CENTERS FOR DISEASE CONTROL AND PREVENTION
NATIONAL CENTER FOR EMERGING AND ZOONOTIC INFECTIOUS DISEASES
DIVISION OF HEALTHCARE QUALITY PROMOTION

NHSN's Guide to the Standardized Antimicrobial Administration Ratio (SAAR)

A Guide to the SAAR Models Under the 2023 Baseline

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Summary

The Standardized Antimicrobial Administration Ratio (SAAR) is the primary summary metric used by the National Healthcare Safety Network (NHSN) to track antimicrobial use in hospitals. Highlighting the SAAR and changes resulting from the updated 2023 baseline, this document is intended to serve both as guidance for those who are new to this metric, as well as a useful reference for more experienced users.

This Guide contains:

- An overview of the SAAR metric
- Recommendations for using the SAAR for action
- Details of each risk adjustment model under the 2023 national baseline

Use this Guide to:

- Understand how the SAAR metric is calculated and interpreted.
- Learn how to use the SAAR for antimicrobial stewardship.
- Learn which location- and hospital-level variables are used for risk adjustment in predicting antimicrobial use for each SAAR model.

Intended Audience

- The Standardized Antimicrobial Administration Ratio (SAAR) is a summary measure that is adjusted for risk of antimicrobial use (AU). The SAAR is available to hospitals participating in the National Healthcare Safety Network (NHSN) AU Option.
- Hospitals can use the SAAR to track AU, compare their AU to a national benchmark, and assess the impact of interventions aimed at improving prescribing practices.
- This document serves as guidance for hospital antimicrobial stewards and individuals at health departments or health systems interested in monitoring AU and understanding what the SAAR is, how NHSN develops SAARs, and how they can use the SAAR for antimicrobial stewardship.

Overview of the Standardized Antimicrobial Administration Ratio (SAAR)

What is the SAAR?

The Standardized Antimicrobial Administration Ratio (SAAR) is a summary measure of antimicrobial use (AU) available to hospitals participating in the AU Option of the National Healthcare Safety Network (NHSN) Antimicrobial Use and Resistance (AUR) Module. NHSN originally developed the metric in 2015—using AU data reported in 2014—as a quantitative tool for hospitals and health systems to make comparisons of AU within and across hospitals to help guide efforts to improve how antimicrobials are prescribed and used. The SAAR compares observed antimicrobial days to predicted antimicrobial days for groups of antimicrobial agents used in specified patient care locations. A SAAR greater than 1.0 indicates more antimicrobial days were observed than predicted; conversely, a SAAR less than 1.0 indicates fewer antimicrobial days were observed than predicted.

How does NHSN calculate the SAAR?

NHSN calculates the SAAR by dividing the number of observed antimicrobial days (also called antimicrobial days of therapy [DOT]) by the number of predicted antimicrobial days. NHSN calculates predicted antimicrobial days by risk-adjusting for factors at both the location- and hospital-level that have been found to be statistically significantly associated with differences in AU rates among the SAAR referent population. The referent population comes from nationally aggregated AU data reported at the patient care location-level to NHSN during the baseline time period.

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

- Observed AU: antimicrobial days reported to the AU Option by a hospital for a SAAR antimicrobial agent category used in a specified patient care location or group of locations (SAAR-eligible locations).
- Predicted AU: antimicrobial days predicted for that same antimicrobial agent category used in the same location or group of locations. NHSN calculates predicted antimicrobial days using risk-adjusted SAAR predictive models.

Why risk-adjust?

A rate of antimicrobial use, defined in the AU Option as antimicrobial days divided by 1,000 days present, serves as the foundational metric for SAARs. The rate of appropriate antimicrobial use can vary among different patient populations due to variations in diagnoses, infection organisms and their antimicrobial susceptibility patterns, sites of infections, and comorbidities. Although NHSN currently lacks the detailed information necessary for comprehensive risk adjustment, it utilizes the characteristics of hospitals and patient care locations associated with a varying mix of patient characteristics as a proxy for risk adjustment. Unlike crude antimicrobial use rates, which do not account for individual differences, risk-adjusted measures (SAARs) facilitate more accurate inter-hospital comparisons.

Why not use stratified rates to make AU comparisons?

Stratified rates are pooled mean rates calculated separately for different types of locations or hospitals. This method, however, only allows for rate comparisons within strata. The SAAR, on the other hand, allows users to summarize data by more than a single stratum by adjusting for AU rate differences between strata. Additionally, SAARs allow for comparisons to the national benchmark from a baseline time period and hospitals can use them to measure progress from a single time point. In other words, standardization permits comparisons between antimicrobial days used by a hospital, group, or state to antimicrobial days predicted based on national data.

New 2023 Baseline SAAR Models for Risk Adjustment

What is a “baseline”?

In the context of the SAAR, the term “baseline” refers to the calendar year of the NHSN data used to develop SAAR models. For 2023 baseline adult, pediatric, and neonatal SAARs, NHSN developed predictive models using AU data reported from eligible adult, pediatric, and neonatal locations during calendar year 2023.

The original 2014 baseline SAAR models included select adult and pediatric locations reporting 2014 AU data. The 2017 baseline SAAR models included more adult and pediatric locations reporting 2017 AU data. Separately, the 2018 baseline SAAR models only included neonatal locations reporting 2018 AU data. We do **not** recommend comparing SAARs generated using different baselines (i.e., 2014, 2017, 2018, and 2023 baselines) because they include different baseline populations, risk adjustments, and SAAR agent categories.

Defining the referent population

A SAAR referent population, which NHSN uses to develop SAAR predictive models, is AU data aggregated from select patient care locations reporting to the AU Option for a particular year, specifically the baseline year. The greater the sample size of locations included in SAAR predictive models, the more precise the SAAR estimates or adjustments. NHSN assesses reporting volume for each location type to ensure sample size is large enough for inclusion in SAAR models. In summary, SAAR referent populations include location types that are important to hospital antimicrobial stewardship, have adequate reporting volume during the baseline year, and report for at least nine months of the baseline year. Table 1 lists, by alphabetical order, the location types eligible for generating SAARs using the 2023 baseline models, organized by population (adult, pediatric, and neonatal). Location types that are newly eligible (i.e., not

included in the previous baseline) are noted in the final column. Table 2 and Table 3 summarize the number of hospitals and patient care locations included in SAAR models and the number of location types that can generate SAARs, by baseline year.

2023 baseline adult SAAR-eligible patient care locations:

- Select adult intensive care units (ICUs): burn, medical, medical cardiac, medical-surgical, neurologic, neurosurgical, surgical, surgical cardiothoracic, trauma
- Select adult wards: burn, labor and delivery, labor, delivery, recovery, postpartum suite, medical, medical-surgical, neurology, neurosurgical, postpartum, pulmonary, surgical
- Adult mixed acuity units
- Adult orthopedic and orthopedic trauma wards
- Adult solid organ transplant specialty care areas
- Adult step-down units
- Adult general hematology-oncology and oncology hematopoietic stem cell transplant wards

2023 baseline pediatric SAAR-eligible patient care locations:

- Select pediatric ICUs: medical, medical-surgical, surgical cardiothoracic
- Select pediatric wards: medical, medical-surgical, surgical
- Pediatric general hematology-oncology and oncology hematopoietic stem cell transplant wards
- Pediatric step-down units

2023 baseline neonatal SAAR-eligible patient care locations:

- Level II special care nurseries
- Level II/III neonatal intensive care units (NICUs)
- Level III NICUs
- Level IV NICUs

Table 1. Location types included in the 2023 baseline SAAR models.

CDC Location Type	CDC Location Code	New SAAR-eligible location type?[1]
Adult Patient Care Locations		
Burn Critical Care	IN:ACUTE:CC:B	Yes
Burn Ward	IN:ACUTE:WARD:B	Yes
Labor and Delivery Ward	IN:ACUTE:WARD:LD	Yes
Labor, Delivery, Recovery, Postpartum Suite	IN:ACUTE:WARD:LD_PP	Yes
Medical Cardiac Critical Care	IN:ACUTE:CC:C	Yes
Medical Critical Care	IN:ACUTE:CC:M	
Medical Ward	IN:ACUTE:WARD:M	
Medical-Surgical Critical Care	IN:ACUTE:CC:MS	

[1] A "Yes" in this column indicates location types that are newly SAAR-eligible (i.e., not included in the previous baseline). A blank cell indicates location types that were included in the 2017 or 2018 baseline.

CDC Location Type	CDC Location Code	New SAAR-eligible location type?[1]
Medical-Surgical Ward	IN:ACUTE:WARD:MS	
Mixed Acuity Unit	IN:ACUTE:MIXED:ALL_ADULT	Yes
Neurologic Critical Care	IN:ACUTE:CC:N	Yes
Neurology Ward	IN:ACUTE:WARD:N	Yes
Neurosurgical Critical Care	IN:ACUTE:CC:NS	Yes
Neurosurgical Ward	IN:ACUTE:WARD:NS	Yes
Oncology General Hematology-Oncology Ward	IN:ACUTE:WARD:ONC_HONC	
Oncology Hematopoietic Stem Cell Transplant Ward	IN:ACUTE:WARD:ONC_HSCT	Yes
Orthopedic Trauma Ward	IN:ACUTE:WARD:T_ORT	Yes
Orthopedic Ward	IN:ACUTE:WARD:ORT	Yes
Postpartum Ward	IN:ACUTE:WARD:PP	Yes
Pulmonary Ward	IN:ACUTE:WARD:PULM	Yes
Solid Organ Transplant Special Care Area	IN:ACUTE:SCA:SOTP	Yes
Step-down Unit	IN:ACUTE:STEP	
Surgical Cardiothoracic Critical Care	IN:ACUTE:CC:CT	Yes
Surgical Critical Care	IN:ACUTE:CC:S	
Surgical Ward	IN:ACUTE:WARD:S	
Trauma Critical Care	IN:ACUTE:CC:T	Yes
Pediatric Patient Care Locations		
Pediatric Medical Critical Care	IN:ACUTE:CC:M_PED	
Pediatric Medical Ward	IN:ACUTE:WARD:M_PED	
Pediatric Medical-Surgical Critical Care	IN:ACUTE:CC:MS_PED	
Pediatric Medical-Surgical Ward	IN:ACUTE:WARD:MS_PED	
Pediatric Oncology General Hematology-Oncology Ward	IN:ACUTE:WARD:ONC_HONC_PED	Yes
Pediatric Oncology Hematopoietic Stem Cell Transplant Ward	IN:ACUTE:WARD:ONC_HSCT_PED	Yes
Pediatric Step-down Unit	IN:ACUTE:STEP:PED	Yes
Pediatric Surgical Cardiothoracic Critical Care	IN:ACUTE:CC:CT_PED	Yes
Pediatric Surgical Ward	IN:ACUTE:WARD:S_PED	
Neonatal Patient Care Locations		
Neonatal Special Care Nursery (Level II)	IN:ACUTE:STEP:NURS	
Neonatal Critical Care (Level II/III)	IN:ACUTE:CC_STEP: NURS	

CDC Location Type	CDC Location Code	New SAAR-eligible location type?[1]
Neonatal Critical Care (Level III)	IN:ACUTE:CC:NURS	
Neonatal Critical Care (Level IV)	IN:ACUTE:CC:NURS_IV	

Table 2. High-level comparison of the number of hospitals and patient care locations included in the 2017/2018 baseline SAAR model referent populations and the 2023 baseline SAAR model referent populations.

Population	2017 or 2018 SAAR Baselines[2]	2023 SAAR Baseline
Adult	450 hospitals 2,160 patient care locations	2,374 hospitals 14,658 patient care locations
Pediatric	106 hospitals 170 patient care locations	398 hospitals 948 patient care locations
Neonatal	304 hospitals 324 patient care locations	770 hospitals 865 patient care locations

Table 3. High-level comparison of the number of location types included in the 2017/2018 baseline SAAR models and the 2023 baseline SAAR models.

Population	2017 or 2018 SAAR Baselines[2]	2023 SAAR Baseline
Adult	8	26
Pediatric	5	9
Neonatal	4	4

Defining SAAR antimicrobial agent categories

NHSN designed SAAR antimicrobial agent categories to enable hospitals and other entities to assess progress toward antimicrobial stewardship goals. These categories are generally mutually exclusive, meaning individual antimicrobials are found in only one SAAR category, except for "All antibacterial agents" and "Antibacterial agents posing highest risk for *Clostridioides difficile* infection (CDI)," which include antimicrobials found in other SAAR categories. CDC sought independent individual feedback from experts in antimicrobial stewardship, most of whom were familiar with the SAAR, to develop categories and decide which antimicrobials to include in each category. The goal was to identify opportunities for stewardship interventions. Although SAAR agent category names may be consistent across baselines, the specific antimicrobials within those categories may differ. For the 2023 baseline, there are seven adult SAAR antimicrobial agent categories, eight pediatric SAAR categories, and seven neonatal SAAR categories.

2023 baseline adult SAAR antimicrobial agent categories:

- Broad spectrum antibacterial agents predominantly used for hospital-onset infections
- Broad spectrum antibacterial agents predominantly used for community-acquired

[2] The 2017 baseline SAAR models included adult and pediatric locations. The 2018 baseline SAAR models only included neonatal locations.

infections
- Antibacterial agents predominantly used for resistant gram-positive infections (e.g., methicillin-resistant *Staphylococcus aureus* [MRSA])
- Narrow-spectrum beta-lactam agents
- Antifungal agents predominantly used for invasive candidiasis
- Antibacterial agents posing the highest risk for CDI
- All antibacterial agents

2023 baseline 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
- Narrow-spectrum beta-lactam agents
- Antibacterial agents predominantly used for resistant gram-positive infections (e.g., MRSA)
- Azithromycin
- Antifungal agents predominantly used for invasive candidiasis
- Antibacterial agents posing the highest risk for CDI
- All antibacterial agents

2023 baseline neonatal SAAR antimicrobial agent categories:
- Vancomycin
- Broad spectrum gram-negative coverage
- Third generation cephalosporins
- Ampicillin
- Aminoglycosides
- Fluconazole
- All antibacterial agents

More information on SAAR agent categories is available in Appendix E of the NHSN AUR Module Protocol. Historical baseline SAARs are described in reference documents for 2014 (adult and pediatric) and for 2017 and 2018 (adult, pediatric, and neonatal).

The SAAR predictive model development process

After defining referent populations and SAAR agent categories, NHSN identified candidate location- and hospital-level factors to consider for risk-adjustment in SAAR predictive models by 1) listing factors reported to NHSN by *all* hospitals, and 2) seeking independent individual feedback from stewardship experts to identify which of these available and uniformly reported factors could explain differences in AU rates. Hospital-level data are collected through the NHSN Patient Safety Component Annual Hospital Survey.

Factors[3] assessed for developing 2023 adult and pediatric SAAR predictive models:
- Patient care location type
- Hospital type
- Hospital teaching status
- Hospital bed size
- Number of ICU beds
- Percentage of ICU beds, calculated as (ICU beds/total hospital beds) x 100

[3] Facility type, hospital teaching status, hospital bed size, number of ICU beds, annual patient days, and annual admissions are taken from the annual hospital survey

- Average hospital length of stay (LOS), calculated as annual patient days/annual admissions

Factors assessed for developing 2023 neonatal SAAR predictive models:

- Patient care location type
- Hospital type
- Hospital teaching status
- Hospital bed size
- Annual number of neonatal admissions[4]
- Annual number of inborn[5] neonatal admissions
- Annual number of outborn[6] neonatal admissions
- Percentage of outborn admissions, calculated as (outborn admissions/neonatal admissions) x 100
- Whether a hospital provides Level III or higher neonatal intensive care[7]
- Whether a hospital accepts neonates as transfers for various specified complex procedures[8]
- Number and percentage of neonatal admissions with birthweight in the following five categories: a) ≤750g, b) 751-1000g, c) 1001-1500g, d) 1501-2500g, e) >2500g

After identifying factors to assess, NHSN began the SAAR model development process to determine which factors (and in what form) were associated with AU rates for each SAAR agent category. NHSN used negative binomial regression to assess these associations. First, each factor was tested individually in univariate models. Factors that were statistically significant in predicting AU rates in univariate models entered multivariate models. NHSN used forward selection, a stepwise method of fitting regression models, to identify a final predictive model that risk adjusted for all factors predictive of AU for each SAAR agent category.

NHSN assessed variables in multiple forms and grouped some levels with similar risk estimates together. For example, in the 2023 baseline adult broad spectrum hospital-onset agent SAAR model, teaching status was associated with AU rates—with non-teaching, undergraduate, and major teaching hospitals having similar rates. NHSN grouped these levels together and created a two-level risk-adjustment variable: graduate teaching hospitals vs. non-teaching, undergraduate, and major teaching hospitals. Additionally, NHSN combined factors if rates varied among only certain strata to prevent risk estimations based on a small subset of locations. For example, in the 2023 baseline neonatal SAAR model for ampicillin, NHSN found that location type, whether hospital provides Level III or higher care, and whether hospital accepts neonates as transfers for various specific complex procedures predicted AU rates in univariate and multivariate models. However, when all three variables were included in the model together, stratified sample sizes were low, and NHSN decided to combine these factors based on risk estimates (specifically, NHSN combined groups with similar estimates).

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[4] From Annual Hospital Survey question: “Excluding Level I units (well newborn nurseries), record the number of neonatal admissions to Special Care Nurseries (Level II) and Intensive Care Units (Level II/III, Level III, Level IV).” Annual neonatal admissions equal the summation of inborn and outborn admissions.
[5] Inborn admission: Admission of an infant delivered in your facility.
[6] Outborn admission: Admission of an infant delivered outside of your facility.
[7] Level III or higher neonatal care as defined by the American Academy of Pediatrics (for example, capable of providing sustained life support, comprehensive care for infants born <32 weeks gestation and weighing <1500 grams, a full range of respiratory support that may include conventional and/or high-frequency ventilation).
[8] Procedures include omphalocele repair, ventriculoperitoneal shunt, tracheoesophageal fistula (TEF)/esophageal atresia repair, bowel resection/reanastomosis, meningomyelocele repair, and cardiac catheterization.

There is one exception to the rule above regarding grouping levels with similar estimates. For consistency with the 2022 baseline Healthcare-Associated Infection (HAI) Standardized Infection Ratio (SIR) modeling approach, NHSN decided that for adult and pediatric SAAR models, the following unit types could not be combined:

- ICUs with wards – Different ICU types could be grouped together if estimates were similar, and different ward types could be grouped together, but ICUs and wards could not be combined with each other.
- Mixed acuity, step-down, solid organ transplant units with other location types – These three types of units could be grouped together but could not be combined with ICUs or with wards, even if parameter estimates were similar to those of ICUs/wards.

You can find details about previous SAAR models and model development in the following NHSN published manuscripts:

- 2014 baseline adult and pediatric SAAR models
- 2017 baseline adult and pediatric SAAR models
- 2018 baseline neonatal SAAR models

SAARs in NHSN

Finding and reading SAAR reports

2017 Baseline Adult and Pediatric SAARs:

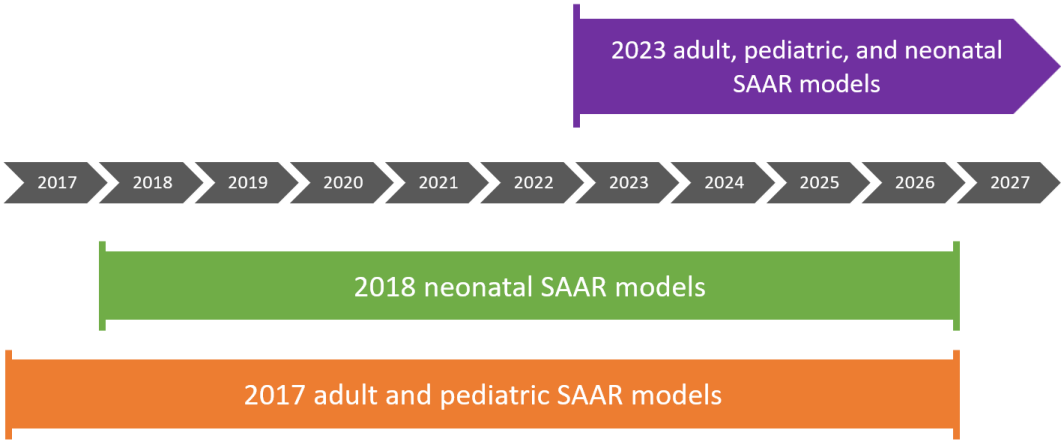
- Available for 8 adult and 5 pediatric location types (adult and pediatric modeled separately)
- 7 adult and 8 pediatric antimicrobial agent categories
- Users can generate SAARs for AU data reported January 2017 through December 2026

2018 Baseline Neonatal SAAR:

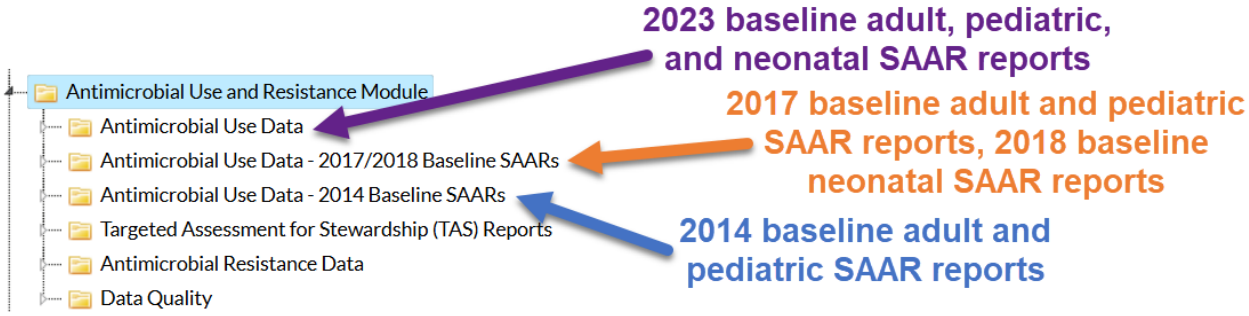
- Available for 4 neonatal location types
- 7 neonatal antimicrobial agent categories
- Users can generate SAARs for AU data reported January 2018 through December 2026

2023 Baseline Adult, Pediatric, and Neonatal SAARs:

- Available for 26 adult, 9 pediatric, and 4 neonatal location types (each population modeled separately)
- 7 adult, 8 pediatric, and 7 neonatal antimicrobial agent categories
- Users can generate SAARs for AU data reported for January 2023 forward



Users can find reports based on each of the SAAR baselines in the NHSN Analysis Reports within the Antimicrobial Use and Resistance Module folder.



The following variables will be found in the SAAR reports in the NHSN application:

- **SAAR Type (SAARTypeAdult2023, SAARTypePed2023, SAARTypeNeo2023):** The SAAR type variable indicates the abbreviated name of the SAAR antimicrobial agent category and patient population (adult, pediatric, neonatal). For example, the broad spectrum antibacterial agents predominantly used for hospital-onset infections SAAR is abbreviated as BSHO. You can find the full name in the report or table title.
- **Antimicrobial Days (antimicrobialDays):** Antimicrobial days represent the total number of calendar days in which a patient receives any amount of a specific antimicrobial agent or a specific group of antimicrobial agents, as documented in the electronic medication administration record (eMAR) or bar-coded medication administration record (BCMA). For each patient, each day that an antimicrobial is administered counts as one antimicrobial day, regardless of the dose or frequency of administration. Antimicrobial days are the SAAR numerator.
- **Predicted Antimicrobial Days (numAUDaysPredicted):** Predicted antimicrobial days are the days of therapy predicted for each SAAR antimicrobial agent category and location, or group of locations, through predictive modeling applied to nationally aggregated AU data for the baseline year. Predicted antimicrobial days are the SAAR denominator.
- **Days Present (numDaysPresent):** Days present are defined as the time period during which a given patient could have antimicrobial exposure in a given patient care location or hospital anytime throughout the day during a calendar month.
- **SAAR:** The SAAR is a ratio comparing observed antimicrobial days to antimicrobial days predicted by a referent, or baseline, population (specifically, predicted antimicrobial days).
- **SAAR p-value (SAAR_pval):** The SAAR p-value is a statistical measure that indicates if observed antimicrobial use is statistically significantly different from predicted antimicrobial use.
- **SAAR 95% Confidence Interval (SAAR95CI):** The 95% confidence interval is the range of values in which NHSN has a high degree of confidence that the true SAAR value lies. However, the SAAR is the most likely value.
- **SAAR Percentile (SAAR_pctl):** The percentile a SAAR falls into based on the distribution of location-specific SAARs found in the NHSN AU Option Report Data Tables. The SAAR Percentile is included in the adult, pediatric, and neonatal SAAR by location reports.

Interpreting the SAAR

The SAAR is a ratio comparing observed AU to AU predicted by a referent, or baseline, population. In general:

- A SAAR > 1.0 indicates greater antimicrobial use than predicted.
- A SAAR = 1.0 indicates antimicrobial use equivalent to predicted use.
- A SAAR < 1.0 indicates less antimicrobial use than predicted.

Two statistical measures, the SAAR p-value and the SAAR 95% confidence interval, accompany the SAAR and aid in its interpretation. The SAAR p-value and 95% confidence interval will always indicate the same statistical significance, and users can interpret them interchangeably. Additionally, the SAAR percentile can be used to contextualize the interpretation of SAARs in the 2023 baseline adult, pediatric, and neonatal SAAR by location reports.

SAAR p-value: The SAAR p-value indicates if observed or reported antimicrobial use is statistically significantly different from predicted antimicrobial use. Due to the large number of days present reported each month, most SAAR p-values are less than or equal to 0.05 (a commonly used, yet arbitrary, cut-point). Please note that statistical significance does not necessarily translate to clinical significance.

- A SAAR p-value ≤ 0.05 indicates reported antimicrobial days **are** statistically significantly different from predicted antimicrobial days.
- A SAAR p-value > 0.05 indicates reported antimicrobial days **are not** statistically significantly different from predicted antimicrobial days.

SAAR 95% Confidence Interval: The SAAR 95% confidence interval is the range of values in which we have a high degree of confidence the true SAAR value lies. However, the SAAR is the most likely value.

- If the 95% confidence interval does not include 1.0 (for example: 95% CI = [0.85, 0.92]), the SAAR is statistically significantly different than 1.0 (specifically, the reported antimicrobial days **are** statistically significantly different from predicted antimicrobial days), and the p-value will be ≤ 0.05.
- If the 95% confidence interval does include 1.0 (for example: 95% CI = [0.85, 1.24]), the SAAR is not statistically significantly different than 1.0 (specifically, the reported antimicrobial days **are not** statistically significantly different from predicted antimicrobial days), and the p-value will be > 0.05.

SAAR Percentile: The SAAR percentile indicates the position of a specific SAAR within the distribution of location-specific SAARs calculated for all locations of the same type, as reported in the most recent NHSN AU Option Report Data Tables. For example, a SAAR for a medical ICU location with a SAAR percentile of 90 indicates 89% of SAAR values reported from medical ICU locations are less than that SAAR and 10% of SAAR values reported from medical ICU locations are higher than it based on data reported into the AU Option.

The SAAR percentile is not generated if the SAAR is not generated (see Circumstances under which NHSN cannot generate SAAR reports or SAAR values below), nor is it generated for locations where the aggregate sample size was too small for analysis (<20 locations nationwide reporting at least nine months of data). For example, pediatric oncology hematopoietic stem cell transplant wards did not have enough locations reporting at least 9 months of data in 2024 for inclusion in the SAAR percentile calculations.

Changes in a location's SAAR over time should also be considered in the context of changes in its SAAR percentile when identifying opportunities for antimicrobial stewardship. For example, a location's SAAR may decrease from one year to the next, yet its SAAR percentile may increase if the national distribution of SAARs has shifted such that the location's SAAR remains higher than a larger proportion of comparable locations. In this situation, the location may still represent a priority for stewardship interventions despite the decrease in its SAAR.

The SAAR, along with a p-value, 95% confidence interval, and percentiles are measures indicating antimicrobial exposure relative to a historical national benchmark (2023 AU baseline), not definitive measures of the appropriateness or judiciousness of antimicrobial use. Additionally, the groupings of antimicrobials for SAAR categories were based on expert opinions to optimize the usefulness for antimicrobial stewardship. Higher SAARs were not meant to indicate a definitive clinical consequence. For example, the agents included in the Antibacterial Agents Posing the Highest Risk for CDI grouping were those associated with higher risk of developing CDI at the individual patient level according to clinical literature. However, when looking at patient care locations, this SAAR is not necessarily associated with same-time CDI incidence. This finding could be because CDI is typically attributed to multiple factors, and the same-time observation of the same patient care location cannot fully reflect the time lag of CDI incidence.

Circumstances under which NHSN cannot generate SAAR reports or SAAR values:

NHSN does not generate a SAAR when the number of predicted antimicrobial days is less than 1.0 to enforce a minimum precision criterion and avoid statistically imprecise SAARs, which typically have extreme values. Small hospitals, such as critical access hospitals, may want to analyze their SAAR data at a higher level of aggregation than month (specifically, quarter, half year, year, or cumulative [all AU data ever reported within the SAAR time period]) to ensure they meet the minimum precision criteria.

For additional circumstances under which NHSN cannot generate SAAR reports or SAAR values, which are listed below, users will receive either a “No Records Met Your Criteria” error message or a missing SAAR value (SAAR = “.”).

All SAARs:

- Locations reporting zero days present for the selected time period.
- Locations reporting more antimicrobial days than days present for any SAAR agent category (except for adult and pediatric All Antibacterial Agents SAARs).

Adult SAARs:

- Adult SAAR locations in a long-term acute care (LTAC) or rehabilitation hospital. The 2023 SAAR baseline adult referent population does not include these hospital types.

Pediatric SAARs:

- Pediatric SAAR locations in critical access, LTAC, oncology, orthopedic, pediatric LTAC, psychiatric, rehabilitation, surgical, women’s, or Veterans Affairs (VA) hospital. The 2023 SAAR baseline pediatric referent population does not include these hospital types.

Neonatal SAARs:

- Neonatal SAAR locations in critical access, LTAC, oncology, orthopedic, pediatric LTAC, psychiatric, rehabilitation, or VA hospital. The 2023 SAAR baseline neonatal referent population does not include these hospital types.

- Hospitals reporting on the NHSN Patient Safety Component Annual Hospital Survey that they do not care for neonates. Specifically, hospitals that respond: “N/A, my hospital does not provide neonatal or newborn patient care services at any level.”
- Hospitals reporting zero inborn and zero outborn admissions on the NHSN Patient Safety Component Annual Hospital Survey.

Example SAAR interpretation

As an example, here is an interpretation of one row of a sample SAAR report for broad spectrum antibacterial agents predominantly used for hospital-onset infections (BSHO) used in adult obstetrics wards.

National Healthcare Safety Network
SAARs Table - All Adult Standardized Antimicrobial Administration Ratios (SAARs) High-Level Indicators and High-Value Targets by Location (2023 Baseline)
As of: March 9, 2026 at 5:24 PM UTC
Date Range: AU_SAAR_ADULT_2023 summaryYr After and Including 2025

Broad spectrum antibacterial agents predominantly used for hospital-onset infections used in adult obstetrics wards

orgID	SAARTypeAdult2023	location	summaryYQ	locCDC	antimicrobialDays	numAUDaysPredicted	numDaysPresent	SAAR	SAAR_pval	SAAR95CI	SAAR_pctl
13860	Adult_BSHO_OB_2023	LABOR11	2025Q3	IN:ACUTE:WARD:LD	312	123.041	8320	2.536	0.0000	2.266, 2.829	95
13860	Adult_BSHO_OB_2023	LABOR11	2025Q4	IN:ACUTE:WARD:LD	285	155.280	10500	1.835	0.0000	1.631, 2.058	88
13860	Adult_BSHO_OB_2023	LDRP	2025Q3	IN:ACUTE:WARD:LD_PP	300	144.484	9770	2.076	0.0000	1.851, 2.322	93
13860	Adult_BSHO_OB_2023	LDRP	2025Q4	IN:ACUTE:WARD:LD_PP	306	112.689	7620	2.715	0.0000	2.424, 3.033	95

Note: Data for example only.

During the third quarter (Q3) of 2025, this hospital reported 312 BSHO antimicrobial days for patients contributing 8,320 days present in their labor and delivery ward (LABOR11). NHSN applied risk-adjustments based on the 2023 baseline adult BSHO SAAR predictive model to calculate 123.041 predicted antimicrobial days for the LABOR11 during 2025Q3. NHSN calculated the SAAR as 312 divided by 123.041, for a SAAR value of 2.536. With a p-value of <0.05 and a 95% confidence interval that does not contain 1.0 (2.266, 2.829), observed antimicrobial use was statistically significantly different from predicted antimicrobial use for the LABOR11 location during 2025Q3. The SAAR percentile of 95 indicates that the SAAR value of 2.536 falls within the 95th percentile for labor and delivery wards. In other words, the LABOR11’s SAAR is higher than 94% of labor and delivery wards and lower than 5% of labor and delivery wards reporting to NHSN.

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.

As an example, the two tables below show risk factors found to be significantly associated with rates of AU for that particular model, and their associated parameter estimates which are used to calculate the number of predicted antimicrobial days for adult broad spectrum antibacterial agents predominantly used for hospital-onset infections (Table 4) and neonatal vancomycin (Table 5) under the 2023 baseline.

Table 4. Risk factors used in the 2023 baseline adult SAAR predictive model for broad spectrum antibacterial agents predominantly used for hospital-onset infections.

Factor	Parameter Estimate	p-value
Intercept	-4.9392	<.0001
Location type: Medical ICU	3.0644	<.0001
Location type: Oncology Hematopoietic Stem Cell Transplant Ward	2.9621	<.0001
Location type: Medical-Surgical ICU, Surgical ICU	2.9448	<.0001
Location type: Burn ICU, Medical Cardiac ICU, Trauma ICU	2.7411	<.0001
Location type: Surgical Cardiothoracic ICU, Neurologic ICU, Neurosurgical ICU	2.5611	<.0001
Location type: Solid Organ Transplant Special Care Area	2.5036	<.0001
Location type: Burn Ward, General Hematology-Oncology Ward, Pulmonary Ward	2.4750	<.0001
Location type: Mixed Acuity Unit, Step-Down Unit	2.2976	<.0001
Location type: Medical-Surgical Ward, Surgical Ward	2.1882	<.0001
Location type: Medical Ward	2.1105	<.0001
Location type: Orthopedic Ward, Orthopedic Trauma Ward	1.7345	<.0001
Location type: Neurosurgical Ward	1.5232	<.0001
Location type: Neurology Ward	1.3758	<.0001

Factor	Parameter Estimate	p-value
Location type: Labor and Delivery Ward, Labor, Delivery, Recovery, Postpartum Suite, Postpartum Ward	REF	-
Facility type: Critical Access, General Acute Care, Oncology, Surgical, Veterans Affairs	0.4214	<.0001
Facility type: Children's, Military, Orthopedic, Psychiatric, Women's, Women's and Children's	REF	-
Number of ICU beds, facility-wide: ≥5	0.2593	<.0001
Number of ICU beds, facility-wide: <5	REF	-
Average hospital length of stay (in days): ≥2.8	0.0909	<.0001
Average hospital length of stay (in days): 1.0 - 2.7	REF	-
Medical school affiliation type: None, Undergraduate, Major	0.0446	0.0009
Medical school affiliation type: Graduate	REF	-

Note: The parameter estimate for a referent group (REF) is 0.0000.

We can put the model details from Table 4 into the negative binomial regression model formula:

 # predicted DOT = Exp [-4.9392
+ 3.0644 (Location type: Medical ICU)
+ 2.9621 (Location type: Oncology Hematopoietic Stem Cell Transplant Ward)
+ 2.9448 (Location type: Medical-Surgical ICU, Surgical ICU)
+ 2.7411 (Location type: Burn ICU, Medical Cardiac ICU, Trauma ICU)
+ 2.5611 (Location type: Surgical Cardiothoracic ICU, Neurologic ICU, Neurosurgical ICU)
+ 2.5036 (Location type: Solid Organ Transplant Special Care Area)
+ 2.4750 (Location type: Burn Ward, General Hematology-Oncology Ward, Pulmonary Ward)
+ 2.2976 (Location type: Mixed Acuity Unit, Step-Down Unit)
+ 2.1882 (Location type: Medical-Surgical Ward, Surgical Ward)
+ 2.1105 (Location type: Medical Ward)
+ 1.7345 (Location type: Orthopedic Ward, Orthopedic Trauma Ward)
+ 1.5232 (Location type: Neurosurgical Ward)
+ 1.3758 (Location type: Neurology Ward)
+ 0.4214 (Facility types: HOSP-CAH, HOSP-GEN, HOSP-ONC, HOSP-SURG, HOSP-VA)
+ 0.2593 (ICU beds: ≥5)
+ 0.0909 (Average length of stay: ≥2.8 days)
+ 0.0446 (Teaching status: None, Undergraduate, Major) **]** x **# days present**

For each variable shown in parentheses above, replace the variable name with (and, therefore, multiply each parameter estimate by) a "1" or "0" depending on whether that factor is present (Yes="1", No="0").

Below is an example of how to calculate predicted broad spectrum hospital-onset antimicrobial days for an adult surgical ward reporting AU data in January 2025. This surgical ward is in a hospital enrolled in NHSN as a non-teaching general acute care hospital with 2 ICU beds and an average length of stay of 4 days. The hospital reported 3 antimicrobial days and 30 days present for this location and month.

In our location example, the completed formula looks like this:

 # predicted DOT = Exp [-4.9392
+ 3.0644 (Location type: Medical ICU) → (0)
+ 2.9621 (Location type: Oncology Hematopoietic Stem Cell Transplant Ward) → (0)
+ 2.9448 (Location type: Medical-Surgical ICU, Surgical ICU) → (0)
+ 2.7411 (Location type: Burn ICU, Medical Cardiac ICU, Trauma ICU) → (0)
+ 2.5611 (Location type: Surgical Cardiothoracic ICU, Neurologic ICU, Neurosurgical ICU) → (0)
+ 2.5036 (Location type: Solid Organ Transplant Special Care Area) → (0)
+ 2.4750 (Location type: Burn Ward, General Hematology-Oncology Ward, Pulmonary Ward) → (0)
+ 2.2976 (Location type: Mixed Acuity Unit, Step-Down Unit) → (0)
+ 2.1882 (Location type: Medical-Surgical Ward, Surgical Ward) → (1)
+ 2.1105 (Location type: Medical Ward) → (0)
+ 1.7345 (Location type: Orthopedic Ward, Orthopedic Trauma Ward) → (0)
+ 1.5232 (Location type: Neurosurgical Ward) → (0)
+ 1.3758 (Location type: Neurology Ward) → (0)
+ 0.4214 (Facility types: HOSP-CAH, HOSP-GEN, HOSP-ONC, HOSP-SURG, HOSP-VA) → (1)
+ 0.2593 (ICU beds: ≥5) → (0)
+ 0.0909 (Average length of stay: ≥2.8 days) → (1)
+ 0.0446 (Teaching status: None, Undergraduate, Major) → (1)
] x # days present

= $e^{[-4.9392+2.1882+0.4214+0.0909+0.0446]}$ x 30 days present
= $e^{[-2.1941]}$ x 30 days present
= 0.1115 x 30 days present
= 3.345 predicted antimicrobial days

Because the hospital does not have ≥5 ICU beds, that variable was multiplied by 0. This location received an adjustment of 2.1882 for being a surgical ward, 0.4214 for being in a general acute care hospital, 0.0909 for having an average length of stay ≥2.8 days, and 0.0446 for being in a non-teaching hospital. To calculate predicted antimicrobial days, sum the adjustments (2.1882, 0.4214, 0.0909, 0.0446) and intercept (-4.9392), exponentiate that sum, and multiply by 30 days present, which results in 3.345 predicted BSHO antimicrobial days for this adult surgical ward for January 2025. To calculate the SAAR, divide observed antimicrobial days by predicted antimicrobial days. In our example:

$$\boldsymbol{SAAR} = \frac{3\ Observed\ antimicrobial\ days\ of\ therapy}{3.345\ Predicted\ antimicrobial\ days\ of\ therapy} = \mathbf{0.897}$$

Table 5. Risk factors used in the 2023 baseline neonatal SAAR predictive model for vancomycin.

Factor	Parameter Estimate	p-value
Intercept	-8.4724	<.0001
Location type: Level III and IV NICUs	2.7417	<.0001
Location type: Level II/III NICUs	2.3672	<.0001
Location type: Level II special care nurseries in a hospital that does NOT provide Level III or higher care	1.2695	<.0001
Location type: Level II special care nurseries in a hospital that DOES provide Level III or higher care	REF	-

Factor	Parameter Estimate	p-value
Percentage of annual neonatal admissions with birthweight ≤750g: ≥3.3%	1.3345	<.0001
Percentage of annual neonatal admissions with birthweight ≤750g: 0.8 - 3.2%	0.6717	<.0001
Percentage of annual neonatal admissions with birthweight ≤750g: <0.8%	REF	-
Total annual neonatal admissions: ≥106	0.9295	<.0001
Total annual neonatal admissions: <106	REF	-

Note: The parameter estimate for a referent group (REF) is 0.0000.

We can put the model details from Table 5 into the negative binomial regression model formula:

 # predicted DOT = Exp [-8.4724
+ 2.7417 (Location type: Level III and IV NICUs)
+ 2.3672 (Location type: Level II/III NICUs)
+ 1.2695 (Location type: Level II special care nurseries in a hospital that does NOT provide Level III or higher care)
+ 1.3345 (Percentage of annual neonatal admissions with birthweight ≤750g: ≥3.3%)
+ 0.6717 (Percentage of annual neonatal admissions with birthweight ≤750g: 0.8 - 3.2%)
+ 0.9295 (Annual neonatal admissions: ≥106) **] x # days present**

For each variable shown in parentheses above, replace the variable name with (and, therefore, multiply each parameter estimate by) a “1” or “0” depending on whether that factor is present (Yes=“1”, No=“0”).

Below is an example of how to calculate predicted vancomycin antimicrobial days for a Level IV NICU reporting AU data in January 2025. This NICU is in a children’s hospital with 624 annual neonatal admissions and 3.8% of neonatal admissions with birthweight ≤750g. This hospital reports 7 antimicrobial days and 350 days present for this location/month.

In our location example, the formula looks like this:

 # predicted DOT = Exp [-8.4724
+ 2.7417 (Location type: Level III and IV NICUs) → (1)
+ 2.3672 (Location type: Level II/III NICUs) → (0)
+ 1.2695 (Location type: Level II special care nurseries in a hospital that does NOT provide Level III or higher care) → (0)
+ 1.3345 (Percentage of annual neonatal admissions with birthweight ≤750g: ≥3.3%) → (1)
+ 0.6717 (Percentage of annual neonatal admissions with birthweight ≤750g: 0.8 - 3.2%) → (0)
+ 0.9295 (Annual neonatal admissions: ≥106) → (1)
] x # days present

= $e^{[-8.4724+2.7417+1.3345+0.9295]}$ **x 350 days present**
= $e^{[-3.4667]}$ **x 350 days present**
= 0.0312 **x 350 days present**
= **10.920 predicted antimicrobial days**

This location received an adjustment of 2.7417 because the location is a Level IV NICU, 0.9295 for being in a hospital with ≥106 annual neonatal admissions, and 1.3345 for having ≥3.3% of neonatal admissions with birthweights ≤750g. To calculate predicted antimicrobial days, we sum the adjustments (2.7417, 0.9295, 1.3345) and the intercept (-8.4724), exponentiate that sum, and multiply by 350, which results in 10.920 predicted vancomycin antimicrobial days for this Level IV NICU in January 2025. To calculate the SAAR, divide observed antimicrobial days by predicted antimicrobial days. In our example:

$$\boldsymbol{SAAR} = \frac{7\ Observed\ antimicrobial\ days\ of\ therapy}{10.920\ Predicted\ antimicrobial\ days\ of\ therapy} = \mathbf{0.641}$$

Additional notes regarding risk-adjustment:

- NHSN separates some risk-adjustment variables into different levels, or categories. For example, NHSN breaks down continuous variables into categories based on decile, quintile, quartile, tertile, and median values. NHSN may group levels further if risk estimates are not statistically significantly different.
- For variables with more than one level, one level is the referent category (specifically, the category to which all other levels are compared). The analyst developing the model can select the referent group. For risk of AU, it is often easier to understand which factors are associated with increased use, rather than decreased use and, when possible, we select the group with the lowest AU risk as the referent category.
- Parameter estimates reflect the nature of the relationship between the variable and the risk of AU. A positive estimate means the risk of AU for the associated group is higher than the referent group. A negative estimate means the risk of AU for the associated group is lower than the referent group.
- Standard errors reflect the precision of parameter estimates, where smaller standard errors indicate a greater level of precision than larger standard errors.
- You can find model details for the 2023 baseline adult, pediatric, and neonatal models at the end of this document.

Using the SAAR for Action

Making SAARs actionable: set targets and prioritize reviews

Defining your benchmark

A benchmark is a point of reference against which comparisons can be made. Hospitals can assess whether they're using antimicrobials at higher or lower rates than the national average by comparing their SAARs to 1.0, which is the nominal benchmark value. SAAR values other than 1.0 may be helpful benchmarks for hospitals, depending on their stewardship goals.

Unlike Standardized Infection Ratios (SIRs), which aim for a target value of 0 when measuring healthcare-associated infections, the target value for antimicrobial use is less straightforward. A SAAR value of 1.0 may not necessarily mean AU is ideal or even good. Please consider clinical judgment and patient information when interpreting SAAR values and setting SAAR targets. Antimicrobial stewards can assess the appropriateness of treatment courses for specific antimicrobials or infections, such as through medication use evaluations, to help set reasonable SAAR targets.

National SAAR distributions can help further inform SAAR benchmarking decisions by allowing hospitals to see where their SAARs are located among all reporting hospitals in the given calendar year. NHSN developed the AU Data Reports and accompanying data tables to provide hospitals with SAAR distributions within SAAR antimicrobial agent categories in adult, pediatric, and neonatal locations to help hospitals set benchmarks. For example, the 50th percentile (i.e., median) BSHO SAAR value for adult labor and delivery wards is 0.885 according to 2024 data, so a hospital may want to set that value as their benchmark rather than the nominal 1.0 value. The SAAR percentile column in the SAAR by location reports can be used to track progress toward a goal or benchmark.

In 2022, CDC released Targeted Assessment for Antimicrobial Stewardship (TAS) reports for NHSN users. TAS is a framework for quality improvement developed to use NHSN AU Option data for action to optimize AU at hospitals. The TAS Reports use a metric called the AU cumulative attributable difference (AU-CAD). The AU-CAD represents the difference between the observed days and a selected SAAR target. The TAS Reports allow for ranking hospitals within groups, or location groups and locations within individual hospitals, by the AU-CAD, to identify where stewardship efforts may have the greatest impact. TAS reports may provide further insight into what SAAR benchmarks are achievable and make the most sense for specific location types and SAAR agent categories. See the NHSN TAS Guide for more information on TAS reports.

Comparing two SAAR values in a meaningful way

Hospitals can compare two SAAR values to assess whether they are statistically significantly different from each other, track progress toward meeting specific stewardship targets, or compare a SAAR to a benchmark value. NHSN users can use the **NHSN Statistics Calculator** within the NHSN application to conduct statistical tests and determine if there is a statistically significant difference between two SAAR values.

Dos:
You can compare SAARs of the same type (e.g., adult broad spectrum antibacterial agents predominantly used for community-acquired infections [BSCA]) using the same SAAR baseline models.

Don'ts:
Do not compare SAARs that are generated using different baseline models. For example, do not compare SAAR values generated using 2017 baseline models with SAAR values generated using 2023 baseline models. Do not pool or compare across different patient populations (adult vs. pediatric vs. neonatal) or across different SAAR agent categories.

Note: You cannot directly compare SAAR values calculated under different baselines because NHSN risk-adjusts each baseline differently. The NHSN AUR Team provided training on how to use the NHSN Statistics Calculator to compare a SAAR to a nominal value and compare two SAARs during an NHSN Annual Training session on advanced AU Option analysis (AUR Training webpage).

For example, a hospital that worked to decrease antifungal agent use for invasive candidiasis in their adult oncology units and hematopoietic stem cell transplant wards wants to assess the impact of their efforts. They want to compare SAAR values for this antimicrobial category across two points in time: the third and fourth quarters of 2025.

orgID	summaryYQ	SAARTypeAdult2023	antimicrobialDays	numAUDaysPredicted	numDaysPresent	SAAR
13860	2025Q3	Adult_NSBL_ONC_2023	804	464.124	10181	1.732
13860	2025Q4	Adult_NSBL_ONC_2023	732	463.590	10182	1.579

Note: Data for example only.

The hospital found the SAAR decreased from 1.732 in 2025Q3 to 1.579 in 2025Q4. The hospital can use the NHSN Statistics Calculator, entering observed and predicted antimicrobial days for each quarter, to find out if this is a statistically significant decrease in their SAAR value.

National Healthcare Safety Network
Comparing Two SAARs
As of: March 9, 2026 at 3:06 PM

	2025Q3	2025Q4
Observed Antimicrobial Administration	804	732
Predicted Antimicrobial Administration	464.124	463.59
SAAR	1.732	1.579

Relative ratio of SAARs (data column 2 / data column 1): 1.579/1.732 = 0.912 (91.2%)
Two-tailed p-value: 0.0696
95% Conf. Interval: 0.825, 1.007

Another way to look at the above results would be to consider relative change between the measures as shown in the table below

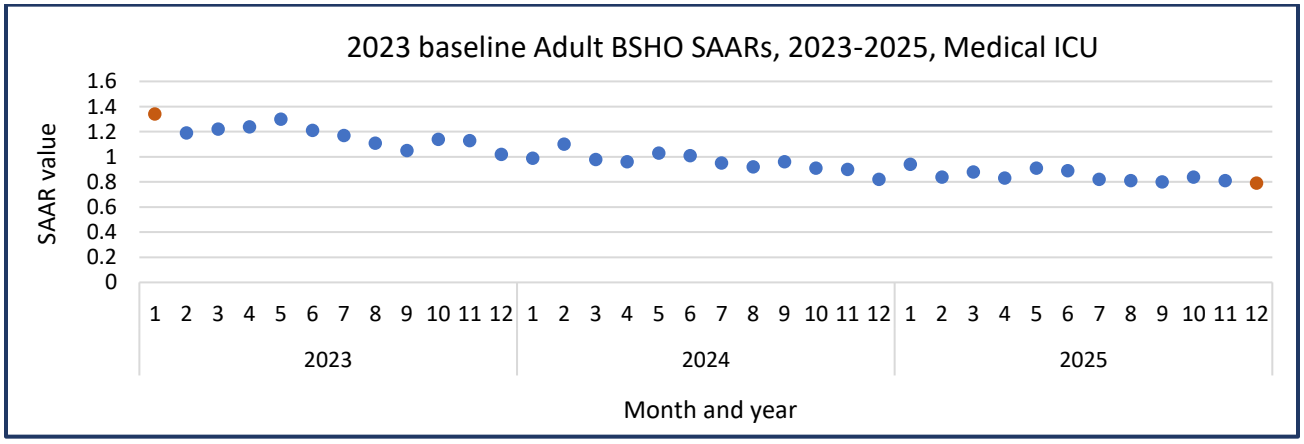
Percent change between SAARs ((data column 2/data column 1)-1*100): (1.579/1.732)-1)*100 = -8.834
Two-tailed p-value: 0.0696
95% Conf. Interval: -17.5, 0.7

Note: Data for example only.

Since the p-value 0.0696 is greater than 0.05, and the 95% confidence interval (0.825, 1.007) does contain 1.0, the change in SAAR value from 1.732 to 1.579 is **not** statistically significant. It is important to keep in mind that SAARs often have large denominators and increased power to find differences statistically significant. While statistical significance is important, it does not mean findings are clinically significant or meaningful.

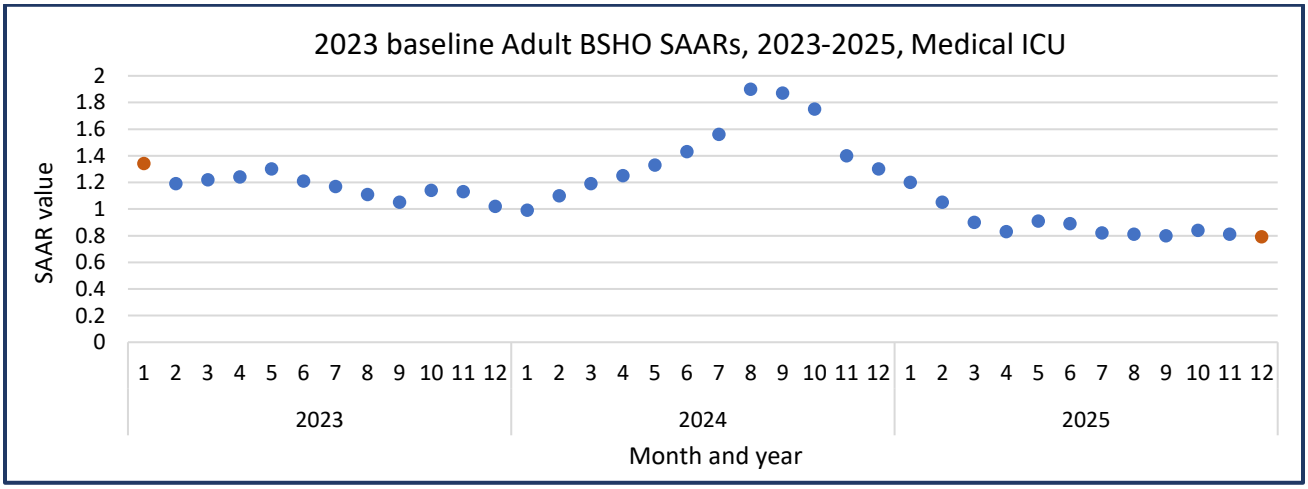
Tracking over time: compare specific time points and account for model-driven shifts

Tracking AU over time is an integral part of antimicrobial stewardship. You may compare two SAAR values across two points in time (as discussed in the Comparing Two SAAR values section). However, it is statistically inappropriate to use SAARs as an outcome for trend analyses, where SAAR values are simultaneously compared across many points in time to determine whether there is a statistically significant change in AU, as the proportionality assumption, discussed in more detail below, is unlikely to hold across a large number of time points. Instead, hospitals interested in assessing AU over many time points may use crude rates and risk-adjust for factors included in the SAAR models and work with their local statistician to develop methods that fit the analysis question of interest.



Note: Data for example only.

In the plot above, this example hospital can visualize their medical ICU's 2023 baseline Adult BSHO SAAR values from January 2023 through December 2025. If they are interested in knowing whether there is a statistically significant change in Adult BSHO use in this location between January 2023 and December 2025, they can use the NHSN Statistics Calculator to compare the SAAR values (two orange dots) for these two points. This type of analysis simply compares the start and end values but does not consider all data points in between. In the plot below, the start and end values are the same as those above, but you can see SAAR values increase greatly in 2024 and the overall pattern of SAARs across the three years looks very different.



Note: Data for example only.

A true trend analysis assesses each data point at a specific aggregation level (for example, monthly, quarterly, etc.) in the time period of interest. As mentioned, it is statistically inappropriate to use SAARs as an outcome for trend analyses to determine whether there has been a statistically significant change in AU across many points in time. Rates, on the other hand, can be used for trend analyses. Work with a local statistician to further understand the proportionality assumption and how to use AU rates to assess long term trends in antimicrobial use in your hospital. NHSN includes the ability to produce SAAR plots to visually display SAARs over time. The steps for running and interpreting this report type are in the SAAR Plot Analysis Quick Reference Guide.

Anticipate shifts from annual survey risk adjustment updates

NHSN uses Patient Safety Component Annual Hospital Survey data for hospital-level risk-adjustment in SAAR models; the survey year is matched to the year of the AU data (specifically 2025 survey values are used when risk adjusting 2025 AU data). However, because hospitals complete surveys annually while reporting AU data monthly, there is a period of 12+ months where NHSN risk-adjusts SAARs using the previous year's survey data. For example, hospitals completed their 2025 surveys in early 2026 using data from the complete 2025 calendar year. If a hospital completes their survey each March, their 2025 survey would be completed in March 2026. If the hospital reports AU data monthly, in February 2026, NHSN calculates their 2025 and 2026 SAARs using 2024 survey data (specifically, the most recent survey data available). Then in March 2026, when they complete their 2025 survey, save it in NHSN, and generate new datasets, NHSN *updates* the 2025 and 2026 SAARs to use 2025 survey data for calculations. 2026 SAARs will use 2025 survey data for risk-adjustment until the hospital completes its 2026 survey in March 2027.

Many hospitals and health systems track SAARs on an ongoing basis and may notice shifts in their SAAR values once current survey data replace old survey data for risk-adjustment in SAAR calculations. The likelihood and magnitude of shifts in SAARs due to survey updates depends on the number and types of risk-adjustments made in each predictive model. All the 2023 baseline SAAR models risk-adjust for at least one survey variable and are susceptible to shifts in SAAR calculations if a hospital changes one or more hospital-level factors that cause it to shift risk-adjustment categories. For example, the adult model for the antibacterial agents predominantly used for resistant gram-positive infections SAAR category risk-adjusts for location type, hospital type, number of hospital beds, and average length of stay, so a hospital can move to a different risk-adjustment category if their survey changes enough year to year.

Example: *How changes to surveys can affect 2023 baseline pediatric azithromycin SAARs*

The pediatric SAAR model for azithromycin risk-adjusts for location type, hospital type, number of ICU beds, average length of stay (LOS), and medical school affiliation.

Pediatric Azithromycin	Estimate
Intercept	-5.9067
Location Type	
Medical ICU, Medical-Surgical ICU	1.9580
Medical Ward, General Hematology-Oncology Ward, Hematopoietic Stem Cell Transplant Ward	1.5633
Step-down Unit	1.3805
Medical-Surgical Ward	1.2032
Surgical Cardiothoracic ICU	1.0997
Surgical Ward	REF
Facility Type	
General Acute Care	0.1347
Children's, Military, Women's and Children's	REF
Number of ICU beds, facility-wide	
Group 1: <70	0.3820
Group 2: ≥70	REF
Average length of stay, facility-wide (in days)	
Group 2: ≥4.7	0.2036
Group 1: 1.0 - 4.6	REF
Medical school affiliation type	
None	0.5432
Undergraduate, Graduate, Major	REF

In 2024, the hospital reports:

- Length of stay – 4.9 days
- Number of ICU beds – 69
- Medical school affiliation – None

In 2025, the hospital reports:

- Length of stay – 4.4 days
- Number of ICU beds – 71
- Medical school affiliation – None

Based on changes in the hospital's average LOS and bed size between 2024 and 2025, they can expect changes in their 2025 pediatric azithromycin SAARs once their 2025 survey data replace their 2024 survey data for SAAR calculations. For LOS, they reported 4.9 days in 2024, which falls in the highest risk category (≥4.7 days), and 4.4 days in 2025, which falls in the lowest (referent) risk category (1.0-4.6 days). For number of ICU beds, they reported 69 ICU beds in 2024, which falls in the highest risk category (<70 ICU beds), and 71 ICU beds in 2025, which falls in the lowest (referent) risk category (≥70 beds). Their medical school affiliation did not change from 2024 to 2025 so they will remain in the highest risk category (None). Only changes in LOS and ICU bed size will affect estimates for predicted antimicrobial days, and total risk-adjustment will be lower using 2025 survey data compared with 2024 survey data:

- LOS estimate 2024 vs. 2025: 0.2036 → 0.0000
- ICU bed estimate 2024 vs. 2025: 0.3820 → 0.0000
- Predicted antimicrobial days using 2025 survey data will decrease by:
  - $= (e^{(0.0000 + 0.0000)} - e^{(0.2036 + 0.3820)})$ x number of days present
  - $= (e^{(0.0000)} - e^{(0.5856)})$ x number of days present
  - = (1.0000 - 1.7961) x number of days present
  - = -1.7961 x number of days present
- Because -1.7961 is less than 1.0, this change in estimation will result in a *smaller* number of predicted antimicrobial days and, therefore, a higher SAAR value.

Scalability of the SAAR: aggregate SAAR data appropriately

Scalability means that hospitals can calculate SAARs at various levels of aggregation. For example, in pre-filtered reports, NHSN calculates SAARs at the location/month-level and the SAAR Location Type/month-level. Users can modify reports to display quarterly or yearly SAARs. Although NHSN currently does not have a built-in option to generate SAARs for multiple hospitals or combinations of select locations, users can manually pool data to calculate SAARs at different levels of aggregation. Examples of how users can aggregate SAAR data within any individual baseline year:

- Across time (months, quarters, or years)
- Across SAAR-eligible locations (within any baseline population, specifically, do not combine 2023 baseline adult data, pediatric data, and/or neonatal data)
- Across hospitals, health systems, or health department jurisdictions

To calculate a pooled SAAR for aggregation levels not available in NHSN, users can export their SAAR data and manually sum observed antimicrobial days across desired levels of aggregation, sum predicted antimicrobial days across those same levels, then divide the pooled observed antimicrobial days by pooled predicted antimicrobial days. For example, you can calculate a pooled SAAR for narrow spectrum beta-lactam agents used in adult obstetrics wards across three different hospitals.

Narrow spectrum beta-lactam agents used in adult obstetrics wards

orgID	summaryYM	SAARTypeAdult2023	antimicrobialDays	numAUDaysPredicted	numDaysPresent	SAAR	SAAR_pval	SAAR95CI
13860	2023M06	Adult_NSBL_OB_2023	148	276.339	1212	0.536	0.0000	0.454, 0.627
14005	2023M06	Adult_NSBL_OB_2023	163	221.530	1558	0.736	0.0000	0.629, 0.856
14059	2023M06	Adult_NSBL_OB_2023	92	80.858	1787	1.138	0.2193	0.922, 1.389

Note: Data for example only.

For June 2023, you can calculate a pooled adult NSBL OB SAAR for these three hospitals using the following formula:

$$\boldsymbol{Pooled\ NSBL\ SAAR} = \frac{orgID\ 13860\ observed\ DOT\ +\ orgID\ 14005\ observed\ DOT\ +\ orgID\ 14059\ observed\ DOT}{orgID\ 13860\ predicted\ DOT\ +\ orgID\ 14005\ predicted\ DOT\ +\ orgID\ 14059\ predicted\ DOT}$$

$$\boldsymbol{Pooled\ NSBL\ SAAR} = \frac{148 + 163 + 92}{276.339 + 221.530 + 80.858}$$

$$\boldsymbol{Pooled\ NSBL\ SAAR} = \frac{403}{578.454} = \mathbf{0.697}$$

Note: This example is an appropriate use of aggregation because we are pooling within the same SAAR agent category (NSBL) and the same patient population (2023 baseline adult locations). We would NOT pool adult NSBL data with pediatric NSBL data. Additionally, we would NOT pool across SAAR agent categories such as adult NSBL data with adult BSHO data.

As a reminder, the SAARs generated in NHSN only include the SAAR eligible location types (see Table 5 in the NHSN AUR Module Protocol). None of the SAARs contain AU data from all inpatient locations in a given hospital. Specifically, NHSN does not offer a facility-wide SAAR because not all location types are SAAR eligible. The closest alternative is the All Antibacterial Agents SAAR, which users can pool across all SAAR-eligible locations within any baseline year and baseline population. For example, you can pool observed and predicted antimicrobial days

for All Antibacterial Agents across all 2023 baseline adult SAAR-eligible locations. You can do the same separately for 2023 baseline pediatric or neonatal SAAR-eligible locations.

While scaling SAAR data can be useful for many efforts in antimicrobial stewardship, there are limitations that users must keep in mind. For example, you cannot aggregate data across baseline populations (specifically, it is inappropriate to pool observed and predicted antimicrobial days across adult, pediatric, and neonatal locations) or baseline years. The more scaling that occurs, the more uncertainty you introduce, and the greater the likelihood that additional factors (not included in risk adjustments) will account for observed changes. The more you aggregate, the more likely the groups you are comparing will differ in certain factors, leading to a loss in proportionality. This concept of proportionality can be found in the 2nd Volume of Breslow and Day's Statistical Methods in Cancer Research.

State, territorial, and local health departments, as well as hospital systems, can generate SAARs for all hospitals in their jurisdiction using the NHSN Group Function. The NHSN Group Function allows users to access multiple hospitals' NHSN data with their permission or, in the case of state, territorial, and local health departments, through a data use agreement. The Group is managed centrally, and while hospitals share data with the group, individual hospitals cannot see data from other group members. You can find more information about the NHSN Group Function on the NHSN Group Function website. State, territorial, and local health departments can find more information on obtaining NHSN data from hospitals in their jurisdiction on the Data Use Agreement (DUA) website. The NHSN AUR Team provided training on setting up and using the NHSN Group Function for AUR data, running SAAR reports at the group level, and aggregating SAARs across multiple hospitals (slides).

Using the SAAR to inform stewardship

Antimicrobial stewardship is the effort to measure and improve how clinicians prescribe antimicrobials. Improving antimicrobial prescribing and use is critical to effectively treat infections, protect patients from harm caused by unnecessary AU, and combat antimicrobial resistance. The Priority Core Elements of Antibiotic Stewardship emphasize tracking and reporting AU to support these activities. Though a SAAR is not a definitive measure of the appropriateness or judiciousness of AU, it can be a valuable tool to help inform and guide antimicrobial stewardship efforts. The following examples highlight how hospitals have applied AU Option data in real-world settings to drive improvements.

AU Option Case Examples

CDC collaborated with hospitals that report data to the AU Option to provide several AU Option Case Examples documenting success stories from hospitals that used their SAAR data to improve provider practices. Examples include:

- Using the SAAR to Track Impact of Multiple Concurrent Antimicrobial Stewardship Interventions
- Targeting a Reduction in Fluoroquinolone Use within a Community Hospital

CDC also funded the Duke Center for Antimicrobial Stewardship and Infection Prevention to develop an implementation guide to aid hospitals in using NHSN data to inform, implement, and assess stewardship initiatives. A series of clinical stewardship scenarios were created based on real-world stewardship work.

In addition to case-based examples, CDC provides structured tools and guidance to help hospitals systematically assess and act on AU Option data.

Targeted Assessment for Antimicrobial Stewardship (TAS) Resources

Several TAS resources are available on our website. Our Keys to Success with TAS webpage provides a brief overview of TAS and links to additional TAS resources. The NHSN TAS Guide provides in-depth information about TAS and the intricacies of each TAS dashboard and report type. The TAS Quick Reference Guides provide practical information on how to run, modify, and interpret each TAS dashboard and report.

Beyond TAS resources, additional guidance is available to support hospitals in identifying and prioritizing opportunities to improve antimicrobial use.

Strategies to Assess Antibiotic Use to Drive Improvements in Hospitals

CDC and The PEW Charitable Trusts collaborated to create Strategies to Assess Antibiotic Use to Drive Improvements in Hospitals. The suggestions outlined in this document help antibiotic stewardship programs (ASPs) in hospitals assess antimicrobial use to see if there are opportunities for improvement. Hospitals can use this assessment tool in conjunction with the SAAR to target assessments in areas with unexpectedly high AU.

Core Elements of Antibiotic Stewardship

CDC documents antimicrobial stewardship best practices in the Core Elements of Hospital ASPs and Priorities for Hospital Core Element Implementation. CDC provides resources for implementing Core Elements in a variety of healthcare settings. Hospitals can also use CDC's Antimicrobial Resistance and Patient Safety Portal to explore national and state antimicrobial stewardship data and track progress.

Additional Resources

General AU Option Materials:

- AUR Module Protocol
- FAQs for the Antimicrobial Use Option
- NHSN AUR Module Training Presentations
- AU Option Case Examples

SAAR Specific Materials:

- SAAR Rebaseline webpage
- SAAR Quick Reference Guide – AU SAAR Table
- SAAR Quick Reference Guide – AU SAAR Table by Location
- SAAR Quick Reference Guide – AU SAAR Bar Chart by Location
- SAAR Quick Reference Guide – AU SAAR Plot
- Keys to Success with the SAAR
- 2014 Baseline SAAR manuscript
- 2017 Baseline Adult and Pediatric SAAR manuscript
- 2018 Baseline Neonatal SAAR manuscript
- Antimicrobial Use Option Data Reports
- Antimicrobial Resistance and Patient Safety Portal Inpatient Antibiotic Use

General NHSN Materials:

- NHSN Location Mapping
- NHSN Annual Hospital Survey
- Instructions for NHSN Annual Hospital Survey
- NHSN Codes and Variables and Statistical Tools
- NHSN Group Function
- NHSN Data Use Agreement (DUA)

Appendix A. Antimicrobial Groupings for 2023 Baseline SAAR Calculations

Below are the SAAR antimicrobial agent categories for adult, pediatric, and neonatal populations and antimicrobials included in each category for the 2023 baseline.

Adult SAAR Antimicrobial Agent Categories

Adult All antibacterial agents
All antibacterial agents in the AUR protocol **except**:

- AMIKACIN LIPOSOME
- AZTREONAM-AVIBACTAM
- GEPOTIDACIN
- SULOPENEM/PROBENECID

Adult Broad spectrum antibacterial agents predominantly used for hospital-onset infections

- AMIKACIN (IV only)
- AZTREONAM (IV only)
- CEFEPIME
- CEFTAZIDIME
- GENTAMICIN (IV only)
- IMIPENEM/CILASTATIN
- MEROPENEM
- PIPERACILLIN/TAZOBACTAM
- TOBRAMYCIN (IV only)

Adult Broad spectrum antibacterial agents predominantly used for community-acquired infections

- CEFACLOR
- CEFDINIR
- CEFIXIME
- CEFOTAXIME
- CEFPODOXIME
- CEFPROZIL
- CEFTRIAXONE
- CEFUROXIME
- CIPROFLOXACIN
- DELAFLOXACIN
- ERTAPENEM
- LEVOFLOXACIN
- MOXIFLOXACIN
- PIVMECILLINAM

Adult Antibacterial agents predominantly used for resistant gram-positive infections (e.g., MRSA)

- CEFTAROLINE
- CEFTOBIPROLE MEDOCARIL
- DALBAVANCIN

- DAPTOMYCIN
- LINEZOLID
- ORITAVANCIN
- TEDIZOLID
- TELAVANCIN
- VANCOMYCIN (IV only)

Adult Narrow spectrum beta-lactam agents

- AMOXICILLIN
- AMOXICILLIN/CLAVULANATE
- AMPICILLIN
- AMPICILLIN/SULBACTAM
- CEFADROXIL
- CEFAZOLIN
- CEFOTETAN
- CEFOXITIN
- CEPHALEXIN
- DICLOXACILLIN
- NAFCILLIN
- OXACILLIN
- PENICILLIN G
- PENICILLIN V

Adult Antibacterial agents posing the highest risk for CDI

This category contains antimicrobials that are part of other SAAR categories.

- CEFACLOR
- CEFDINIR
- CEFEPIME
- CEFIXIME
- CEFOTAXIME
- CEFOTETAN
- CEFOXITIN
- CEFPODOXIME
- CEFPROZIL
- CEFTAZIDIME
- CEFTAZIDIME/AVIBACTAM
- CEFTRIAXONE
- CEFUROXIME
- CIPROFLOXACIN
- CLINDAMYCIN
- DELAFLOXACIN
- ERTAPENEM
- IMIPENEM/CILASTATIN
- IMIPENEM/CILASTATIN/RELEBACTAM
- LEVOFLOXACIN
- MEROPENEM
- MEROPENEM/VABORBACTAM
- MOXIFLOXACIN

Adult Antifungal agents predominantly used for invasive candidiasis

- ANIDULAFUNGIN
- CASPOFUNGIN
- FLUCONAZOLE
- MICAFUNGIN
- REZAFUNGIN

Pediatric SAAR Antimicrobial Agent Categories

Pediatric All antibacterial agents

All antibacterial agents in the AUR protocol **except**:

- AMIKACIN LIPOSOME
- AZTREONAM-AVIBACTAM
- GEPOTIDACIN
- SULOPENEM/PROBENECID

Pediatric Broad spectrum antibacterial agents predominantly used for hospital-onset infections

- AMIKACIN (IV only)
- AZTREONAM (IV only)
- CEFEPIME
- CEFTAZIDIME
- CIPROFLOXACIN
- DELAFLOXACIN
- ERTAPENEM
- IMIPENEM/CILASTATIN
- LEVOFLOXACIN
- MEROPENEM
- MOXIFLOXACIN
- PIPERACILLIN/TAZOBACTAM
- TOBRAMYCIN (IV only)

Pediatric Broad spectrum antibacterial agents predominantly used for community-acquired infections

- AMOXICILLIN/CLAVULANATE
- AMPICILLIN/SULBACTAM
- CEFACLOR
- CEFDINIR
- CEFIXIME
- CEFOTAXIME
- CEFPODOXIME
- CEFPROZIL
- CEFTRIAXONE
- CEFUROXIME
- PIVMECILLINAM

Pediatric Antibacterial agents predominantly used for resistant gram-positive infections (e.g., MRSA)

- CEFTAROLINE
- CEFTOBIPROLE MEDOCARIL
- CLINDAMYCIN
- DALBAVANCIN
- DAPTOMYCIN
- LINEZOLID
- ORITAVANCIN
- TEDIZOLID
- TELAVANCIN
- VANCOMYCIN (IV only)

Pediatric Narrow spectrum beta-lactam agents

- AMOXICILLIN
- AMPICILLIN
- CEFADROXIL
- CEFAZOLIN
- CEFOTETAN
- CEFOXITIN
- CEPHALEXIN
- DICLOXACILLIN
- NAFCILLIN
- OXACILLIN
- PENICILLIN G
- PENICILLIN V

Pediatric Azithromycin

- AZITHROMYCIN

Pediatric Antibacterial agents posing the highest risk for CDI

This category contains antimicrobials that are part of other SAAR categories.

- CEFACLOR
- CEFDINIR
- CEFEPIME
- CEFIXIME
- CEFOTAXIME
- CEFOTETAN
- CEFOXITIN
- CEFPODOXIME
- CEFPROZIL
- CEFTAZIDIME
- CEFTAZIDIME/AVIBACTAM
- CEFTRIAXONE
- CEFUROXIME
- CIPROFLOXACIN
- CLINDAMYCIN
- DELAFLOXACIN
- ERTAPENEM
- IMIPENEM/CILASTATIN
- IMIPENEM/CILASTATIN/RELEBACTAM

- LEVOFLOXACIN
- MEROPENEM
- MEROPENEM/VABORBACTAM
- MOXIFLOXACIN

Pediatric Antifungal agents predominantly used for invasive candidiasis
- ANIDULAFUNGIN
- CASPOFUNGIN
- FLUCONAZOLE
- MICAFUNGIN
- REZAFUNGIN

Neonatal SAAR Antimicrobial Agent Categories

Neonatal All antibacterial agents
All antibacterial agents in the AUR protocol except:
- AMIKACIN LIPOSOME
- AZTREONAM-AVIBACTAM
- GEPOTIDACIN
- SULOPENEM/PROBENECID

Neonatal Vancomycin
- VANCOMYCIN (IV only)

Neonatal Broad spectrum gram-negative coverage
- CEFEPIME (IV only)
- ERTAPENEM (IV only)
- IMIPENEM/CILASTATIN (IV only)
- MEROPENEM (IV only)
- PIPERACILLIN/TAZOBACTAM (IV only)

Neonatal Third generation Cephalosporins
- CEFOTAXIME (IV only)
- CEFTAZIDIME (IV only)
- CEFTRIAXONE (IV only)

Neonatal Ampicillin
- AMPICILLIN (IV and IM only)

Neonatal Aminoglycosides
- AMIKACIN (IV only)
- GENTAMICIN (IV and IM only)
- TOBRAMYCIN (IV only)

Neonatal Fluconazole
- FLUCONAZOLE (IV and oral only)

Appendix B. 2023 Baseline SAAR Model Details

Below are the 2023 baseline adult, pediatric, and neonatal SAAR risk models by SAAR antimicrobial agent category.

Adult: Broad spectrum antibacterial agents predominantly used for hospital-onset infections

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-4.9392	0.048	-5.034	-4.845	10451.80	<.0001
Location Type						
Medical ICU	3.0644	0.024	3.017	3.112	15893.80	<.0001
Oncology Hematopoietic Stem Cell Transplant Ward	2.9621	0.059	2.847	3.077	2544.47	<.0001
Medical-Surgical ICU, Surgical ICU	2.9448	0.017	2.911	2.979	28984.80	<.0001
Burn ICU, Medical Cardiac ICU, Trauma ICU	2.7411	0.032	2.678	2.804	7210.87	<.0001
Surgical Cardiothoracic ICU, Neurologic ICU, Neurosurgical ICU	2.5611	0.026	2.510	2.613	9474.91	<.0001
Solid Organ Transplant Special Care Area	2.5036	0.073	2.361	2.646	1179.62	<.0001
Burn Ward, General Hematology-Oncology Ward, Pulmonary Ward	2.4750	0.028	2.420	2.530	7711.94	<.0001
Mixed Acuity Unit, Step-Down Unit	2.2976	0.017	2.264	2.331	17896.70	<.0001
Medical-Surgical Ward, Surgical Ward	2.1882	0.015	2.160	2.217	22303.50	<.0001
Medical Ward	2.1105	0.017	2.078	2.143	15988.70	<.0001
Orthopedic Ward, Orthopedic Trauma Ward	1.7345	0.028	1.680	1.789	3850.68	<.0001
Neurosurgical Ward	1.5232	0.057	1.412	1.635	717.85	<.0001
Neurology Ward	1.3758	0.044	1.290	1.462	990.20	<.0001
Labor and Delivery Ward, Labor, Delivery, Recovery, Postpartum Suite, Postpartum Ward	REF	.	.	.	.	.
Facility Type						
Critical Access, General Acute Care, Oncology, Surgical, Veterans Affairs	0.4214	0.043	0.338	0.505	97.65	<.0001
Children's, Military, Orthopedic, Psychiatric, Women's, Women's and Children's	REF	.	.	.	.	.
Number of ICU beds, facility-wide						
≥5	0.2593	0.020	0.219	0.299	161.90	<.0001
<5	REF	.	.	.	.	.
Average length of stay, facility-wide (in days)						
≥2.8	0.0909	0.022	0.047	0.135	16.63	<.0001
1.0 - 2.7	REF	.	.	.	.	.

[9] SE=standard error
[10] CLs=confidence limits

Medical school affiliation type						
None, Undergraduate, Major	0.0446	0.014	0.018	0.071	10.94	0.0009
Graduate	REF	.	.	.	.	.

Adult: Broad spectrum antibacterial agents predominantly used for community-acquired infections

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-6.0608	0.074	-6.205	-5.916	6769.17	<.0001
Location Type						
Oncology Hematopoietic Stem Cell Transplant Ward	3.8199	0.057	3.708	3.932	4468.77	<.0001
Medical Ward, Medical-Surgical Ward, Pulmonary Ward, General Hematology-Oncology Ward	2.9825	0.014	2.955	3.010	45304.80	<.0001
Medical ICU, Medical-Surgical ICU	2.9631	0.016	2.931	2.995	32481.50	<.0001
Mixed Acuity Unit, Step-Down Unit, Solid Organ Transplant Special Care Area	2.8558	0.017	2.823	2.889	28655.60	<.0001
Surgical Ward	2.7151	0.021	2.675	2.756	17369.70	<.0001
Medical Cardiac ICU, Neurologic ICU, Neurosurgical ICU, Surgical ICU	2.6716	0.024	2.625	2.718	12833.40	<.0001
Burn ICU, Surgical Cardiothoracic ICU, Trauma ICU	2.5765	0.028	2.522	2.631	8534.99	<.0001
Burn Ward, Neurology Ward, Neurosurgical Ward, Orthopedic Ward, Orthopedic Trauma Ward	2.4581	0.023	2.413	2.503	11531.20	<.0001
Labor and Delivery Ward, Labor, Delivery, Recovery, Postpartum Suite, Postpartum Ward	REF	.	.	.	.	.
Facility Type						
Critical Access, Oncology	1.0365	0.080	0.881	1.192	169.86	<.0001
General Acute Care, Surgical, Veterans Affairs	0.9325	0.074	0.788	1.077	159.54	<.0001
Military, Psychiatric	0.4831	0.089	0.308	0.658	29.35	<.0001
Children's, Orthopedic, Women's, Women's and Children's	REF	.	.	.	.	.
Number of ICU beds, facility-wide						
5 - 11	0.2936	0.018	0.258	0.329	267.84	<.0001
12 - 33	0.1695	0.014	0.143	0.196	158.67	<.0001
<5	0.1342	0.026	0.083	0.186	25.96	<.0001
34 - 82	0.1200	0.012	0.097	0.143	101.99	<.0001
≥83	REF	.	.	.	.	.
Medical school affiliation type						
None, Undergraduate	0.0947	0.012	0.072	0.117	67.78	<.0001
Graduate	0.0404	0.014	0.013	0.067	8.59	0.0034
Major	REF	.	.	.	.	.
Average length of stay, facility-wide (in days)						
1.0 - 5.1	0.0807	0.010	0.061	0.100	66.24	<.0001
≥5.2	REF	.	.	.	.	.

Adult: Antibacterial agents predominantly used for resistant gram-positive infections (e.g., MRSA)

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-6.6969	0.094	-6.882	-6.512	5045.09	<.0001
Location Type						
Medical ICU	4.0969	0.030	4.038	4.156	18256.60	<.0001
Burn Ward	3.9966	0.117	3.768	4.225	1172.82	<.0001
Burn ICU, Surgical Cardiothoracic ICU, Medical-Surgical ICU, Surgical ICU	3.9779	0.025	3.929	4.027	25682.60	<.0001
Medical Cardiac ICU, Neurologic ICU, Neurosurgical ICU, Trauma ICU	3.7961	0.033	3.733	3.860	13666.80	<.0001
Oncology Hematopoietic Stem Cell Transplant Ward, Orthopedic Ward, Pulmonary Ward	3.5030	0.031	3.442	3.564	12515.10	<.0001
Mixed Acuity Unit, Step-Down Unit, Solid Organ Transplant Special Care Area	3.3782	0.025	3.329	3.427	18108.20	<.0001
General Hematology-Oncology Ward, Medical Ward, Medical-Surgical Ward, Orthopedic Trauma Ward	3.3604	0.023	3.315	3.406	20871.20	<.0001
Neurosurgical Ward, Surgical Ward	3.2942	0.027	3.241	3.348	14470.20	<.0001
Neurology Ward	2.8222	0.047	2.731	2.914	3638.74	<.0001
Labor and Delivery Ward	0.5374	0.032	0.475	0.600	279.93	<.0001
Labor, Delivery, Recovery, Postpartum Suite	0.3214	0.032	0.259	0.384	100.55	<.0001
Postpartum Ward	REF	.	.	.	.	.
Facility Type						
General Acute Care, Psychiatric, Surgical, Veterans Affairs	0.6592	0.090	0.482	0.836	53.31	<.0001
Critical Access, Military, Oncology, Orthopedic	0.5269	0.093	0.344	0.710	31.93	<.0001
Children's, Women's, Women's and Children's	REF	.	.	.	.	.
ICU beds (as a percentage of total beds), facility-wide						
≥23.1%	0.0362	0.014	0.008	0.064	6.50	0.0108
18.9% - 23.0%	0.0690	0.014	0.042	0.096	25.13	<.0001
12.6% -18.8%	0.0217	0.010	0.002	0.042	4.43	0.0353
<12.6%	REF	.	.	.	.	.
Average length of stay, facility-wide (in days)						
≥6.4	0.2262	0.025	0.178	0.274	84.55	<.0001
4.6 - 6.3	0.1521	0.023	0.108	0.196	45.42	<.0001
2.8 - 4.5	0.1147	0.022	0.071	0.159	26.15	<.0001
1.0 - 2.7	REF	.	.	.	.	.

Adult: Narrow-spectrum beta-lactam agents

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-3.5688	0.063	-3.692	-3.446	3236.97	<.0001
Location Type						
Orthopedic Ward	2.1686	0.066	2.039	2.298	1071.37	<.0001
Labor and Delivery Ward, Orthopedic Trauma Ward	1.7985	0.064	1.673	1.924	784.80	<.0001
Surgical Cardiothoracic ICU	1.7575	0.068	1.624	1.891	666.21	<.0001
Surgical Ward	1.4760	0.063	1.353	1.600	548.36	<.0001
Neurologic ICU, Neurosurgical ICU, Surgical ICU, Trauma ICU	1.3853	0.065	1.259	1.512	461.83	<.0001
Burn Ward, Labor, Delivery, Recovery, Postpartum Suite, Neurosurgical Ward	1.2910	0.064	1.166	1.416	411.71	<.0001
Medical-Surgical Ward	1.0456	0.061	0.925	1.166	290.20	<.0001
Burn ICU	0.8968	0.106	0.690	1.104	71.94	<.0001
Mixed Acuity Unit	0.8883	0.065	0.762	1.015	188.62	<.0001
Neurology Ward	0.8607	0.074	0.715	1.006	133.98	<.0001
Medical Cardiac ICU, Medical-Surgical ICU	0.8540	0.062	0.733	0.976	189.76	<.0001
Medical Ward	0.7462	0.062	0.625	0.867	146.63	<.0001
Step-down Unit, Solid Organ Transplant Special Care Area	0.7447	0.062	0.623	0.867	143.37	<.0001
Medical ICU	0.6869	0.064	0.561	0.813	114.11	<.0001
General Hematology-Oncology Ward, Pulmonary Ward	0.5400	0.066	0.410	0.670	66.69	<.0001
Postpartum Ward	0.4732	0.064	0.348	0.598	54.90	<.0001
Oncology Hematopoietic Stem Cell Transplant Ward	REF	.	.	.	.	.
Facility Type						
Orthopedic	0.7465	0.152	0.449	1.044	24.18	<.0001
Surgical	0.3203	0.073	0.178	0.463	19.46	<.0001
Critical Access, Children's, General Acute Care, Military, Oncology, Psychiatric, Veterans Affairs, Women's, Women's and Children's	REF	.	.	.	.	.
Number of ICU beds, facility-wide						
<5	0.1364	0.025	0.088	0.185	30.44	<.0001
≥34	0.1011	0.016	0.069	0.133	38.66	<.0001
12 - 33	0.0740	0.017	0.041	0.107	19.57	<.0001
5 - 11	REF	.	.	.	.	.
Medical school affiliation type						
Major, Graduate	0.1155	0.011	0.093	0.138	103.39	<.0001
None, Undergraduate	REF	.	.	.	.	.
Average length of stay, facility-wide (in days)						
1.0 - 2.7	0.1908	0.024	0.145	0.237	66.14	<.0001
≥2.8	REF	.	.	.	.	.

Adult: Antifungal agents predominantly used for invasive candidiasis

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-7.9831	0.056	-8.093	-7.873	20112.80	<.0001
Location Type						
Oncology Hematopoietic Stem Cell Transplant Ward	5.5764	0.085	5.411	5.742	4352.81	<.0001
Solid Organ Transplant Special Care Area	4.5505	0.103	4.349	4.752	1960.34	<.0001
Surgical ICU	4.2655	0.054	4.160	4.371	6229.30	<.0001
General Hematology-Oncology Ward	4.1436	0.050	4.045	4.242	6789.38	<.0001
Burn ICU, Surgical Cardiothoracic ICU, Medical ICU, Medical-Surgical ICU, Trauma ICU	3.7862	0.036	3.717	3.856	11365.00	<.0001
Medical Cardiac ICU	3.2540	0.063	3.131	3.377	2696.50	<.0001
Burn Ward, Pulmonary Ward	3.1965	0.086	3.027	3.366	1370.84	<.0001
Mixed Acuity Unit, Step-down Unit	3.1005	0.037	3.029	3.172	7218.78	<.0001
Surgical Ward	3.0055	0.040	2.927	3.084	5642.69	<.0001
Medical Ward, Medical-Surgical Ward, Orthopedic Trauma Ward	2.8942	0.034	2.828	2.961	7213.77	<.0001
Neurologic ICU, Neurosurgical ICU	2.8075	0.059	2.692	2.923	2251.36	<.0001
Neurology Ward, Neurosurgical Ward, Orthopedic Ward	2.2456	0.043	2.161	2.330	2701.58	<.0001
Labor and Delivery Ward, Labor, Delivery, Recovery, Postpartum Suite	0.7319	0.040	0.653	0.811	329.58	<.0001
Postpartum Ward	REF	.	.	.	.	.
Facility Type						
Critical Access, General Acute Care, Military, Oncology	0.4027	0.035	0.335	0.471	133.94	<.0001
Children's, Orthopedic, Psychiatric, Surgical, Veterans Affairs, Women's, Women's and Children's	REF	.	.	.	.	.
Number of ICU beds, facility-wide						
≥83	0.5489	0.034	0.483	0.615	266.75	<.0001
24 - 82	0.3451	0.031	0.284	0.406	121.73	<.0001
16 - 23	0.2604	0.035	0.192	0.329	54.79	<.0001
5 - 15	0.1551	0.032	0.092	0.218	23.17	<.0001
<5	REF	.	.	.	.	.
Average length of stay, facility-wide (in days)						
≥5.5	0.3050	0.025	0.256	0.354	150.98	<.0001
3.4 - 5.4	0.1339	0.022	0.091	0.177	37.75	<.0001
1.0 - 3.3	REF	.	.	.	.	.
Medical school affiliation type						
Major	0.0491	0.014	0.021	0.077	11.74	0.0006
None, Undergraduate, Graduate	REF	.	.	.	.	.

Adult: Complementary group of antibacterial agents

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-3.7253	0.039	-3.801	-3.649	9272.04	<.0001
Location Type						
Solid Organ Transplant Special Care Area	2.2359	0.067	2.105	2.367	1120.00	<.0001
Oncology Hematopoietic Stem Cell Transplant Ward, Pulmonary Ward	1.9727	0.043	1.889	2.057	2106.71	<.0001
Medical ICU	1.8327	0.026	1.782	1.883	5057.13	<.0001
Medical-Surgical, Surgical ICU	1.6918	0.021	1.651	1.733	6558.66	<.0001
General Hematology-Oncology Ward, Medical Ward, Medical-Surgical Ward	1.4848	0.019	1.448	1.522	6224.04	<.0001
Mixed Acuity Unit, Step-down Unit	1.4737	0.021	1.433	1.514	5059.29	<.0001
Burn ICU, Medical Cardiac ICU, Trauma ICU	1.3739	0.032	1.311	1.437	1841.93	<.0001
Burn Ward, Surgical Ward	1.3306	0.023	1.285	1.376	3288.58	<.0001
Surgical Cardiothoracic ICU	1.2584	0.033	1.195	1.322	1502.62	<.0001
Neurologic ICU, Neurosurgical ICU	0.9799	0.037	0.908	1.052	714.67	<.0001
Orthopedic Ward, Orthopedic Trauma Ward	0.9571	0.029	0.901	1.013	1128.09	<.0001
Neurology Ward, Neurosurgical Ward	0.7786	0.035	0.711	0.847	505.26	<.0001
Labor and Delivery Ward	0.5399	0.026	0.489	0.591	427.22	<.0001
Labor, Delivery, Recovery, Postpartum Suite	0.1975	0.026	0.148	0.247	60.09	<.0001
Postpartum Ward	REF	.	.	.	.	.
Facility Type						
Critical Access, General Acute Care, Oncology, Veterans Affairs	0.2547	0.032	0.192	0.318	62.31	<.0001
Children's, Military, Orthopedic, Psychiatric, Surgical, Women's, Women's and Children's	REF	.	.	.	.	.
Number of ICU beds, facility-wide						
<6	-0.0729	0.019	-0.110	-0.036	15.17	<.0001
≥16	-0.0699	0.011	-0.092	-0.048	39.83	<.0001
6 - 15	REF	.	.	.	.	.
Average length of stay, facility-wide (in days)						
≥6.4	0.0668	0.012	0.043	0.090	30.92	<.0001
1.0 - 4.5	0.0333	0.009	0.016	0.051	14.30	0.0002
4.6 - 6.3	REF	.	.	.	.	.
Medical school affiliation type						
None, Undergraduate, Major	0.0421	0.012	0.019	0.066	12.37	0.0004
Graduate	REF	.	.	.	.	.

Adult: Antibacterial agents posing the highest risk for CDI

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-5.1629	0.127	-5.411	-4.915	1661.48	<.0001
Location Type						
Oncology Hematopoietic Stem Cell Transplant Ward	3.2808	0.050	3.183	3.379	4328.91	<.0001
Medical ICU	2.8152	0.021	2.775	2.856	18594.40	<.0001
Medical-Surgical ICU	2.6919	0.015	2.662	2.722	30778.10	<.0001
General Hematology-Oncology Ward, Pulmonary Ward	2.5878	0.025	2.540	2.636	11136.90	<.0001
Burn ICU, Medical Cardiac ICU, Surgical ICU, Trauma ICU	2.5272	0.021	2.485	2.569	13974.90	<.0001
Neurologic ICU, Neurosurgical ICU, Surgical Cardiothoracic ICU	2.3948	0.023	2.351	2.439	11272.90	<.0001
Burn Ward, Medical Ward, Medical-Surgical Ward	2.3361	0.012	2.313	2.360	37863.30	<.0001
Solid Organ Transplant Special Care Area, Step-down Unit, Mixed Acuity Unit	2.3342	0.015	2.306	2.363	25957.50	<.0001
Surgical Ward	2.1290	0.018	2.094	2.164	14284.80	<.0001
Neurology Ward, Neurosurgical Ward, Orthopedic Ward, Orthopedic Trauma Ward	1.8687	0.020	1.829	1.908	8633.06	<.0001
Labor and Delivery Ward, Labor, Delivery, Recovery, Postpartum Suite, Postpartum Ward	REF	.	.	.	.	.
Facility Type						
Critical Access, General Acute Care, Oncology, Surgical, Veterans Affairs	1.1551	0.126	0.909	1.401	84.56	<.0001
Children's, Military, Psychiatric, Women's, Women's and Children's	0.7460	0.131	0.490	1.002	32.59	<.0001
Orthopedic	REF	.	.	.	.	.
Number of beds, facility-wide						
<44	0.0088	0.019	-0.028	0.045	0.22	0.6357
44 - 73	0.1293	0.020	0.091	0.168	43.33	<.0001
74 - 325	0.0746	0.008	0.058	0.091	79.44	<.0001
≥326	REF	.	.	.	.	.
Medical school affiliation type						
None, Undergraduate	0.0960	0.010	0.077	0.115	102.57	<.0001
Graduate, Major	REF	.	.	.	.	.
Average length of stay, facility-wide (in days)						
≥2.8	0.0757	0.019	0.038	0.113	15.82	<.0001
1.0 - 2.7	REF	.	.	.	.	.

Pediatric: Broad spectrum antibacterial agents predominantly used for hospital-onset infections

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-1.3584	0.081	-1.518	-1.199	278.89	<.0001
Location Type						
Step-down Unit	-1.4433	0.115	-1.669	-1.218	157.76	<.0001
Medical Ward, Medical-Surgical Ward, Surgical Ward	-1.3442	0.071	-1.484	-1.205	356.72	<.0001
Medical ICU, Medical-Surgical ICU	-0.7061	0.078	-0.859	-0.553	82.12	<.0001
Surgical Cardiothoracic ICU	-0.4758	0.112	-0.696	-0.256	17.92	<.0001
General Hematology-Oncology Ward, Hematopoietic Stem Cell Transplant Ward	REF	.	.	.	.	.
Number of beds, facility-wide						
≥592	0.3110	0.064	0.185	0.437	23.55	<.0001
199 - 591	0.1479	0.058	0.034	0.262	6.46	0.0110
<199	REF	.	.	.	.	.

Pediatric: Broad spectrum antibacterial agents predominantly used for community-acquired infections

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-3.2972	0.065	-3.424	-3.170	2595.95	<.0001
Location Type						
Medical ICU, Medical-Surgical ICU	1.1726	0.068	1.039	1.307	294.66	<.0001
Medical Ward, Medical-Surgical Ward, Surgical Ward	0.8299	0.065	0.702	0.958	161.35	<.0001
General Hematology-Oncology Ward	0.5658	0.078	0.414	0.718	53.34	<.0001
Step-down Unit	0.3452	0.089	0.172	0.519	15.17	<.0001
Hematopoietic Stem Cell Transplant Ward	0.0890	0.135	-0.175	0.353	0.44	0.5091
Surgical Cardiothoracic ICU	REF	.	.	.	.	.
Number of ICU beds, facility-wide						
<54	0.1698	0.042	0.088	0.252	16.37	<.0001
54 - 69	0.3648	0.060	0.247	0.482	37.06	<.0001
70 - 167	0.1926	0.034	0.127	0.259	32.57	<.0001
≥168	REF	.	.	.	.	.
Facility Type						
General Acute Care	0.1832	0.029	0.127	0.240	40.50	<.0001
Children's, Military, Women's and Children's	REF	.	.	.	.	.
Medical school affiliation type						
None	0.3129	0.081	0.154	0.472	14.93	0.0001
Undergraduate, Graduate, Major	REF	.	.	.	.	.

Pediatric: Narrow-spectrum beta-lactam agents

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-3.0255	0.073	-3.169	-2.882	1706.46	<.0001
Location Type						
Surgical Cardiothoracic ICU	1.2786	0.082	1.118	1.439	242.61	<.0001
Surgical Ward	0.8010	0.103	0.600	1.002	60.84	<.0001
Step-down Unit	0.5609	0.084	0.396	0.726	44.58	<.0001
Medical ICU, Medical-Surgical ICU	0.5461	0.059	0.431	0.661	86.30	<.0001
Medical Ward, Medical-Surgical Ward, Hematopoietic Stem Cell Transplant Ward	0.5200	0.055	0.413	0.627	90.76	<.0001
General Hematology-Oncology Ward	REF	.	.	.	.	.
ICU beds (as a percentage of total beds), facility-wide						
≥12.8%	0.1197	0.046	0.030	0.210	6.81	0.0090
<12.8%	REF	.	.	.	.	.
Medical school affiliation type						
None, Major	0.0999	0.042	0.017	0.183	5.59	0.0181
Undergraduate, Graduate	REF	.	.	.	.	.

Pediatric: Antibacterial agents predominantly used for resistant gram-positive infections (e.g., MRSA)

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-3.3660	0.092	-3.546	-3.186	1338.51	<.0001
Location Type						
Medical ICU, Medical-Surgical ICU, Surgical Cardiothoracic ICU	0.9304	0.082	0.769	1.092	127.78	<.0001
General Hematology-Oncology Ward, Hematopoietic Stem Cell Transplant Ward	0.6033	0.094	0.420	0.787	41.68	<.0001
Medical Ward, Medical-Surgical Ward, Surgical Ward	0.2058	0.080	0.049	0.363	6.63	0.0100
Step-down Unit	REF	.	.	.	.	.
Number of beds, facility-wide						
≥780	0.2272	0.044	0.140	0.314	26.28	<.0001
<780	REF	.	.	.	.	.
ICU beds (as a percentage of total beds), facility-wide						
≥12.8%	0.2131	0.052	0.112	0.314	17.12	<.0001
<12.8%	REF	.	.	.	.	.

Pediatric: Azithromycin

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-5.9067	0.185	-6.269	-5.545	1021.14	<.0001
Location Type						
Medical ICU, Medical-Surgical ICU	1.9580	0.184	1.598	2.318	113.86	<.0001
Medical Ward, General Hematology-Oncology Ward, Hematopoietic Stem Cell Transplant Ward	1.5633	0.182	1.206	1.921	73.51	<.0001
Step-down Unit	1.3805	0.215	0.960	1.802	41.30	<.0001
Medical-Surgical Ward	1.2032	0.182	0.847	1.560	43.73	<.0001
Surgical Cardiothoracic ICU	1.0997	0.214	0.681	1.518	26.51	<.0001
Surgical Ward	REF	.	.	.	.	.
Facility Type						
General Acute Care	0.1347	0.060	0.017	0.253	4.99	0.0255
Children's, Military, Women's and Children's	REF	.	.	.	.	.
Number of ICU beds, facility-wide						
<70	0.3820	0.072	0.242	0.522	28.57	<.0001
≥70	REF	.	.	.	.	.
Average length of stay, facility-wide (in days)						
≥4.7	0.2036	0.067	0.071	0.336	9.11	0.0025
1.0 - 4.6	REF	.	.	.	.	.
Medical school affiliation type						
None	0.5432	0.164	0.221	0.865	10.94	0.0009
Undergraduate, Graduate, Major	REF	.	.	.	.	.

Pediatric: Antifungal agents predominantly used for invasive candidiasis

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-6.2214	0.265	-6.742	-5.701	549.61	<.0001
Location Type						
Hematopoietic Stem Cell Transplant Ward	3.2033	0.353	2.512	3.894	82.54	<.0001
General Hematology-Oncology Ward	2.5129	0.208	2.106	2.920	146.61	<.0001
Surgical Cardiothoracic ICU	1.4689	0.230	1.018	1.920	40.81	<.0001
Medical ICU, Medical-Surgical ICU	1.0818	0.182	0.725	1.439	35.20	<.0001
Medical Ward, Medical-Surgical Ward, Surgical Ward	0.0656	0.176	-0.278	0.410	0.14	0.7086
Step-down Unit	REF	.	.	.	.	.
Number of ICU beds, facility-wide						
≥86	0.9426	0.113	0.722	1.163	70.27	<.0001
55 - 85	0.5013	0.124	0.258	0.745	16.28	<.0001
<55	REF	.	.	.	.	.
Average length of stay, facility-wide (in days)						
≥4.9	0.2670	0.092	0.086	0.448	8.35	0.0039

1.0 - 4.8	REF	.	.	.	.	.
Medical school affiliation type						
None, Graduate, Major	0.6563	0.200	0.265	1.048	10.78	0.0010
Undergraduate	REF	.	.	.	.	.
Facility Type						
Children's, Military, Women's and Children's	0.2389	0.076	0.090	0.388	9.86	0.0017
General Acute Care	REF	.	.	.	.	.

Pediatric: Complementary group of antibacterial agents

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-3.1831	0.045	-3.271	-3.095	5062.85	<.0001
Location Type						
Step-down Unit	0.2464	0.090	0.071	0.422	7.54	0.0060
Medical ICU, Medical-Surgical ICU, Surgical Cardiothoracic ICU	0.2450	0.043	0.161	0.329	32.47	<.0001
General Hematology-Oncology Ward, Hematopoietic Stem Cell Transplant Ward	0.7701	0.066	0.641	0.899	136.41	<.0001
Medical Ward, Medical-Surgical Ward, Surgical Ward	REF	.	.	.	.	.
Facility Type						
Children's, Military, Women's and Children's	0.2253	0.040	0.147	0.303	32.02	<.0001
General Acute Care	REF	.	.	.	.	.
Number of ICU beds, facility-wide						
≥168	0.6063	0.062	0.486	0.727	96.93	<.0001
85 - 167	0.4884	0.054	0.383	0.594	82.31	<.0001
55 - 84	0.2444	0.063	0.120	0.369	14.90	0.0001
<55	REF	.	.	.	.	.
Average length of stay, facility-wide (in days)						
≥6.1	0.1996	0.043	0.115	0.284	21.46	<.0001
1.0 - 3.5	0.1925	0.072	0.052	0.333	7.17	0.0074
3.6 - 6.0	REF	.	.	.	.	.

Pediatric: Antibacterial agents posing the highest risk for CDI

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-2.3597	0.097	-2.550	-2.170	592.07	<.0001
Location Type						
General Hematology-Oncology Ward, Hematopoietic Stem Cell Transplant Ward	1.1440	0.080	0.988	1.300	206.03	<.0001
Medical ICU, Medical-Surgical ICU	0.8306	0.071	0.691	0.971	135.39	<.0001
Surgical Cardiothoracic ICU	0.6263	0.091	0.449	0.804	47.73	<.0001
Medical Ward, Medical-Surgical Ward, Surgical Ward	0.2701	0.068	0.137	0.404	15.72	<.0001

Step-down Unit	REF	.	.	.	.	.
Number of beds, facility-wide						
≥780	0.1005	0.038	0.026	0.175	6.94	0.0084
<780	REF	.	.	.	.	.
ICU beds (as a percentage of total beds), facility-wide						
≥8.8%	0.1658	0.072	0.025	0.306	5.34	0.0209
<8.8%	REF	.	.	.	.	.

Neonatal: Vancomycin

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-8.4724	0.303	-9.066	-7.879	782.50	<.0001
Location Type and whether facility provides Level III or higher care						
Level III and Level IV NICUs	2.7417	0.229	2.293	3.190	143.55	<.0001
Level II/III NICUs	2.3672	0.231	1.914	2.820	104.83	<.0001
Level II special care nurseries in a facility that does NOT provide Level III or higher care	1.2695	0.254	0.771	1.768	24.93	<.0001
Level II special care nurseries in a facility that DOES provide Level III or higher care	REF	.	.	.	.	.
Percentage of annual neonatal admissions in very lowest birthweight category A (≤750g)						
≥3.3%	1.3345	0.116	1.108	1.562	132.79	<.0001
0.8% - 3.2%	0.6717	0.100	0.477	0.867	45.50	<.0001
<0.8%	REF	.	.	.	.	.
Total number of annual neonatal admissions						
≥106	0.9295	0.191	0.555	1.304	23.70	<.0001
<106	REF	.	.	.	.	.

Neonatal: Broad spectrum gram-negative coverage

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-10.1102	0.376	-10.846	-9.374	724.65	<.0001
Percentage of annual neonatal admissions in very lowest birthweight category A (≤750g)						
≥3.3%	1.9043	0.176	1.560	2.249	117.44	<.0001
1.8% - 3.2%	1.5423	0.169	1.210	1.874	82.86	<.0001
0.1% - 1.7%	1.1657	0.149	0.873	1.458	60.93	<.0001
0.0%	REF	.	.	.	.	.

Location Type, whether facility provides Level III or higher care, and whether facility accepts neonates as transfers for various specific complex procedures[11]						
Level III NICUs in facilities accepting neonates as transfers; and Level IV NICUs	3.7028	0.309	3.097	4.308	143.59	<.0001
Level II special care nurseries in a facility that does NOT provide Level III or higher care; and Level II/III NICUs; and Level III NICUs in facilities NOT accepting neonates as transfers	3.0984	0.304	2.502	3.695	103.67	<.0001
Level II special care nurseries in a facility that DOES provide Level III or higher care	REF	.	.	.	.	.
Total number of annual neonatal admissions						
≥243	1.2109	0.242	0.738	1.684	25.14	<.0001
106 - 242	0.7644	0.238	0.298	1.231	10.31	0.0013
<106	REF	.	.	.	.	.
Number of beds, facility-wide						
≥433	0.3801	0.120	0.146	0.614	10.12	0.0015
<433	REF	.	.	.	.	.

Neonatal: 3rd generation cephalosporins

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-6.5786	0.167	-6.906	-6.251	1552.55	<.0001
Location Type						
Level III NICUs; Level IV NICUs	0.5220	0.139	0.249	0.795	14.03	0.0002
Level II special care nurseries; Level II/III NICUs	REF	.	.	.	.	.
Number of annual outborn neonatal admissions						
≥61	0.8421	0.190	0.469	1.215	19.61	<.0001
2 - 60	0.3952	0.162	0.077	0.714	5.92	0.0150
<2	REF	.	.	.	.	.
Percentage of annual neonatal admissions in very lowest birthweight category A (≤750g)						
≥0.8%	0.5058	0.146	0.219	0.792	11.97	0.0005
<0.8%	REF	.	.	.	.	.
Percentage of annual neonatal admissions in low birthweight category D (1501-2500g)						
<26.3%	0.5779	0.134	0.315	0.841	18.50	<.0001
≥26.3%	REF	.	.	.	.	.
Number of beds, facility-wide						
≥253	0.4126	0.139	0.141	0.684	8.85	0.0029
<253	REF	.	.	.	.	.

[11] Procedures include: Omphalocele repair; ventriculoperitoneal shunt; tracheoesophageal fistula/esophageal atresia repair; bowel resection/reanastomosis; meningomyelocele repair; cardiac catheterization

Neonatal: Ampicillin

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-3.6107	0.124	-3.854	-3.368	848.84	<.0001
Percentage of annual neonatal admissions in normal birthweight category E (>2500g)						
≥63.3%	0.4747	0.059	0.360	0.589	65.71	<.0001
51.9% - 63.2%	0.2608	0.055	0.153	0.369	22.28	<.0001
<51.9%	REF	.	.	.	.	.
Number of annual outborn neonatal admissions						
<7	0.2250	0.046	0.136	0.314	24.32	<.0001
≥7	REF	.	.	.	.	.
Location Type, whether facility provides Level III or higher care, and whether facility accepts neonates as transfers for various complex procedures[11]						
Level II special care nurseries in a facility that does NOT provide Level III or higher care; and Level III NICUs in facilities NOT accepting neonates as transfers	0.9719	0.122	0.733	1.211	63.56	<.0001
Level II/III NICUs; and Level III NICUs in facilities accepting neonates as transfers; and Level IV NICUs	0.8574	0.119	0.623	1.091	51.58	<.0001
Level II special care nurseries in a facility that DOES provide Level III or higher care	REF	.	.	.	.	.

Neonatal: Aminoglycosides

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-4.3109	0.150	-4.605	-4.017	823.86	<.0001
Percentage of annual neonatal admissions in very low birthweight category A, B, C (≤1500g)						
<4.8%	0.4322	0.080	0.276	0.588	29.53	<.0001
4.8% - 13.8%	0.2357	0.062	0.114	0.358	14.31	0.0002
≥13.9%	REF	.	.	.	.	.
Number of annual outborn neonatal admissions						
<7	0.1808	0.056	0.072	0.290	10.53	0.0012
≥7	REF	.	.	.	.	.
Location Type and whether facility provides Level III or higher care						
Level II special care nurseries in a facility that does NOT provide Level III or higher care; and Level II/III NICUs; and Level III NICUs; and Level IV NICUs	0.8897	0.144	0.608	1.172	38.19	<.0001
Level II special care nurseries in a facility that DOES provide Level III or higher care	REF	.	.	.	.	.
Facility Type						
General Acute Care, Surgical	0.3675	0.090	0.190	0.545	16.52	<.0001

Children's, Military, Women's, and Women's and Children's	REF	.	.	.	.	.
Number of beds, facility-wide						
<378	0.1444	0.055	0.037	0.252	6.87	0.0088
≥378	REF	.	.	.	.	.

Neonatal: Fluconazole

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-9.7103	0.387	-10.469	-8.952	629.89	<.0001
Percentage of annual neonatal admissions in very lowest birthweight category A (≤750g)						
≥3.3%	1.5483	0.172	1.211	1.886	81.01	<.0001
0.8% - 3.2%	1.1243	0.150	0.830	1.419	56.10	<.0001
<0.8%	REF	.	.	.	.	.
Location Type						
Level III NICUs; Level IV NICUs	1.6565	0.190	1.284	2.029	76.06	<.0001
Level II/III NICUs	1.4021	0.178	1.054	1.750	62.39	<.0001
Level II special care nurseries	REF	.	.	.	.	.
Total number of annual neonatal admissions						
≥244	2.4571	0.373	1.726	3.189	43.34	<.0001
106 - 243	2.0487	0.382	1.300	2.797	28.76	<.0001
<106	REF	.	.	.	.	.

Neonatal: All antibacterial agents

Parameter	Estimate	SE[9]	Wald 95% CLs[10]		Wald χ2	χ2 P-Value
Intercept	-2.6122	0.111	-2.830	-2.395	554.41	<.0001
Location Type and whether facility provides Level III or higher care						
Level IV NICUs	1.0968	0.118	0.865	1.329	85.94	<.0001
Level II special care nurseries in a facility that does NOT provide Level III or higher care; Level III NICUs	0.9411	0.110	0.725	1.157	73.12	<.0001
Level II/III NICUs	0.8214	0.111	0.604	1.039	54.74	<.0001
Level II special care nurseries in a facility that DOES provide Level III or higher care	REF	.	.	.	.	.
Percentage of annual neonatal admissions in low birthweight category D (1501-2500g)						
<31.8%	0.2364	0.038	0.161	0.312	37.95	<.0001
≥31.8%	REF	.	.	.	.	.
Number of annual outborn neonatal admissions						
<7	0.1692	0.044	0.084	0.255	15.01	0.0001
≥78	0.1250	0.057	0.014	0.236	4.88	0.0271
7 - 77	REF	.	.	.	.	.

Appendix C. Revision History

Revised Date	Version	Description
02/01/2023	1.0	Added 2018 baseline neonatal SAAR model details, information about TAS, and updates for 2023.
03/17/2023	1.1	Technical Writer review; added sections: Revision History and Intended Audience.
08/01/2026	1.2	Made comprehensive updates across the document to reference the 2023 baseline. Added 2023 baseline adult, pediatric, and neonatal SAAR model details. Reorganized the Using the SAAR for Action section.