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

- [x] Public health/disease surveillance
- [x] Quality improvement (internal to the specific organization)
- [x] 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 ≥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 ≥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

*Data for example only

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

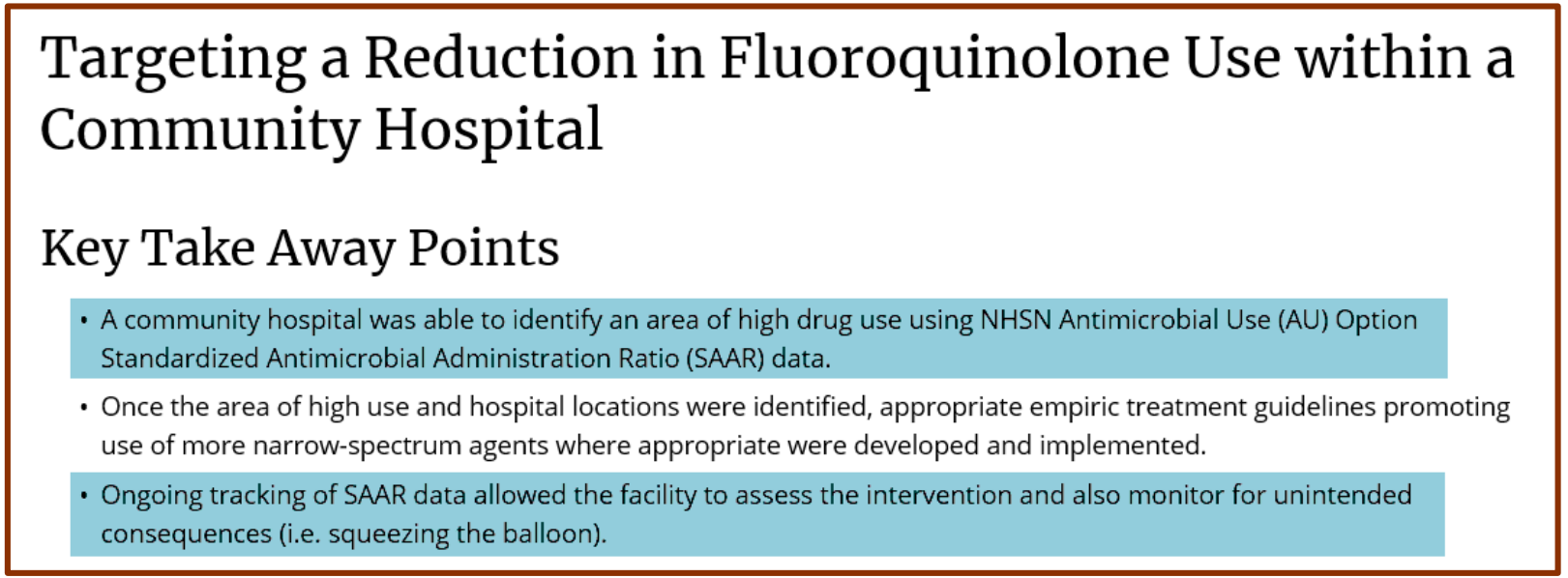
Yes, it is!

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.

*Data for example only

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).

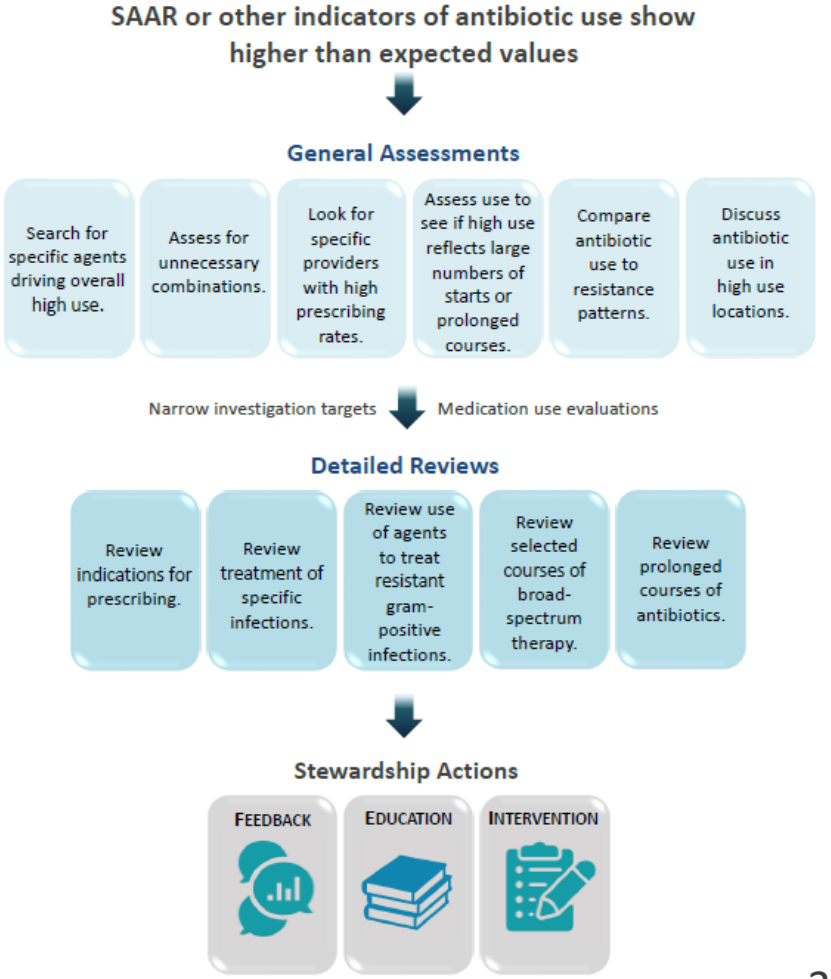
Using the SAAR for stewardship

STRATEGIES TO ASSESS ANTIBIOTIC USE TO DRIVE IMPROVEMENTS IN HOSPITALS

CDC 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



Next Steps for the SAAR

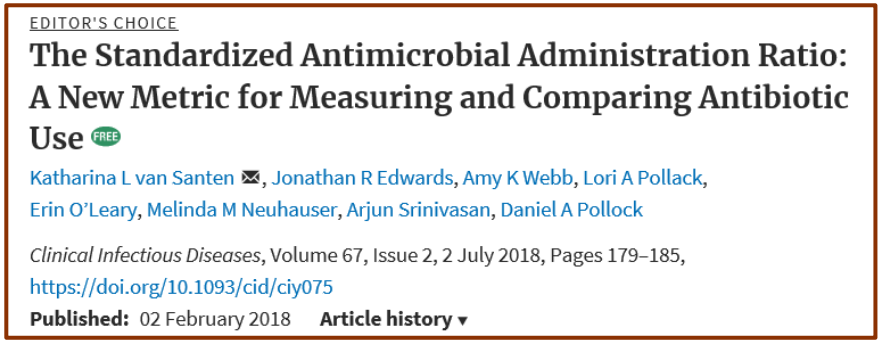
Next steps for the SAAR

- 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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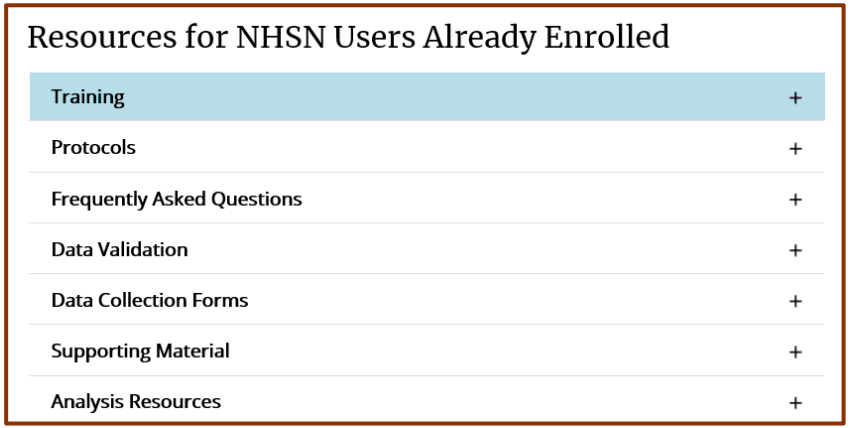


Resources for NHSN Users Already Enrolled

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

Questions?

NHSN@cdc.gov

Thank you!

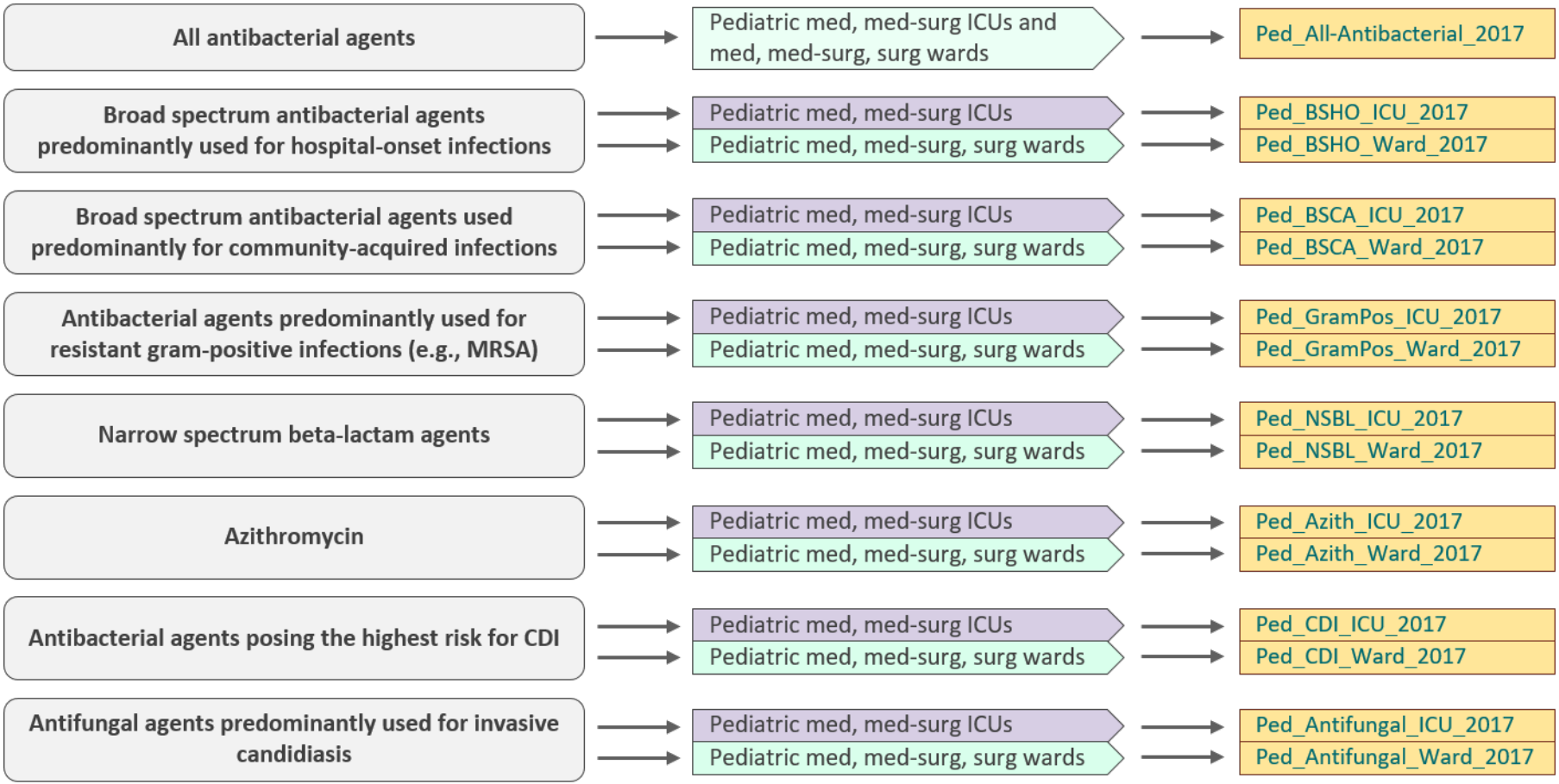
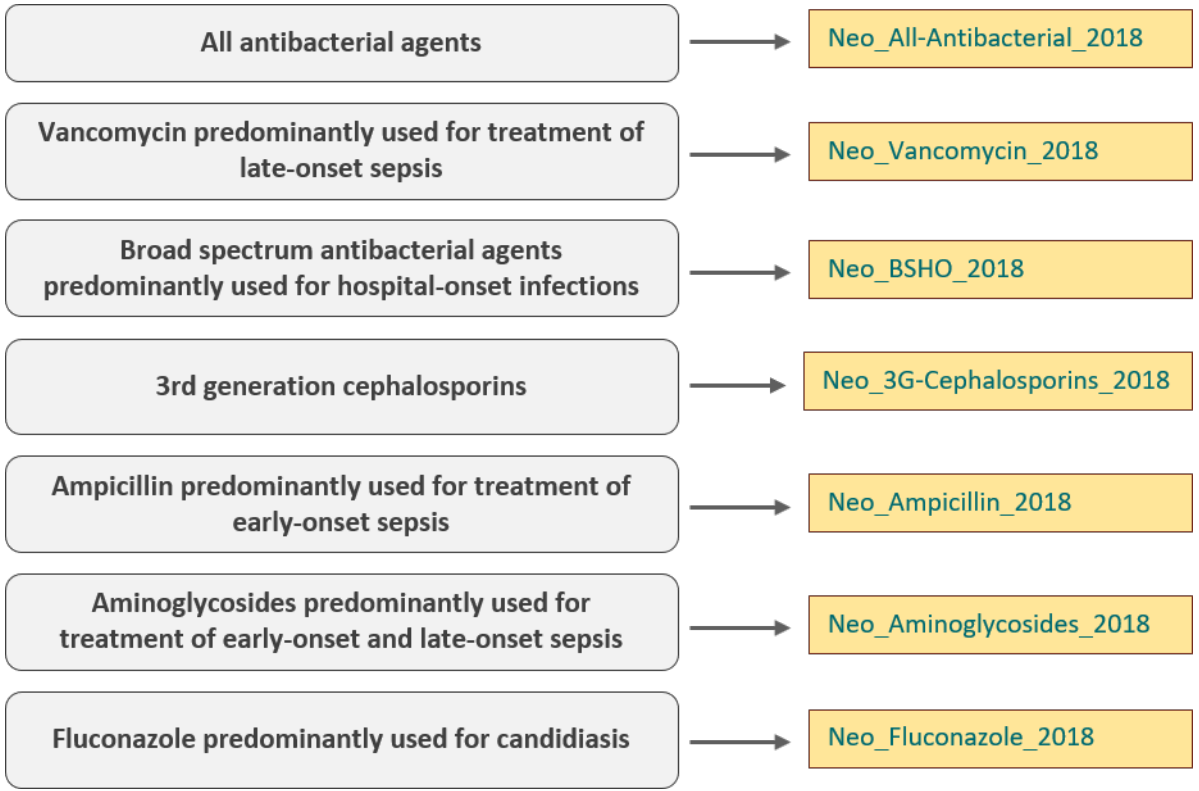
For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

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)