



2022 National Healthcare Safety Network (NHSN) Antimicrobial Use (AU) Option Report

Centers for Disease Control and Prevention

National Center for Emerging and Zoonotic Infectious Diseases

Division of Healthcare Quality Promotion

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Executive Summary

Monitoring antimicrobial use (AU) is an important component of antimicrobial stewardship programs (ASPs). AU data delivered to ASPs allow stewards to develop, select, and assess interventions aimed at optimizing antimicrobial prescribing¹. These interventions, in turn, serve to improve the effectiveness of antimicrobial treatment, protect patients from harms caused by unnecessary antimicrobial exposure, and curb antimicrobial resistance associated with prophylactic and therapeutic excess²⁻⁴.

Patient care and public health are most likely to benefit from monitoring AU when collection and analysis of data are systematic and standardized. Leveraging electronic medication administration records and automating AU data submission from hospitals reduces reporting burden and allows facilities to reuse AU data. These AU surveillance principles and practices are fundamental to CDC's National Healthcare Safety Network (NHSN) AU Option. Hospitals submit AU data electronically to NHSN, where the data are aggregated, analyzed, and used to produce inpatient AU benchmarks. The Standardized Antimicrobial Administration Ratio (SAAR) is NHSN's risk-adjusted AU metric. The SAAR is available to hospitals reporting to NHSN's AU Option from select patient-care locations.

The 2022 NHSN AU Option Report summarizes SAAR distributions and antimicrobial use within each SAAR antimicrobial agent category among adult, pediatric, and neonatal patient care locations (specified in [Table 1](#)). The report includes data from acute care hospitals that reported at least nine months of data in 2022 from SAAR locations: 2,007 hospitals reported from eligible adult SAAR locations, 369 reported from pediatric SAAR locations, and 760 reported from neonatal SAAR locations. The distributions of SAARs inform stewardship efforts by showing hospitals how their SAARs compare with the national distribution and local, state, and territorial health departments how their SAARs compare with others. Hospitals can consider the distributions to set facility-specific targets when using the NHSN Targeted Assessment for Antimicrobial Stewardship (TAS) Strategy. The percentage of AU by class and drug within a SAAR antimicrobial agent category provides insight into prescribing practices across different patient care locations, such as medical critical care units (also known as intensive care units, or ICUs) compared to medical wards. Facilities may evaluate usage patterns in the context of their local treatment guidelines, penicillin allergy algorithms, antimicrobial resistance rates, and formulary. For more information and resources related to TAS, refer to the TAS Guide⁵.

Standardized Antimicrobial Administration Ratio (SAAR)

The SAAR is a ratio of observed antimicrobial days to predicted antimicrobial days. We developed each SAAR predictive model included in this report by applying negative binomial regression to AU data from eligible adult and pediatric locations (2017 data) and eligible neonatal locations (2018 data). We derived the SAAR values in this report by using pooled observed antimicrobial days from 2022 divided by pooled predicted days calculated using the SAAR models. [Table 1](#) and [Table 2](#) list SAAR patient care locations and antimicrobial agent categories, respectively.

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

The SAAR can be used to track AU changes over time at individual hospitals and as a benchmarking metric for comparing AU in similar patient care locations nationally. While the SAAR is not a measure of appropriateness of AU, it allows ASPs to compare their AU to a national baseline. These analyses allow facilities to assess whether they are using antimicrobials at higher rates than predicted (i.e., SAAR values > 1), which can prompt facilities to further evaluate prescribing practices and intervene, if necessary, to optimize AU. The SAAR Guide⁶ and Antimicrobial Use and Resistance (AUR) Module Protocol⁷ contain more information on the SAAR.

Table 1. Eligible SAAR patient care locations (2017 adult and pediatric baseline, 2018 neonatal baseline)

Adult SAAR Locations	Pediatric SAAR Locations	Neonatal SAAR Locations
<ul style="list-style-type: none"> • Medical critical care units • Medical-surgical critical-care units • Surgical critical care units • Medical wards • Medical-surgical wards • Surgical wards • Step down units • General hematology-oncology wards 	<ul style="list-style-type: none"> • Medical critical care units • Medical-surgical critical care units • Medical wards • Medical-surgical wards • Surgical wards 	<ul style="list-style-type: none"> • Level II special care nurseries • Level II/III critical care units • Level III critical care units • Level IV critical care units

The CDC Locations and Descriptions and Instructions for Mapping Patient Care Locations document⁸ contains the NHSN patient care location definitions.

Abbreviations: Standardized Antimicrobial Administration Ratio (SAAR).

Table 2. SAAR antimicrobial agent categories (2017 adult and pediatric baseline, 2018 neonatal baseline)

Adult SAAR Categories	Pediatric SAAR Categories	Neonatal SAAR Categories
All antibacterial agents (All)	All antibacterial agents (All)	All antibacterial agents (All)
Broad spectrum antibacterial agents predominantly used for hospital-onset infections (BSHO)	Broad spectrum antibacterial agents predominantly used for hospital-onset infections (BSHO)	Vancomycin predominantly used for treatment of late-onset sepsis (Vanc)
Broad spectrum antibacterial agents predominantly used for community-acquired infections (BSCA)	Broad spectrum antibacterial agents predominantly used for community-acquired infections (BSCA)	Broad spectrum antibacterial agents predominantly used for hospital-onset infections (BSHO)
Antibacterial agents predominantly used for resistant Gram-positive infections (e.g., MRSA) (GramPos)	Antibacterial agents predominantly used for resistant Gram-positive infections (e.g., MRSA) (GramPos)	Third generation cephalosporins (CephS)
Narrow spectrum beta-lactam agents (NSBL)	Narrow spectrum beta-lactam agents (NSBL)	Ampicillin predominantly used for treatment of early-onset sepsis (Amp)
Antibacterial agents posing the highest risk for CDI (CDI)	Antibacterial agents posing the highest risk for CDI (CDI)	Aminoglycosides predominantly used for treatment of early-onset and late-onset sepsis (Amino)
Antifungal agents predominantly used for invasive candidiasis (Antifungal)	Antifungal agents predominantly used for invasive candidiasis (Antifungal)	Fluconazole predominantly used for candidiasis (Fluco)
	Azithromycin (Azith)	

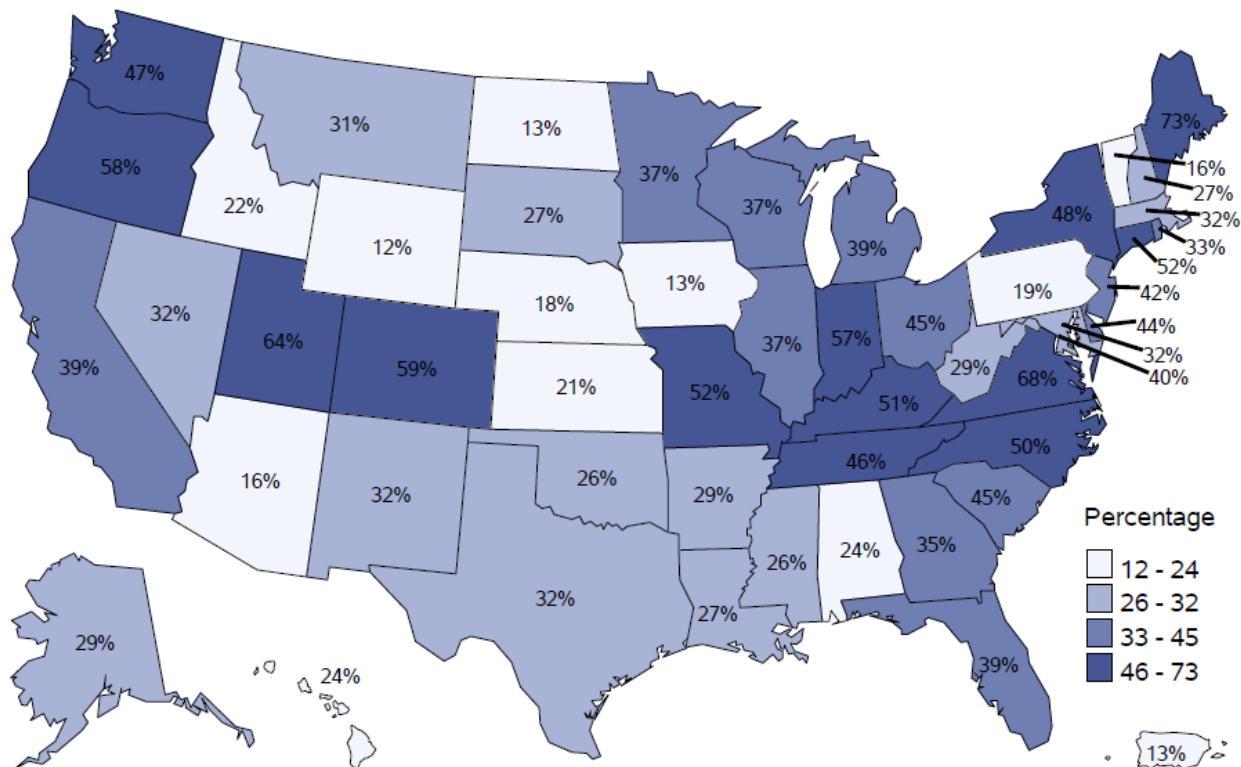
For the list of specific agents included in each SAAR category, refer to Appendix E of the AUR Module protocol⁷.

Abbreviations: Standardized Antimicrobial Administration Ratio (SAAR), All antibacterial agents (All), Broad spectrum antibacterial agents predominantly used for hospital-onset infections (BSHO), Broad spectrum antibacterial agents predominantly used for community-acquired infections (BSCA), Methicillin-resistant *Staphylococcus aureus* (MRSA), Antibacterial agents predominantly used for resistant Gram-positive infections (GramPos), Narrow spectrum beta-lactam agents (NSBL), Antibacterial agents posing the highest risk for *Clostridioides difficile* infection (CDI), Antifungal agents predominantly used for invasive candidiasis (Antifungal), Azithromycin (Azith), Vancomycin predominantly used for treatment of late-onset sepsis (Vanc), Third generation cephalosporins (CephS), Ampicillin predominantly used for treatment of early-onset sepsis (Amp), Aminoglycosides predominantly used for treatment of early-onset and late-onset sepsis (Amino), Fluconazole predominantly used for candidiasis (Fluco).

Centers for Medicare and Medicaid Services (CMS) and the Office of the National Coordinator for Health Information Technology (ONC) identified the NHSN AUR Module reporting as one option to meet the

Public Health Registry reporting element within the CMS Medicare Promoting Interoperability (PI) Program (formerly the Meaningful Use Program) for eligible hospitals and critical access hospitals (CAHs) in 2017. In August 2022, CMS published the [2023 Final Rule](#) for the Medicare PI Program for eligible hospitals and CAHs that required a new AUR Surveillance measure under the Public Health and Clinical Data Exchange Objective. To obtain credit for calendar year 2024, eligible hospitals and CAHs must attest to active engagement with NHSN to submit AUR data for the electronic health record (EHR) reporting period, or else claim an applicable exclusion⁹. Although no federal AU reporting mandates were in effect during the period covered by this report, the publication of CMS’ Final Rule contributed to increased AU Option enrollment at the end of 2022. As of January 1, 2023, 2,640 facilities reported at least one month of data to the AU Option. Participation, by state, among facilities eligible to report ranged from 12% in Wyoming to 73% in Maine ([Figure 1](#)).

Figure 1. Percentage of hospitals reporting at least one month of data to the AU Option among NHSN acute care hospitals* by state/jurisdiction as of January 1, 2023



*Acute care hospitals include critical access, children’s, general acute care, long-term acute care, military, oncology, orthopedic, psychiatric, inpatient rehabilitation, surgical, Veterans Affairs, women’s, and women’s and children’s hospitals.

Abbreviations: Antimicrobial Use (AU), National Healthcare Safety Network (NHSN).

High-level SAAR comparison, 2019 vs. 2020 vs. 2021 vs. 2022

The following Figures 2a-c represent select 2019, 2020, 2021, and 2022 pooled mean SAARs, by antimicrobial agent category for select location types. The pooled mean SAARs varied across years, locations, and antimicrobial categories. The [2022 AU Report data tables](#) provide SAAR distributions and

the percentage of AU by class and drug within each SAAR antimicrobial agent category. We anticipate that pooled mean SAARs and distributions the Excel data tables display will help ASPs assess how their facility’s AU compares to others. We calculated pooled mean SAARs at the annual level (rather than the quarter level as in previous years’ reports) to improve readability.

We cannot say how much variation in SAARs between years is related to COVID-19, the result of changes to prescribing practices due to antimicrobial stewardship efforts, or because of changes in which hospitals reported to the NHSN AU Option. A recent publication described AU rates reported to the NHSN AU Option between January 2019 and July 2022 to characterize changes in AU during the COVID-19 pandemic¹⁰.

Visual comparisons in pooled mean SAARs year to year are subjective and may not represent statistically significant or clinically meaningful changes. Temporal changes may be due to different facilities contributing data each year or changes in AU within individual facilities. For example, we noticed higher BSCA SAARs in pediatric ICUs and wards in 2022. Further analysis showed that it was due to high rates of antimicrobial use in BSCA categories reported from some of the hospitals that newly contributed data in 2022 (369 hospitals contributed data in 2022 compared to 341 hospitals in 2021).

Figure 2a. Select 2019, 2020, 2021, and 2022 pooled mean SAARs, by antimicrobial agent category for adult ICUs and wards

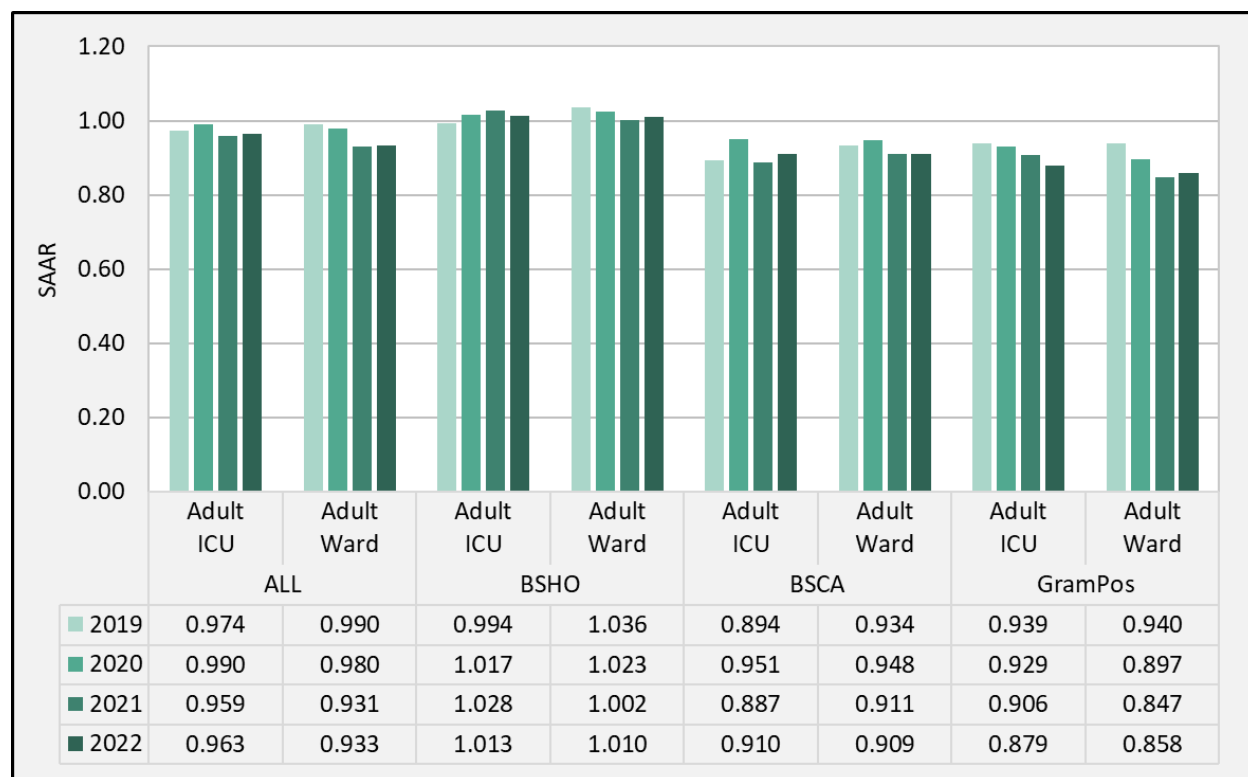


Figure 2a notes:

- Adult ICUs include medical critical care units, medical-surgical critical care units, and surgical critical care units. Adult wards include medical wards, medical-surgical wards, and surgical wards. Step-down units and adult general hematology-oncology units are not included in pooled means.
- Only facilities reporting ≥ 9 months of data in each year were included in analyses. This does not

represent a continuous cohort of reporters.

- Predicted use (the SAAR denominator) is based on antimicrobial use rates in 2017 among adult SAAR referent populations.
- A SAAR <1.0 does not necessarily mean antimicrobial use and prescribing is clinically appropriate and a SAAR >1.0 does not necessarily mean antimicrobial use and prescribing is clinically inappropriate.
- Abbreviations: Standardized Antimicrobial Administration Ratio (SAAR), intensive care unit (ICU), All antibacterial agents (All), Broad spectrum antibacterial agents predominantly used for hospital-onset infections (BSHO), Broad spectrum antibacterial agents predominantly used for community-acquired infections (BSCA), Antibacterial agents predominantly used for resistant Gram-positive infections (GramPos).

Figure 2b. Select 2019, 2020, 2021, and 2022 pooled mean SAARs, by antimicrobial agent category for pediatric ICUs and wards

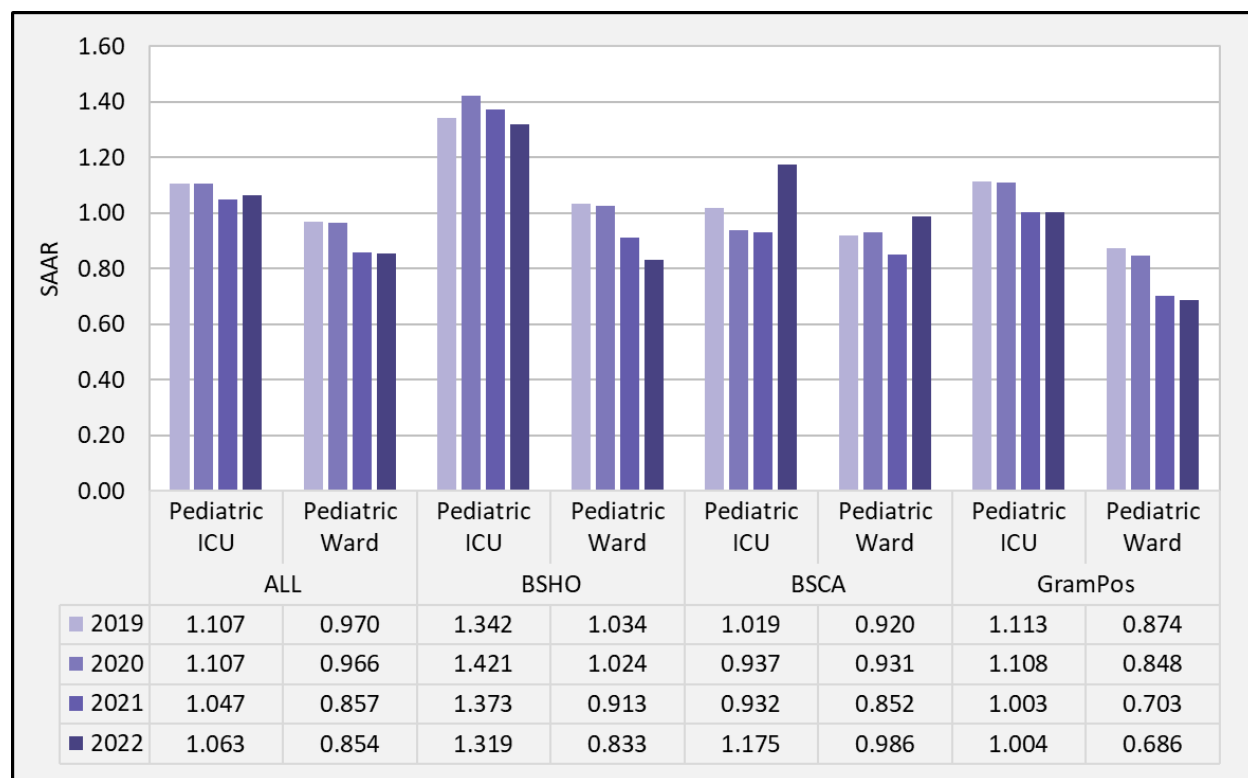


Figure 2b notes:

- Pediatric ICUs include medical critical care units and medical-surgical critical care units. Pediatric wards include medical wards, medical-surgical wards, and surgical wards.
- Only facilities reporting ≥9 months of data in each year were included in analyses. This does not represent a continuous cohort of reporters.
- Predicted use (the SAAR denominator) is based on antimicrobial use rates in 2017 among pediatric SAAR referent populations.
- A SAAR <1.0 does not necessarily mean antimicrobial use and prescribing is clinically appropriate and a SAAR >1.0 does not necessarily mean antimicrobial use and prescribing is clinically inappropriate.

inappropriate.

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

Figure 2c. Select 2019, 2020, 2021, and 2022 pooled mean SAARs, by antimicrobial agent category for neonatal locations

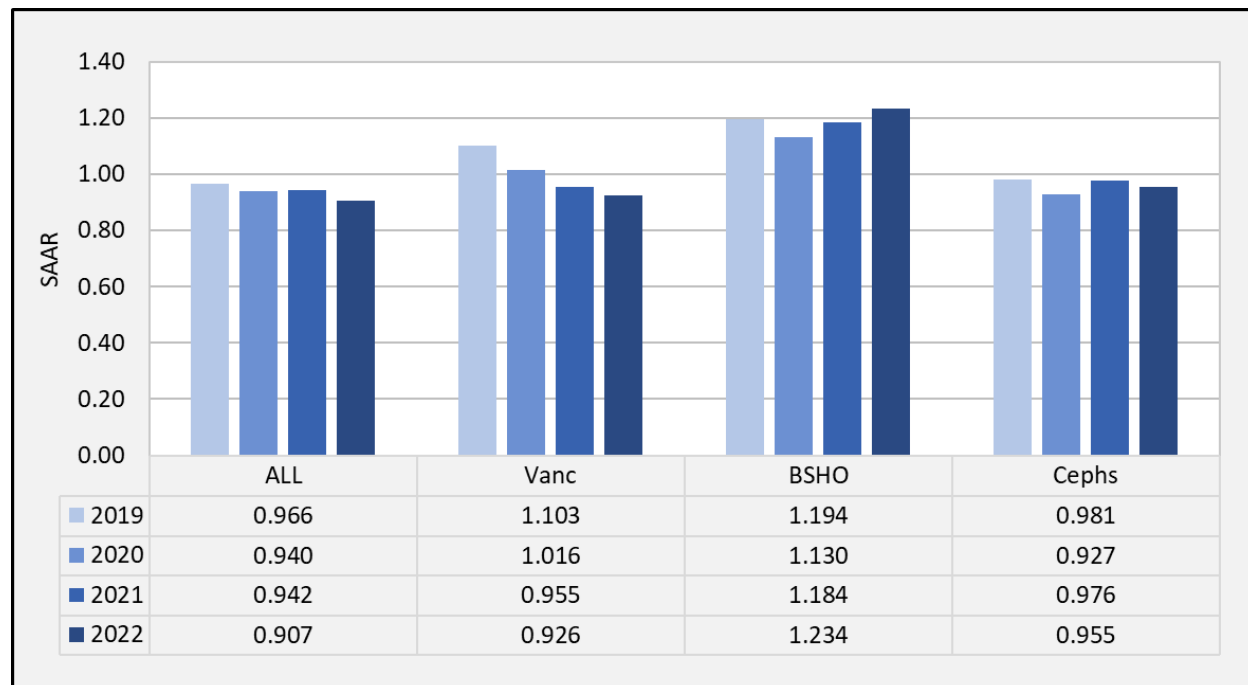


Figure 2c notes:

- Neonatal locations include step down neonatal nurseries (Level II), Level II/III NICUs, Level III NICUs, and Level IV NICUs.
- Only facilities reporting ≥ 9 months of data in each year were included in analyses. This does not represent a continuous cohort of reporters.
- Predicted use (the SAAR denominator) is based on antimicrobial use rates in 2018 among neonatal SAAR referent populations.
- A SAAR < 1.0 does not necessarily mean antimicrobial use and prescribing is clinically appropriate and a SAAR > 1.0 does not necessarily mean antimicrobial use and prescribing is clinically inappropriate.
- *Abbreviations: Standardized Antimicrobial Administration Ratio (SAAR), intensive care unit (ICU), All antibacterial agents (All), Vancomycin predominantly used for treatment of late-onset sepsis (Vanc), Broad spectrum antibacterial agents predominantly used for hospital-onset infections (BSHO), Third generation cephalosporins (Ceph).*

2022 Antimicrobial Use Data

The 2022 AU Data Report provides a summary of pooled mean SAARs and percentages of use within SAAR antimicrobial agent categories in adult, pediatric, and neonatal locations in the following sections. The [2022 AU Report data tables](#) provide more detailed information about SAAR distributions and the percentage of AU by class and drug within a SAAR antimicrobial agent category. The 2022 AU Report Excel data tables include the following:

- Overview and Table of Contents
- Characteristics of NHSN acute care hospitals reporting for adult, pediatric, and neonatal SAAR locations for ≥ 9 months in 2022
- SAAR distributions for adult, pediatric, and neonatal SAAR antimicrobial agent category by location type
- Percentage of antimicrobial use by class and drug for each SAAR antimicrobial agent category by location type
- SAAR distributions for adult, pediatric, and neonatal SAAR antimicrobial agent category by state
- Antimicrobial use by World Health Organization (WHO) Access, Watch, Reserve (AWaRe) Classification in 2022

Adult SAAR antimicrobial agent categories

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

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

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

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

the highest risk for Clostridioides difficile infection (CDI), Antifungal agents predominantly used for invasive candidiasis (Antifungal).

Highlights of percentage of AU by class and drug for each adult SAAR antimicrobial agent category are outlined below:

- Within the **All antibacterial SAAR** category, the top 10 antibacterial agents represented 77.9%–86.7% of use, depending on the SAAR location. In most SAAR locations, the three most commonly used agents included vancomycin, piperacillin-tazobactam, and either ceftriaxone or cefepime. An exception to this was surgical wards, where ceftazidime (instead of ceftriaxone or cefepime) was included in the top three (AU Report Excel Data Table 2a2).
- Within the **BSHO SAAR** category, piperacillin-tazobactam was the most commonly used agent in ICUs, non-oncology wards, and step down units, followed by cefepime. Piperacillin-tazobactam represented 41.6%–60.6% of antimicrobial use in SAAR locations. The percentage of piperacillin-tazobactam and cefepime use was similar in hematology-oncology wards (40.2% and 43.8%, respectively) (AU Report Excel Data Table 2b2).
- Within the **BSCA SAAR** category, ceftriaxone had the highest use across all location types, followed by levofloxacin and ciprofloxacin. Surgical ICUs and wards had a higher proportion of ertapenem use (range of 6.8%–7.2%) compared to other SAAR locations (range of 3.6%–4.7%) (AU Report Excel Data Table 2c2).
- Within the **GramPos SAAR** category, intravenous vancomycin was the predominant agent used in all SAAR locations, followed by linezolid and daptomycin (AU Report Excel Data Table 2d2).
- Within the **NSBL SAAR** category, ceftazidime had the highest use across all SAAR locations. (AU Report Excel Data Table 2e2).
- Within the **CDI SAAR** category, third and fourth generation cephalosporins had the highest use across all SAAR locations. General hematology-oncology wards had a higher proportion of fluoroquinolone use among antimicrobials in this category (29.4%) compared to other SAAR locations (range of 8.2%–17.2%). Surgical ICUs (6.4%) and surgical wards (7.2%) had a higher proportion of clindamycin use compared to other SAAR locations (range of 2.1%–4.8%) (AU Report Excel Data Table 2f2).
- Within the **Antifungal SAAR** category, echinocandins represented approximately half (range of 48.4%–57.9%) of use in ICUs and step down units. Wards had a higher proportion of fluconazole use (range of 73.1%–80.1%) than echinocandin use (range of 19.1%–26.9%) (AU Report Excel Data Table 2g2).

Pediatric SAAR antimicrobial agent categories

More hospitals reported from pediatric locations in 2022 than 2021 (369 hospitals contributed data in 2022 compared to 341 hospitals in 2021). Higher pooled mean pediatric BSCA SAARs in 2022 are due to high rates of antimicrobial use in BSCA categories reported from some of the hospitals that newly contributed data in 2022. The pediatric distributions in 2022 included 48 children's and women's and children's hospitals compared to 38 in the 2021 AU Option Report (AU Report Excel Data Table 1b); this

allowed us to calculate location-specific percentiles among pediatric surgical wards for all SAAR types for the first time (AU Report Excel Data Tables 3a1, 3b1, 3c1, 3d1, 3e1, 3f1, 3g1, and 3h1). The pooled mean SAAR values differ across location type and SAAR category ([Table 4](#)).

Table 4. Pooled mean SAAR values by pediatric location type and SAAR antimicrobial agent category

Pediatric SAAR Location Type	Pediatric SAAR Antimicrobial Agent Categories							
	All Antibacterial	BSHO	BSCA	GramPos	NSBL	Azithromycin	CDI	Anti-fungal
Medical ICUs	1.062	2.202	1.136	0.699	0.962	0.884	1.037	0.931
Medical-Surgical ICUs	1.063	1.300	1.177	1.019	0.748	0.635	1.277	1.425
Medical Wards	0.811	0.674	0.988	0.656	0.866	0.618	0.868	1.594
Medical-Surgical Wards	0.856	0.845	0.976	0.698	0.936	0.495	0.863	1.632
Surgical Wards	1.010	1.712	1.101	0.674	0.762	1.121	0.850	1.267

Abbreviations: Standardized Antimicrobial Administration Ratio (SAAR), intensive care unit (ICU), All antibacterial agents (All Antibacterial), Broad spectrum antibacterial agents predominantly used for hospital-onset infections (BSHO), Broad spectrum antibacterial agents predominantly used for community-acquired infections (BSCA), Antibacterial agents predominantly used for resistant Gram-positive infections (GramPos), Narrow spectrum beta-lactam agents (NSBL), Antibacterial agents posing the highest risk for Clostridioides difficile infection (CDI), Antifungal agents predominantly used for invasive candidiasis (Antifungal).

Highlights of percentage of AU by class and drug for each pediatric SAAR antimicrobial agent category (for categories with more than one agent) are outlined below:

- Within the **All antibacterial SAAR** category, the top ten antibacterial agents represented 63.3%–74.7% of use, depending on the SAAR location. For all SAAR locations, ceftriaxone had either the highest or second highest antibacterial use (AU Report Excel Data Table 3a2).
- Within the **BSHO SAAR** category, cefepime and piperacillin-tazobactam were the top agents used (in varying order) in all SAAR locations. Medical wards had a higher proportion of aminoglycoside use (7.3%) than other SAAR locations (range of 0.9%–2.1%) (AU Report Excel Data Table 3b2).
- Within the **BSCA SAAR** category, ceftriaxone was the predominant agent used across all SAAR locations. Ampicillin-sulbactam and amoxicillin-clavulanate use were the next highest. Medical and medical-surgical ICUs had a higher proportion of second and third generation cephalosporins use (78.1% and 75.8%, respectively) than other SAAR locations (range of 59.4%–68.9%) (AU Report Excel Data Table 3c2).
- Within the **GramPos SAAR** category, vancomycin (range of 44.8%–70.9%) and clindamycin (range of 17.9%–46.8%) represented the majority of use, depending on the SAAR location. Other agents were rarely used (AU Report Excel Data Table 3d2).

- Within the **NSBL SAAR** category, cefazolin, ampicillin, and amoxicillin were the top agents used in all SAAR locations (AU Report Excel Data Table 3e2).
- Within the **CDI SAAR** category, ceftriaxone, cefepime, and clindamycin (in varying order) were the most commonly used agents across SAAR locations. Among antimicrobial agents in this category, medical and medical-surgical ICUs had a higher proportion of second and third generation cephalosporins use (85.3% and 83.2%, respectively) than other SAAR locations (range of 70.0%–73.6%), where clindamycin made up the difference (AU Report Excel Data Table 3g2).
- Within the **Antifungal SAAR** category, fluconazole was the top agent for all SAAR locations except medical ICUs. Medical ICUs were the only SAAR location where echinocandins were used more frequently than azoles (68.0% compared to 32.0%, respectively). In other SAAR locations, azoles accounted for 51.6%–79.0% of use (AU Report Excel Data Table 3h2).

Neonatal SAAR antimicrobial agent categories

There were 760 facilities that reported data from eligible neonatal SAAR locations (AU Report Excel Data Table 1c). The pooled mean SAAR values differ across location type and SAAR category ([Table 5](#)).

Table 5. Pooled mean SAAR values by neonatal location type and SAAR antimicrobial agent category

Neonatal SAAR Location Type	Neonatal SAAR Antimicrobial Agent Categories						
	All Antibacterial	Vanc	BSHO	Cephs	Amp	Amino-glycosides	Fluco ^a
Step Down Neonatal Nursery (Level II)	0.926	1.250	3.071	0.240	0.635	0.589	–
Level II/III Neonatal ICU	0.624	0.762	1.746	0.862	0.833	0.724	0.915
Level III Neonatal ICU	1.040	1.006	1.087	1.037	0.922	0.774	1.100
Level IV Neonatal ICU	0.863	0.998	1.178	1.086	0.805	0.638	1.368

^aNeonatal fluconazole SAARs are not available for Level II step-down neonatal nurseries.

Abbreviations: Standardized Antimicrobial Administration Ratio (SAAR), intensive care unit (ICU), All antibacterial agents (All Antibacterial), Vancomycin predominantly used for treatment of late-onset sepsis (Vanc), Broad spectrum antibacterial agents predominantly used for hospital-onset infections (BSHO), Third generation cephalosporins (Cephs), Ampicillin predominantly used for treatment of early-onset sepsis (Amp), Aminoglycosides predominantly used for treatment of early-onset and late-onset sepsis (Aminoglycosides), Fluconazole predominantly used for candidiasis (Fluco).

Highlights of percentage of AU by class and drug for each neonatal SAAR antimicrobial agent category (for categories with more than one agent) are outlined below.

- Within the **All antibacterial SAAR** category, the top two antibacterial agents, ampicillin and gentamicin, represented the largest portion (range of 43.0%–83.8%) of antibacterial use in all SAAR locations. Vancomycin was the next most commonly used antibacterial in all SAAR locations except Level II step down nurseries, for which it was Penicillin G. Erythromycin use dropped in

Level II step-down nurseries between 2021 and 2022 (2,330 compared to 268 antimicrobial days, respectively). This may be a result of increased focus on data quality surrounding routes of administration. Erythromycin eye drops are used for ophthalmic conditions in neonates, but the ophthalmic route is not eligible for AU Option reporting⁷ (AU Report Excel Data Table 4a2).

- Within the **BSHO SAAR** category, the proportions of cefepime use (range of 48.3%–66.6%) and piperacillin/tazobactam use (range of 25.6%–35.7%) were similar across all SAAR locations (AU Report Excel Data Table 4c2).
- Within the **3rd generation cephalosporins SAAR** category, ceftazidime accounted for the majority of use (range of 77.8%–93.2%) in all SAAR locations (AU Report Excel Data Table 4d2).
- Within the **Aminoglycosides SAAR** category, gentamicin accounted for almost all use in each SAAR location (range of 94.8%–98.7%) (AU Report Excel Data Table 4f2).

WHO AWaRe Classification

The WHO Expert Committee on Selection and Use of Essential Medicines developed the AWaRe classification for antimicrobials in 2017 as a tool to support antimicrobial stewardship efforts at local, national, and global levels. AWaRe classifies antimicrobials into three groups according to their indications and effect on antimicrobial resistance to emphasize the importance of appropriate antimicrobial use^{11,12}.

- **Access:** Antimicrobials that offer the best therapeutic value with the least effect on antimicrobial resistance.
- **Watch:** Antimicrobials that are indicated for only specific, limited situations and that may be targets for antimicrobial resistance.
- **Reserve:** “Last resort” antimicrobials; use of these antimicrobials is closely monitored to ensure continued effectiveness for life-threatening conditions.

Medication availability differs across countries and not all antimicrobials included in the WHO AWaRe classifications are available and approved for use in the United States. We listed the antimicrobials reported to the AU Option and included in each WHO AWaRe classification in Appendix D of the 2022 AU Report Excel data tables.

We reported unadjusted antimicrobial days within each AWaRe classification. This analysis included more facilities than the SAAR analyses because we did not need to limit inclusion by the facility and location types in the SAAR models. There were 2,175 facilities that reported at least nine months of AU data from inpatient locations and at least one antimicrobial day in one or more of the AWaRe classifications in 2022 (AU Report Excel Data Table 8a).

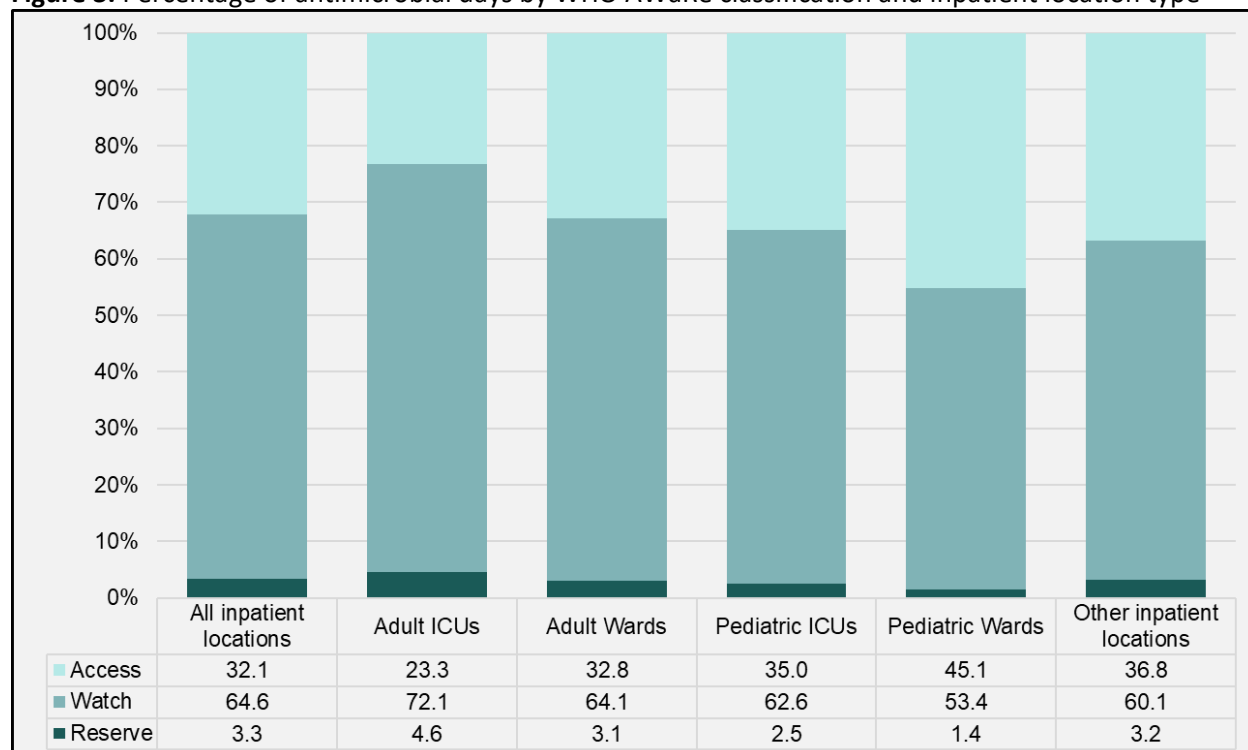
Table 6. Antimicrobial usage by WHO AWaRe classification and location type

Location Type ^a	WHO AWaRe Classification		
	Access Antimicrobial Days	Watch Antimicrobial Days	Reserve Antimicrobial Days
All locations	22,584,921	45,468,675	2,329,245
Adult ICUs	2,911,751	9,006,321	569,045
Adult Wards	14,654,484	28,582,865	1,374,403
Pediatric ICUs	277,711	497,007	19,632
Pediatric Wards	805,050	953,808	25,642
Other locations	3,935,925	6,428,674	340,523

^aLocation types include all inpatient locations eligible for AU Option reporting and follow the NHSN patient care location definitions in the CDC Locations and Descriptions and Instructions for Mapping Patient Care Locations document⁸.

Abbreviations: World Health Organization (WHO), Access Watch Reserve (AWaRe), intensive care unit (ICU).

Figure 3. Percentage of antimicrobial days by WHO AWaRe classification and inpatient location type



Abbreviations: World Health Organization (WHO), Access Watch Reserve (AWaRe), intensive care unit (ICU).

Use of antimicrobials in the Watch classification was lower in pediatric wards (53.4%) than the other

location types (range of 60.1%–72.1%). The Reserve classification accounted for less than 5% of antimicrobial days across all location types. Use of antimicrobials in the Reserve classification was highest in adult ICUs (4.6%) and lowest in pediatric wards (1.4%).

Conclusion

NHSN serves as a source system for risk-adjusted AU benchmarks and other AU summary statistics for hospital ASPs to monitor and improve antimicrobial prescribing. The 2019, 2020, and 2021 NHSN AU Reports provided national summaries of SAAR distributions and AU within each SAAR antimicrobial agent category by location, and this 2022 AU Report provides an update on those data. It is possible that the COVID-19 pandemic influenced antimicrobial use in 2020. This influence was likely less in 2021 and 2022. However, NHSN does not collect data on hospital-level COVID-19 or its complications that allow us to adjust for the effect of COVID-19. The data on AU provide quantitative indicators of differential use of antimicrobial agents across facilities for common clinical scenarios, such as treatment of hospital-onset and community-acquired infections and surgical prophylaxis. Facilities and health departments can compare their AU to national SAAR distributions and state-specific SAAR distributions, which can help inform stewardship efforts such as goal setting for the NHSN TAS Strategy. The AU cumulative attributable difference (AU-CAD), the metric used in TAS reports and dashboards, translates a SAAR target into a numeric antimicrobial day reduction (or addition), providing a concrete goal to drive action. Stewards can also explore and visualize state-level SAAR distributions on the [AR & Patient Safety Portal](#).








Many facilities integrated monitoring and benchmarking from the NHSN AU Option into the 7 Core Elements of Hospital Antibiotic Stewardship Programs to optimize antimicrobial use at their facility or healthcare system¹. In addition, CDC released the Priorities for Hospital Core Element Implementation in 2022 to highlight a subset of implementation approaches that are highly effective or prioritized by stewardship experts ([Figure 4](#)). The goal of the Priorities is to enhance the quality and effect of antimicrobial stewardship programs.

Discussions with AU Option users suggest the following best practices for using AU data to inform action:

- Submit monthly hospital AU data to the NHSN AU Option to guide tracking and reporting for ASPs.
- To ensure the accuracy of the AU data, run the AU Option data quality line list report available in the NHSN application regularly and perform more extensive data quality checks following the NHSN AUR data validation protocol annually (or every time a new EHR system or surveillance software is employed).
- Review NHSN AU data at least quarterly and track SAAR and AU data over time to both inform and assess stewardship interventions. Use SAAR distributions by location and percentage of antimicrobials by class or drug for additional context of prescribing practices at your facility.
- Report SAAR and AU data on a regular basis to senior leadership, hospital board, hospital committees (e.g., antimicrobial stewardship, infection control, Pharmacy & Therapeutics), and providers.
- Establish facility-specific SAAR target goals for quality improvement using AU-CAD in the TAS reports and dashboards.
- Create or participate in the NHSN AU Option Group Function as part of a healthcare system, health department, or collaborative¹³.

Figure 4. The Core Elements of Hospital Antibiotic Stewardship Programs and the Priorities for Hospital Core Element Implementation

Hospitals that have implemented the Hospital Core Elements of Antibiotic Stewardship can implement the Priorities for Hospital Core Element Implementation to further enhance their stewardship program.

Hospital Core Elements	Priorities for Hospital Core Element Implementation
Hospital Leadership Commitment	
 <p>Dedicate necessary human, financial, and information technology resources.</p>	Antibiotic stewardship physician and/or pharmacist leader(s) have antibiotic stewardship responsibilities in their contract, job description, or performance review.
Accountability	
 <p>Appoint a leader or co-leaders, such as a physician and pharmacist, responsible for program management and outcomes.</p>	Antibiotic stewardship program is co-led by a physician and pharmacist.*
Pharmacy/Stewardship Expertise	
 <p>Appoint a pharmacist, ideally as the co-leader of the stewardship program, to help lead implementation efforts to improve antibiotic use.</p>	Antibiotic stewardship physician and/or pharmacist leader(s) have completed infectious diseases specialty training, a certificate program, or other training on antibiotic stewardship.
Action	
 <p>Implement interventions, such as prospective audit and feedback or preauthorization, to improve antibiotic use.</p>	Antibiotic stewardship program has facility-specific treatment recommendations for common clinical condition(s) and performs prospective audit/feedback or preauthorization.
Tracking	
 <p>Monitor antibiotic prescribing, impact of interventions, and other important outcomes, like <i>C. difficile</i> infections and resistance patterns.</p>	Hospital submits antibiotic use data to the NHSN Antimicrobial Use Option.
Reporting	
 <p>Regularly report information on antibiotic use and resistance to prescribers, pharmacists, nurses, and hospital leadership.</p>	Antibiotic use reports are provided at least annually to target feedback to prescribers. In addition, the antibiotic stewardship program monitors adherence to facility-specific treatment recommendations for at least one common clinical condition.
Education	
 <p>Educate prescribers, pharmacists, nurses, and patients about adverse reactions from antibiotics, antibiotic resistance, and optimal prescribing.</p>	No implementation priority identified.

* For critical access hospitals (CAHs), this criterion can be met if the hospital has a physician leader with a pharmacist involved in stewardship (recognizing that some CAHs do not have pharmacists on staff, so co-leadership is not possible).

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An accessible version of “The Core Elements of Hospital Antibiotic Stewardship Programs and the Priorities for Hospital Core Element Implementation” is available at <https://www.cdc.gov/antibiotic-use/core-elements/hospital/priorities.html>.

Abbreviations: Clostridioides difficile (C. difficile), National Healthcare Safety Network (NHSN), critical access hospital (CAH).

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