2019 National Healthcare Safety Network Antimicrobial Use Option Report

Centers for Disease Control and Prevention

National Center for Emerging and Zoonotic Infectious Diseases

Division of Healthcare Quality Promotion

November 2020

Suggested citation: CDC. 2019 National Healthcare Safety Network Antimicrobial Use Option Report. Atlanta, GA: U.S. Department of Health and Human Services, CDC; 2020. Available at: https://www.cdc.gov/nhsn/pdfs/datastat/2019-au-report-508.pdf

Table of Contents

Executive Summary

Monitoring antimicrobial use (AU) is an important component of antibiotic stewardship programs (ASPs). AU data delivered to ASPs enable stewards to develop, select, and assess interventions aimed at optimizing antimicrobial prescribing.[1] These interventions, in turn, serve to improve antimicrobial treatment effectiveness, protect patients from harms caused by unnecessary antimicrobial exposure, and curb antimicrobial resistance associated with prophylactic and therapeutic excess.[2-4]

The benefits of monitoring AU for patient care and public health are most likely to be achieved when data collection and analysis are systematic and standardized. Leveraging electronic medication administration records and automating AU data submissions from hospitals reduces reporting burden and facilitates reuse of 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, available to hospitals reporting to NHSN's AU Option from select patient care locations.

The 2019 NHSN AU Option Report (2019 AU Report) provides the first summary of SAAR distributions and percentages of use within the SAAR antimicrobial agent categories in adult, pediatric and neonatal patient care locations (specified below). The 2019 AU Report includes data from 1,222 facilities that reported at least 9 months of data for adult, 287 for pediatric, and 475 for neonatal SAAR locations. The SAAR distributions can help inform stewardship efforts by enabling hospitals to see how their SAARs compare to the national distribution. Facilities can use the distributions as one of the considerations to set facility-specific SAAR target goals. The percentage of AU by class and drug within a SAAR antimicrobial agent category provides insight into prescribing practices across differing patient locations such as medical critical care units (ICUs) compared to medical wards. Facilities may evaluate these usage patterns in context of their local treatment guidelines, antimicrobial resistance rates and formulary.

NHSN AU Option Standardized Antimicrobial Administration Ratio (SAAR)

The SAAR is a ratio of observed antimicrobial days to predicted antimicrobial days. Each SAAR predictive model included in this report was developed using negative binomial regression applied to AU data from eligible adult and pediatric locations (2017 data) and eligible neonatal locations (2018 data). SAAR patient care locations and antimicrobial agent categories are listed in Tables 1 and 2, respectively.

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

The SAAR can be used to track AU changes over time at individual healthcare facilities and as a benchmarking metric for comparison of AU in similar patient care locations nationally. While the SAAR is not a measure of appropriateness of AU, it enables ASPs to compare their AU to a national baseline. These types of analyses enable facilities to assess whether they are using antimicrobials at higher rates than predicted (i.e., SAAR values > 1), which can prompt hospitals to further evaluate prescribing

practices and ultimately intervene if necessary, to optimize AU. More information on the SAAR can be found in the SAAR Guide[5] and AUR Module Protocol[6].

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

Adult SAAR Locations (N=8)	Pediatric SAAR Locations (N=5)	Neonatal SAAR Locations (N=3)
- 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	- Medical critical care units - Medical-surgical critical care units - Medical wards - Medical-surgical wards - Surgical wards	- Level II special care nurseries - Level II/III critical care units - Level III critical care units

*NHSN patient care location definitions can be found here: https://www.cdc.gov/nhsn/pdfs/pscmanual/15locationsdescriptions_current.pdf

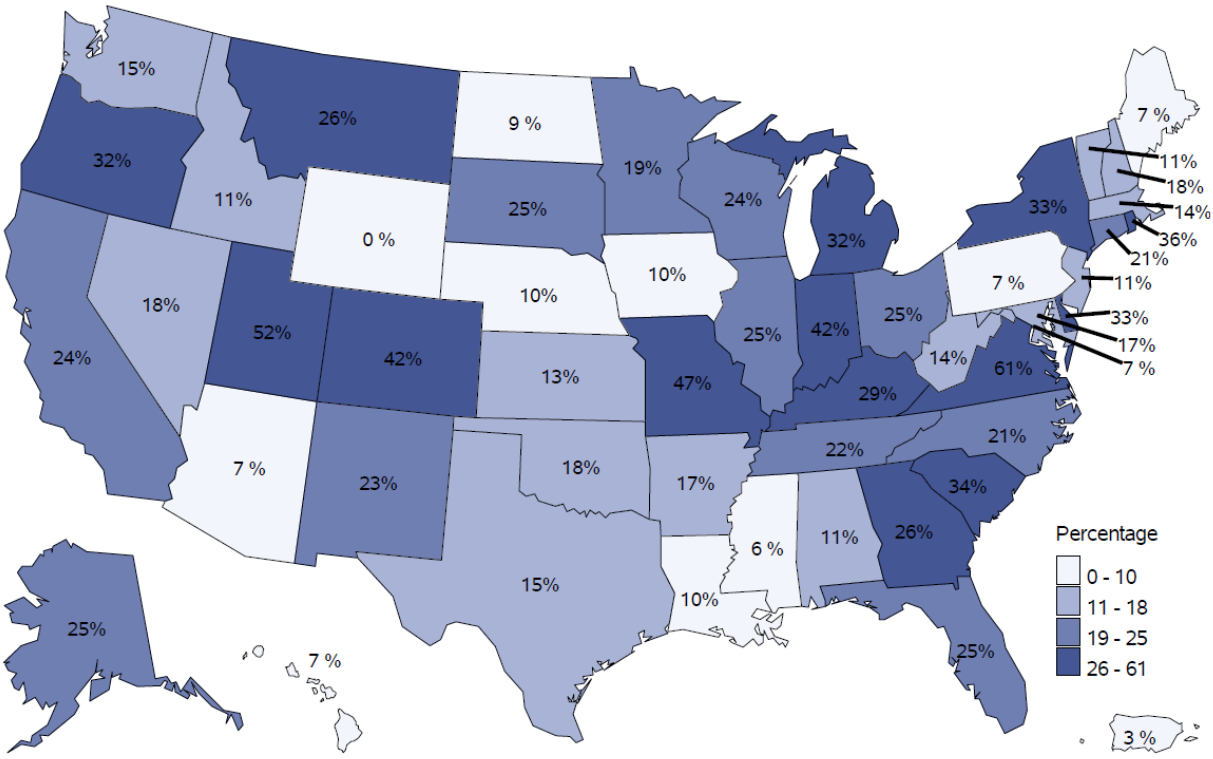
Table 2. SAAR antimicrobial agent categories (2017 baseline adult and pediatric, 2018 baseline neonatal)*

Adult SAAR Categories (N=7)	Pediatric SAAR Categories (N=8)	Neonatal SAAR Categories (N=7)
All antibacterial agents	All antibacterial agents	All antibacterial agents
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 (3rd gen 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	

*For the list of specific agents included in each SAAR category please reference Appendix E of the AUR Module protocol: https://www.cdc.gov/nhsn/PDFs/pscManual/11pscAURcurrent.pdf.

Facility data submissions to the NHSN AU Option are voluntary. No state or federal AU reporting requirements were in effect during the time period covered by this report. However, the SAAR is the statistical centerpiece of the NHSN AU measure endorsed by the National Quality Forum in 2015 (NQF #2720) and re-endorsed by NQF in 2019 for surveillance and quality improvement purposes.[7] This endorsement, coupled with NHSN's collaboration with ASPs and other partners, has prompted an increase in voluntary AU reporting to NHSN. As of December 1, 2019, 1,496 facilities had reported at least one month of data to the AU Option (Figure 1).

Figure 1. Percentage of active NHSN acute care facilities reporting at least one month of data to the AU Option as of December 1, 2019.



2019 Antimicrobial Use Data

The 2019 AU Report 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 2019
- SAAR distributions for each adult, pediatric and neonatal SAAR antimicrobial agent category by location type
- Percentage of AU by antimicrobial class and drug for each SAAR antimicrobial agent category by location type (if applicable)

Adult SAAR antimicrobial agent categories

Over 1,200 acute care hospitals contributed data for at least 9 months to adult SAAR patient care locations in 2019. The pooled mean SAAR values differ across location type and SAAR category (Table 3). The SAAR values in this Report were derived using pooled observed antimicrobial days from 2019 divided by pooled predicted days calculated using the 2017 baseline SAAR model.

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

Adult SAAR Location Type	Adult SAAR Antimicrobial Agent Categories						
	All Antibacterial	**BSHO**	**BSCA**	**GramPos**	**NSBL**	**CDI**	**Antifungal**
Medical ICUs	0.985	0.979	0.900	1.009	0.915	1.126	0.868
Medical-Surgical ICUs	0.971	1.007	0.873	0.915	0.959	0.958	0.890
Surgical ICUs	0.947	0.943	0.977	0.896	0.817	1.087	1.102
Medical Wards	0.983	0.983	0.942	0.941	1.024	0.992	0.905
Medical-Surgical Wards	0.999	1.088	0.910	0.943	1.078	0.979	0.948
Surgical Wards	0.985	1.044	0.988	0.963	0.873	1.046	1.022
Step Down Units	0.934	0.933	0.879	0.900	0.972	0.938	0.834
General Hematology-Oncology Wards	1.043	1.051	0.991	1.011	1.055	1.078	1.009

*Refer to technical tables for 2019 SAAR distributions for each SAAR antimicrobial agent category by location type. Abbreviations: BSHO - Broad spectrum antibacterial agents predominantly used for hospital-onset infections; BSCA - Broad spectrum antibacterial agents predominantly used for community-acquired infections; GramPos - Antibacterial agents predominantly used for resistant Gram-positive infections (e.g., MRSA); NSBL - Narrow spectrum beta-lactam agents; CDI - Antibacterial agents posing the highest risk for CDI; Antifungal - Antifungal agents predominantly used for invasive candidiasis.

While most pooled mean SAARs are centered around 1.0, there are small differences by location type and across SAAR antimicrobial agent categories. For example, on average, in 2019 surgical ICUs used only 0.817 NSBL antimicrobial days for each antimicrobial day predicted.

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

- Within the **all antibacterial SAAR** category, the top 10 antibacterial agents represented 77.5% - 85.8% of use, depending on the SAAR location. In most SAAR locations, the three most commonly used antimicrobial agents include vancomycin, piperacillin-tazobactam and ceftriaxone. In the surgical ICUs and surgical wards, cefazolin instead of ceftriaxone is included in top three. In general hematology-oncology wards, vancomycin, cefepime and piperacillin-tazobactam are the top three commonly used antibacterial agents.

- Within the **BSHO SAAR**, piperacillin-tazobactam was the most commonly used agent in ICUs, wards, and step down units. Antipseudomonal cephalosporins were the next most commonly used agents in ICUs, wards, and step down units. Antipseudomonal carbapenems had higher percentages of use in ICUs compared to wards. For general hematology-oncology wards, the percentage of piperacillin-tazobactam and antipseudomonal cephalosporins were comparable.

- Within the **BSCA SAAR**, ceftriaxone had the highest use in ICUs, wards, and step down units, followed by fluroquinolones. For general hematology-oncology wards, the percentage of ceftriaxone and fluroquinolones were comparable. Ertapenem had higher use in the surgical ICUs and surgical wards compared to other SAAR locations.

- Within the **GramPos SAAR**, vancomycin was the predominate agent used in all SAAR locations followed by linezolid and daptomycin. In ICUs and step down units, linezolid had slightly higher use than other SAAR locations.

- Within the **NSBL SAAR**, cefazolin had the highest use across all SAAR locations with the highest percentage of use in surgical ICUs and surgical wards.

- Within the **CDI SAAR**, the 3rd and 4th generation cephalosporins had the highest use across all SAAR locations. Fluoroquinolones, the next most commonly used agents, contributed to higher percentages in wards and general hematology-oncology compared to ICUs and step down units. Clindamycin accounted for approximately 10% for both surgical ICUs and surgical wards compared to lower percentages in other locations (range: 3.3-7.7%).

- Within the **antifungal SAAR**, both fluconazole and echinocandins contributed to approximately 50% of use in the medical ICUs. Fluconazole use was slightly higher than echinocandins in medical-surgical and surgical ICUs and much higher than echinocandins in other locations.

Pediatric SAAR antimicrobial agent categories

A lower number of acute care hospitals (n=287) contributed data to pediatric SAAR locations than the number contributing to the adult SAAR locations. The pooled mean SAAR values differ across location type and SAAR category (Table 4).

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

Pediatric SAAR Location Type	Pediatric SAAR Antimicrobial Agent Categories							
	All Antibacterial	**BSHO**	**BSCA**	**GramPos**	**NSBL**	**Azithro-mycin**	**CDI**	**Anti-fungal**
Medical ICUs	1.263	2.599	1.122	1.079	1.136	0.870	1.206	1.237
Medical-Surgical ICUs	1.098	1.287	1.021	1.115	0.854	0.834	1.226	1.711
Medical Wards	1.051	1.099	1.025	0.965	0.950	1.086	1.160	2.165
Medical-Surgical Wards	0.945	0.973	0.886	0.852	1.032	0.765	0.934	1.883
Surgical Wards	0.959	1.652	0.885	0.823	0.792	1.325	0.887	1.386

*Refer to technical tables for 2019 SAAR distributions for each SAAR antimicrobial agent category by location type. Abbreviations: BSHO - Broad spectrum antibacterial agents predominantly used for hospital-onset infections; BSCA - Broad spectrum antibacterial agents predominantly used for community-acquired infections; GramPos - Antibacterial agents predominantly used for resistant Gram-positive infections (e.g., MRSA); NSBL - Narrow spectrum beta-lactam agents; CDI - Antibacterial agents posing the highest risk for CDI; Antifungal - Antifungal agents predominantly used for invasive candidiasis.

Variability in SAARs appears greater in pediatric locations compared to adult locations, which may relate to both the smaller pediatric sample size and possibly greater variability in pediatric AU overall. In 2019, pediatric BSHO use in medical ICUs and surgical wards was 2.599 and 1.652 times higher than predicted by the 2017 national baseline, on average. However, sample sizes for these two location types were quite low, with just 14 medical ICUs and 16 surgical wards contributing data to 2019 SAAR distributions. With small sample sizes, even one location with a high number of days present can greatly impact the overall pooled mean SAAR.

Highlights of percentage of AU by class and/or drug for each pediatric SAAR antimicrobial agent category (if more than one agent is included) are outlined below:

- Within the **all antibacterial SAAR** category, the top 10 antibacterial agents represented 62.9% - 76.2% of use in pediatric SAAR locations, depending on the location type. In medical and medical-surgical ICUs, vancomycin, ceftriaxone, cefepime (in varying order) were the three most commonly used antibacterial agents. In medical wards, ceftriaxone, clindamycin and vancomycin were included in the top three while ceftriaxone, piperacillin-tazobactam, and cefazolin (in varying order) were the top three for medical-surgical and surgical wards.

- Within the **BSHO SAAR**, antipseudomonal cephalosporins and piperacillin-tazobactam were the top agents used (in varying order) in all SAAR locations. Antipseudomonal cephalosporins had highest percentage use in the medical ICUs, medical-surgical ICUs, and medical wards while

piperacillin-tazobactam had higher use in surgical wards and medical-surgical wards. The third most commonly used agent varied across location type (i.e., carbapenems in ICUs and surgical wards, aminoglycosides in medical wards, and fluoroquinolones in medical-surgical wards).

- Within the **BSCA SAAR**, ceftriaxone was the predominate agent used in all SAAR locations. Ampicillin-sulbactam and amoxicillin-clavulanate were the next most commonly used agents.

- Within the **GramPos SAAR**, vancomycin and clindamycin combined represented 91.7% - 96.8%, depending on the SAAR location. Vancomycin had higher use in ICUs while clindamycin had higher use in wards.

- Within the **NSBL SAAR**, cefazolin had the highest use within each SAAR location except the medical ward. In medical wards, amoxicillin and ampicillin each contributed to approximately 30% of use, while cefazolin contributed roughly 21%.

- Within the **CDI SAAR**, the 3rd and 4th generation cephalosporins had the highest use for all SAAR locations. Clindamycin, the next commonly used agent, contributed higher percentages in wards compared to ICUs. Fluoroquinolones accounted for lowest usage across all SAAR locations.

- Within the **antifungal SAAR**, fluconazole was the most commonly used agent for all SAAR locations, with highest percentage of use in surgical wards and medical-surgical wards.

Neonatal SAAR antimicrobial agent categories

Four hundred and seventy-five acute care hospitals contributed data to neonatal SAAR locations. The pooled mean SAAR values differ across location type and SAAR category (Table 5).

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

Neonatal SAAR Location Type	Neonatal SAAR Antimicrobial Agent Categories						
	All Antibacterial	**Vanco-mycin**	**BSHO**	**3rd gen Cephalo-sporins**	**Ampi-cillin**	**Amino-glycosides**	**Flucon-azole[a]**
Step Down Neonatal Nursery (Level II)	0.701	1.551	1.118	0.540	0.739	0.758	--
Level II/III Neonatal ICU	0.898	0.912	1.490	0.916	0.857	0.876	0.924
Level III Neonatal ICU	1.139	1.192	1.124	1.068	0.933	0.941	1.236

*Refer to technical tables for 2019 SAAR distributions for each SAAR antimicrobial agent category by location type.
[a]Neonatal fluconazole SAARs are not available for Level II neonatal step down nurseries.
Abbreviations: BSHO - Broad spectrum antibacterial agents predominantly used for hospital-onset infections.

Highlights of percentage of AU by class and/or drug for each neonatal SAAR antimicrobial agent category (if more than one agent is included) are outlined below.

- Within the **all antibacterial SAAR**, the top 2 antibacterial agents, ampicillin and gentamicin, represented a large portion of antibacterial use in all SAAR locations (85.2% in Level II nurseries, 70.4% in Level II/III NICUs, and 54.2% in Level III NICUs).

- Within the **BSHO SAAR**, similar usage patterns were seen in Level II and Level II/III locations with cefepime contributing approximately 50% followed by piperacillin-tazobactam and meropenem. In Level III, both cefepime and piperacillin-tazobactam contributed approximately 43%, and meropenem contributed 14.2%.

- Within the **3rd generation cephalosporins SAAR**, ceftazidime represented the majority of use (approximately 78% in all SAAR locations) followed by cefotaxime and ceftriaxone.

- Within the **aminoglycosides SAAR**, gentamicin accounted for almost all use for each SAAR location.

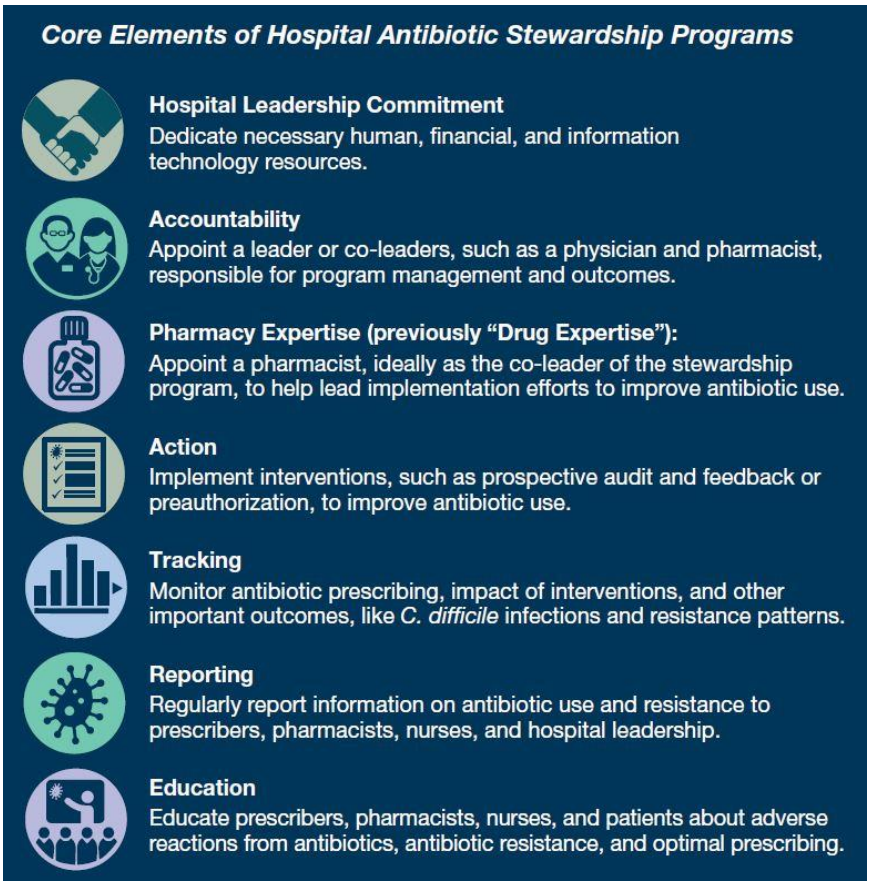
Conclusion

NHSN serves as a source system for risk-adjusted AU benchmarks and other AU summary statistics that hospital ASPs can use in their efforts to monitor and improve antimicrobial prescribing. The 2019 NHSN AU Report provides the first national summary of SAAR distributions and AU within each SAAR antimicrobial agent category by location. The AU data provide quantitative indicators of differential use of antimicrobial agents across facilities for common clinical scenarios, including treatment of hospital-onset and community-acquired infections. Facilities can compare their AU to national SAAR distributions, which can help inform stewardship efforts including goal setting. Many facilities have integrated monitoring and benchmarking from NHSN AU Option into the 7 Core Elements of Hospital Antibiotic Stewardship Programs to optimize antibiotic use (Figure 2) at their facility and/or healthcare system.[1] Discussions with AU Option users suggest the following best practices for using AU data for action:

1) Submit monthly hospital AU data to the NHSN AU Option to guide tracking and reporting for ASPs.
2) Review NHSN AU data at least quarterly to track SAAR/AU data over time to both inform and assess stewardship interventions. Use SAAR distributions by location and percentage of antimicrobials by class and/or drug for additional context of prescribing practices at your facility.
3) Report SAAR/AU data on a regular basis to senior leadership, hospital board, hospital committees (e.g., antibiotic stewardship, infection control, Pharmacy & Therapeutics) and providers.
4) Establish facility-specific SAAR target goals for quality improvement.
5) Create and/or participate in the NHSN AU Option Group Function as part of a healthcare system, health department and/or collaborative.

The NHSN AU Option continues to evolve to meet the needs of ASPs. Future NHSN application releases will include annual aggregate SAAR distributions by location type, and these distributions will be accessible to facilities within the application. Future NHSN capabilities also will include AU-cumulative attributable difference by SAAR antimicrobial agent category and location type to facilitate facility-specific SAAR target goals.

Figure 2. Core elements of hospital antibiotic stewardship programs



Accessible version of "Core elements of hospital antibiotic stewardship programs": https://www.cdc.gov/antibiotic-use/core-elements/hospital.html

Acknowledgements

We thank the antibiotic stewards, infection preventionists, hospital epidemiologists, and other dedicated hospital and health department staff who work to support AU surveillance and antibiotic stewardship. This report was prepared by the CDC's National Center for Emerging and Zoonotic Infectious Diseases, Division of Healthcare Quality Promotion staff.

References

1. Centers for Disease Control and Prevention. The core elements of hospital antibiotic stewardship programs: 2019. https://www.cdc.gov/antibiotic-use/healthcare/pdfs/hospital-core-elements-H.pdf. Accessed October 1, 2020.
2. Davey P, Marwick CA, Scott CL, Charani E, McNeil K, Brown E, et al. *Interventions to improve antibiotic prescribing practices for hospital inpatients*. The Cochrane database of systematic reviews. 2017 Feb 9;2:Cd003543.
3. Karanika S, Paudel S, Grigoras C, Kalbasi A, Mylonakis E. *Systematic Review and Meta-analysis of Clinical and Economic Outcomes from the Implementation of Hospital-Based Antimicrobial Stewardship Programs*. Antimicrobial Agents and Chemotherapy. 2016 Aug;60(8):4840-52.
4. Baur D, Gladstone BP, Burkert F, Carrara E, Foschi F, Dobele S, et al. *Effect of antibiotic stewardship on the incidence of infection and colonisation with antibiotic-resistant bacteria and Clostridium difficile infection: a systematic review and meta-analysis*. The Lancet Infectious diseases. 2017 Sep;17(9):990-1001.
5. Centers for Disease Control and Prevention. Standardized Antimicrobial Administration Ratio. https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/aur/au-saar-guide-508.pdf. Accessed October 28, 2020.
6. Centers for Disease Control and Prevention. Antimicrobial Use and Resistance (AUR) Module. https://www.cdc.gov/nhsn/pdfs/pscmanual/11pscaurcurrent.pdf. Accessed October 1, 2020.
7. National Quality Forum. National Healthcare Safety Network (NHSN) antimicrobial use measure. National Quality Forum measure #2720. http://www.qualityforum.org/QPS. Accessed October 9, 2020.