages 179–185,

<https://doi.org/10.1093/cid/ciy075>

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## Resources for NHSN Users Already Enrolled

|                            |   |
|----------------------------|---|
| Training                   | + |
| Protocols                  | + |
| Frequently Asked Questions | + |
| Data Validation            | + |
| Data Collection Forms      | + |
| Supporting Material        | + |
| Analysis Resources         | + |

# Questions?

[NHSN@cdc.gov](mailto:NHSN@cdc.gov)

Thank you!

For more information, contact CDC  
1-800-CDC-INFO (232-4636)  
TTY: 1-888-232-6348 [www.cdc.gov](http://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.

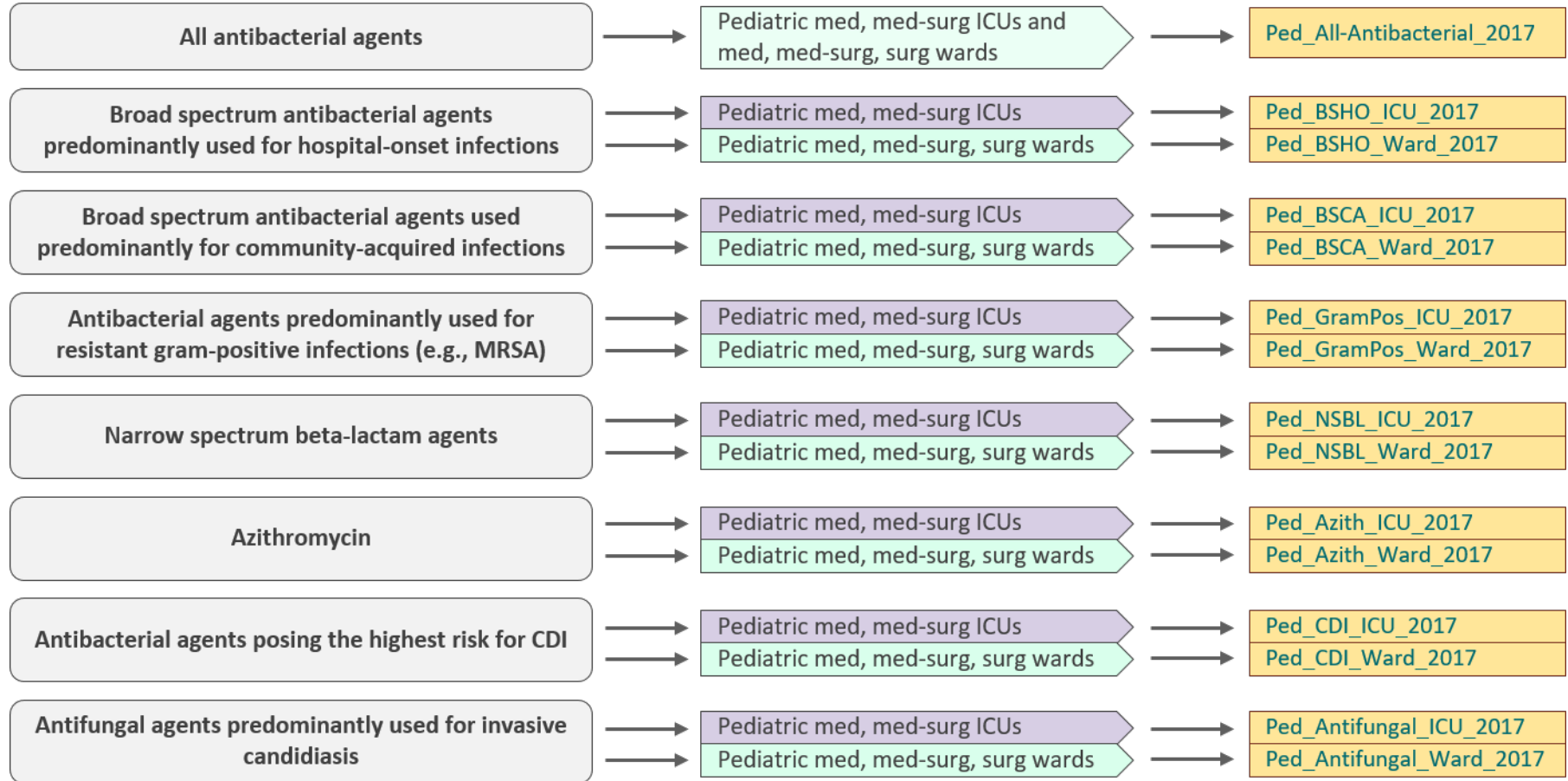


**Additional Slides**

# 25 adult SAAR types available (2017 baseline)



# 15 pediatric SAAR types available (2017 baseline)





## 7 neonatal SAAR types available (2018 baseline)

