



## Antimicrobial Use and Resistance (AUR) Module

### Table of Contents

Introduction	1
<b>1. Antimicrobial Use (AU) Option</b>	2
Introduction	2
Requirements	3
Data Analyses	7
References	12
Appendix A. Table of Instructions: Antimicrobial Use	13
Appendix B. List of Antimicrobials	15
Appendix C. Example Calculations of Antimicrobial Days	19
Appendix D. List of SAARs	22
Appendix E. Antimicrobial Groupings for SAAR & Rate Table Calculations	25
<b>2. Antimicrobial Resistance (AR) Option</b>	31
Introduction	31
Requirements	32
Data Analyses	39
References	46
Appendix F. List of Eligible Organisms for the NHSN AR Option	47
Appendix G. Technical and Isolate Based Report Variables	53
Appendix H. Denominator Data Variables	55
Appendix I. NHSN AR Option Phenotype Definitions	56

### Introduction

This module contains two options: one focused on antimicrobial use and the second on antimicrobial resistance. To participate in either option, facility personnel responsible for reporting antimicrobial use (AU) or resistance (AR) data to the National Healthcare Safety Network (NHSN) must coordinate with their pharmacy and/or laboratory information software providers to configure their system to generate standard formatted file(s) to be imported into NHSN. The format provided for data submission follows the [Health Level 7 \(HL7\) Clinical Document Architecture \(CDA\)](#) standard.<sup>7</sup> Manual data entry is not available for the AUR Module. Facilities can participate in one (AU or AR) or both (AU and AR) options at any given time.

### Purpose

The NHSN AUR Module provides a mechanism for individual facilities and NHSN Group users to report and analyze antimicrobial use and/or resistance data to inform benchmarking, reduce antimicrobial resistant infections through antimicrobial stewardship, and interrupt transmission of resistant pathogens at individual facilities or facility networks.<sup>6</sup>



## 1. Antimicrobial Use (AU) Option

**Introduction:** Antimicrobial resistance rates continue to increase in hospitals across the United States.<sup>1</sup> One of the four CDC core initiatives to combat the spread of antimicrobial resistance is improving the use of antimicrobials.<sup>2</sup> Studies show that providing timely and reliable feedback of information to clinicians regarding their prescribing practices, such as through antimicrobial usage reports, can improve appropriateness of antimicrobial use.<sup>3-5</sup>

**Objectives:** The primary objective of the Antimicrobial Use (AU) Option is to facilitate risk-adjusted inter- and intra-facility antimicrobial use benchmarking. A secondary objective is to evaluate antimicrobial use trends over time at the facility and national levels.

**Methodology:** The primary antimicrobial use metric reported to the AU Option is antimicrobial days per 1,000 days present. An antimicrobial day (also known as day of therapy) is defined by any amount of a specific antimicrobial agent administered in a calendar day to a particular patient as documented in the electronic medication administration record (eMAR) and/or bar coding medication record (BCMA) (refer to Numerator Data section starting on page 14-3 for more information); all antimicrobial days for a specific agent administered across a population are summed in aggregate.<sup>8-11</sup> Days present are defined as the aggregate number of patients housed in a patient care location or facility anytime throughout a day during a calendar month (refer to Denominator Data section starting on page 14-5 for more information). For each facility, the numerator (antimicrobial days) is aggregated by month for each patient care location and overall for inpatient areas facility-wide (specifically, facility-wide inpatient or FacWideIN). Similarly, the denominator (days present) is calculated for the corresponding patient care-location-month or facility-wide inpatient-month.

A secondary antimicrobial use metric, antimicrobial days per 100 admissions, is reported to the AU Option for facility-wide inpatient (FacWideIN) data. The numerator and denominators are further defined below and must adhere to the data format prescribed by the [HL7 CDA Implementation Guide](#) developed by the CDC and HL7.<sup>7</sup> Manual data entry is not available for the NHSN AU Option.

**Settings:** All inpatient facilities (for example, general acute care hospitals, critical access hospitals, children's hospitals, oncology hospitals, long term acute care hospitals, inpatient rehabilitation facilities, and inpatient psychiatric hospitals) enrolled in NHSN and reporting to the Patient Safety Component can participate in the AU Option. Facilities must have the ability to collect the numerator and denominator data electronically and upload those data into NHSN using the required CDA specifications. NHSN does not currently support the submission of data into the AU Option from ambulatory surgery centers, long term care facilities (specifically, skilled nursing facilities, nursing homes) or outpatient dialysis facilities.

NHSN strongly encourages the submission of data from all NHSN-defined inpatient locations (including procedural areas like operating rooms), facility-wide inpatient (FacWideIN), and select outpatient acute care settings (specifically, outpatient emergency department [ED], pediatric emergency department [ED], and 24-hour observation area) from which the numerator



and denominator data can be accurately captured. The AU Option does not accept data from other outpatient locations such as outpatient clinics. The FacWideIN record should contain data from all inpatient locations and inpatient procedural areas from which the numerator and denominator can be accurately captured. A comprehensive submission will enable a facility to optimize inter- and/or intra-facility comparisons among specific wards, combined wards, and facility-wide data.

NHSN delineates a CDC-defined designation (CDC Location) for patient care areas/locations where patients have similar disease conditions or are receiving care for similar medical or surgical specialties. Each facility location is “mapped” to one CDC Location within the NHSN facility. The specific CDC Location code is determined by the type of patients cared for in that area according to the NHSN location mapping algorithm for acuity level and service type. The patient care areas include adult, pediatric, and neonatal units as defined by NHSN Codes. See the [NHSN Locations chapter](#) for more information regarding location mapping. Note that the same patient care locations should be used throughout NHSN for both AUR and HAI reporting. Facilities should not map separate locations only for AUR reporting.

### **Requirements:**

Each month:

1. The facility must indicate the specific locations from which they plan to submit antimicrobial use data in the [Patient Safety Monthly Reporting Plan](#).
  - a. When reporting AU Option data from inpatient and outpatient locations, list FacWideIN, each individual inpatient location, and each individual outpatient location as separate rows in the plan.
2. The CDA files submitted by the facility contain all data fields outlined in the *Table of Instructions* ([Appendix A](#)) for each location.
3. The facility uploads data via CDA files for all locations indicated in the Monthly Reporting Plan.
  - a. Submit one file for each individual patient care location as well as a separate file for FacWideIN. As an example, a facility with three patient care locations will upload three separate files for each individual location and one additional file for FacWideIN for a total of four files per month.

NHSN recommends the facility uploads data into NHSN for a given calendar month by the end of the subsequent calendar month.

### **Numerator Data (Antimicrobial Days):**

Antimicrobial Days (also known as Days of Therapy): Defined as the aggregate sum of days for which any amount of a specific antimicrobial agent was administered to individual patients as documented in the eMAR and/or BCMA.<sup>8-11</sup> [Appendix B](#) provides the full list of antimicrobial agents collected in the NHSN AU Option. Aggregate antimicrobial days are reported monthly for inpatient locations, facility-wide inpatient (FacWideIN), and three select outpatient acute care settings (specifically, outpatient ED, pediatric ED, and 24-hour observation area) for select



antimicrobial agents and stratified by route of administration (specifically, intravenous, intramuscular, digestive, and respiratory).

Refer to [Table 1](#) and [Table 2](#) for the definitions of drug-specific antimicrobial days and stratification based on route of administration. For example, when a provider administers a patient 1 gram Vancomycin intravenously twice daily for three days, three “Vancomycin Days (total)” and three “Vancomycin Days (IV)” are counted when stratified by intravenous route of administration. Please note antimicrobials that have an extended half-life, such as Dalbavancin and Oritavancin, are only counted as an antimicrobial day on the day of administration. Similarly, in the case of renal impairment, antimicrobials such as Vancomycin are only counted as an antimicrobial day on the day of administration. [Table 3](#) summarizes the data elements for numerator calculation. [Appendix C](#) provides additional examples of antimicrobial day calculation.

Please note facilities should report “0” (zero) antimicrobial days when no aggregate use occurred during a given reporting period for a specific antimicrobial agent/route (for example, Zanamivir via the respiratory route) in a location where the agent/route is used and can be accurately captured in the eMAR or BCMA system. Facilities should report “NA” (Not Applicable) when data are not available for a specific antimicrobial agent/route in a location (specifically, the agent can’t be electronically captured at that facility). A value (specifically, a number  $\geq 1$ , “0”, or “NA”) must be reported for every antimicrobial agent and route of administration listed in [Appendix B](#) for every location record for each month. Antimicrobial agents and routes of administration cannot be left blank.

**Table 1. Classification and Definition of Routes of Administration for Antimicrobial Days**

<b>Classification: Route of Administration<sup>a</sup></b>	<b>Definition<sup>b</sup></b>
Intravenous (IV)	An intravascular route that begins with a vein.
Intramuscular (IM)	A route that begins within a muscle.
Digestive Tract	A route that begins anywhere in the digestive tract extending from the mouth through rectum. <sup>c</sup>
Respiratory Tract	A route that begins within the respiratory tract, including the oropharynx and nasopharynx.

<sup>a</sup> Other routes of administration are excluded from the AU Option reporting (for example, antibiotic locks, intraperitoneal, intrapleural, intraventricular, irrigation, topical) and should not be included in the total antimicrobial days nor the sub-stratification of the routes of administration.

<sup>b</sup> Definitions were drawn from SNOMED qualifier value hierarchy. Refer to the [CDA Antimicrobial Use \(AU\) Toolkit](#) for specific codes corresponding to each route of administration.

<sup>c</sup> For example, rectal administration of Vancomycin.



**Table 2. Example Stratification of Antimicrobial Days by Route of Administration**

Month/ Year- Location	Antimicrobial Agent	Drug-specific Antimicrobial Days				
		Total <sup>a</sup>	IV	IM	Digestive <sup>b</sup>	Respiratory
Month/ Year Location	Tobramycin	Tobramycin Days (Total)	Tobramycin Days (IV)	Tobramycin Days (IM)	Tobramycin Days (Digestive)	Tobramycin Days (Respiratory)
01/2019 Med Ward		1	1	0	0	1

<sup>a</sup> Drug-specific antimicrobial days (total) attributes one antimicrobial day for any route of administration. For example, if a provider administered Tobramycin to a patient intravenously *and* via a respiratory route on the same day, the antimicrobial days would be counted as “one Tobramycin Day (Total)” and the stratification by route of administration would be “one Tobramycin Day (IV)” and “one Tobramycin Day (Respiratory)”.

<sup>b</sup> Tobramycin is used for an example of route stratification only and is not FDA approved for administration via the digestive route.

**Table 3. Data Elements for Antimicrobial Days**

Data Element	Details
<b>Antimicrobial Agents</b>	Defined as select antimicrobial agents and stratified by route of administration (specifically, intravenous, intramuscular, digestive, and respiratory). Refer to <a href="#">Appendix B</a> for a complete list of antimicrobials. The list of select antimicrobials will evolve with time as new agents become commercially available and old agents are removed from the market. <i>Topical antimicrobial agents are not included in the NHSN AU Option.</i>
<b>Data source</b>	Antimicrobial days are derived from antimicrobial administration data documented in the eMAR and/or BCMA only. Usage derived from other data sources (for example, pharmacy orders, doses dispensed, doses billed) <u>cannot</u> be submitted.
<b>Location</b>	Antimicrobial days are aggregated for each inpatient location, facility-wide inpatient, and three select outpatient acute-care settings (specifically, outpatient ED, pediatric ED, and 24-hour observation area) per the <a href="#">NHSN location definitions</a> .
<b>Time Unit</b>	Antimicrobial days for a specific antimicrobial agent and stratification by route of administration are aggregated monthly per location.

**Denominator Data (Days Present and Admissions):** The numerator will be analyzed against the denominators of days present (all locations) and admissions (for facility-wide inpatient [FacWideIN] only). The denominators are further defined below.

Days present: Days present are defined as the time period during which a given patient is at risk for antimicrobial exposure in a given patient location. The definition of days present differs from the definition of patient days used in other NHSN modules. Days present is further defined below in context of calculation for patient care location-specific analyses and facility-wide inpatient analyses. Please note that a separate calculation for days present is required for each patient care location compared to facility-wide inpatient.



For patient care location-specific analyses, days present are calculated as the number of patients who were present, regardless of patient status (for example, inpatient, observation), for any portion of each day during a calendar month for a patient care location. The aggregate measure is calculated by summing days present for that location and month. The day of admission, discharge, and transfer to and from locations will be included in the days present count. Below are examples that illustrate appropriate days present calculation:

- A patient admitted to the medical ward on Monday and discharged two days later on Wednesday contributes three days present in the medical ward because the patient was present in that specific location at some point during each of the three calendar days (specifically, Monday, Tuesday, and Wednesday).
- On the day a patient is transferred from a medical critical care unit to a medical ward, the patient contributes one day present in the medical critical care unit and one day present in the medical ward because the patient was present in both locations at some point during that calendar day. Similarly, a patient contributes days present to the operating room or ED if data are submitted from these locations.
- One patient can only contribute one day present for a specific location per calendar day. One patient cannot contribute more than one day present to any one unique location on the same day, but can contribute a day present to two different locations on the same day. For example, a patient transferred from the surgical ward to the operating room and back to the surgical ward in a calendar day contributes one day present to the surgical ward and one day present to the operating room.

For facility-wide inpatient (FacWideIN) analyses, days present are calculated as the number of patients who were present in an inpatient location within the facility for any portion of each day during a calendar month. The aggregate measure is calculated by summing up all of the days present for facility-wide inpatient for a given month. Thus, a sum of days present from location-specific analyses would be higher than days present for the facility (FacWideIN), because transfers between wards can account for multiple location “days present” for a given patient on a single calendar day. Therefore, it is not permissible to sum the individual days present for location-specific analyses to achieve the facility-wide inpatient (FacWideIN) days present count. The calculation must be a separate summation for facility-wide inpatient analyses.

Please note that only inpatient locations in which both the antimicrobial days (numerator) and the days present (denominator) can be accurately electronically captured should be included in the FacWideIN counts. Additionally, outpatient locations (ED, pediatric ED, and 24-hr observation) should **not** be included in FacWideIN counts.

Admissions: Admissions are defined as the aggregate number of patients admitted to an inpatient location within the facility (facility-wide inpatient) starting on first day of each calendar month through the last day of the calendar month. This is the same definition for admissions used in the [NHSN MDRO/CDI Module](#). In the AU Option, admissions are reported only for facility-wide inpatient (FacWideIN).





**Table 4. Location-specific and Facility-wide Inpatient Metrics**

<b>Patient Care Location-Specific Analyses</b>
<p><b>Rate of Antimicrobial Days per 1,000 Days Present</b></p> $\frac{\text{Drug specific antimicrobial days per patient care location per month}}{\text{Days present per patient care location per month}} \times 1000$ <p>Notes:</p> <ul style="list-style-type: none"><li>• One patient can contribute only one day present per calendar day for each specific location.</li><li>• Summed total may be higher when compared to facility-wide count (reflecting transfers between locations).</li></ul>
<b>Facility-wide Inpatient Analyses</b>
<p><b>Rate of Antimicrobial Days per 1,000 Days Present</b></p> $\frac{\text{Drug specific antimicrobial days for all inpatient units in a facility per month}}{\text{Days present per facility wide inpatient per month}} \times 1000$ <p>Notes:</p> <ul style="list-style-type: none"><li>• One patient can contribute only one day present per calendar day for a facility. Thus, one denominator is obtained for all inpatient locations in an entire facility.</li><li>• The day present measure for facility-wide inpatient should be lower when compared to sum total from location-specific comparison.</li><li>• Only include inpatient units where both the antimicrobial days (numerator) and the days present (denominator) can be accurately electronically captured.</li><li>• Exclude outpatient locations.</li></ul>
<p><b>Rate of Antimicrobial Days per 100 Admissions</b></p> $\frac{\text{Drug specific antimicrobial days for inpatient units in a facility per month}}{\text{Admissions per facility wide inpatient per month}} \times 100$ <p>Notes:</p> <ul style="list-style-type: none"><li>• Only calculated for facility-wide inpatient for the AU Option.</li><li>• Only include inpatient units where both the antimicrobial days (numerator) and the days present and admissions (denominators) can be accurately electronically captured.</li><li>• Exclude outpatient locations.</li></ul>

**Data Analyses:**

All AU Option data reported to NHSN can be analyzed. After generating analysis datasets within NHSN, users can view reported data using various NHSN analysis reports to visualize and analyze data in more detail. For example, descriptive analysis reports such as line lists, bar charts and pie charts are available. In addition, measures of antimicrobial use are available in rate tables and SAAR reports.



## Types of AU Option Analysis Reports

### Standardized Antimicrobial Administration Ratio (SAAR):

The Standardized Antimicrobial Administration Ratio (SAAR) is a metric developed by CDC to analyze and report antimicrobial use data in summary form. The SAAR is calculated by dividing observed antimicrobial use by predicted antimicrobial use.

$$SAAR = \frac{\text{Observed Antimicrobial Use}}{\text{Predicted Antimicrobial Use}}$$

The observed antimicrobial use is the number of days of therapy, or antimicrobial days, reported by a facility for a specified category of antimicrobial agents in a specified group of patient care locations. The predicted antimicrobial use is calculated using predictive models developed by CDC and applied to nationally aggregated 2017 adult and pediatric or 2018 neonatal AU data reported to NHSN from the same group of patient care location types. Separate predictive models are developed for each specific antimicrobial agent category.

The SAAR can be generated for 22 antimicrobial agent categories (7 adult, 8 pediatric, and 7 neonatal) and 17 specific NHSN location types (8 adult, 5 pediatric, and 4 neonatal), for a total of 47 possible SAARs (see [Appendix D](#)), each of which can serve as a high-value target or high-level indicator for antimicrobial stewardship programs. The antimicrobial agent categories were determined by CDC with input from external adult, pediatric, and neonatal infectious disease physicians and pharmacists. The SAAR agent categories are listed below. The specific antimicrobial agents in each category can be found in [Appendix E](#).

- Adult SAAR antimicrobial agent categories
  - All antibacterial agents
  - Broad spectrum antibacterial agents predominantly used for hospital-onset infections
  - Broad spectrum antibacterial agents predominantly used for community-acquired infections
  - Antibacterial agents predominantly used for resistant Gram-positive infections (e.g., MRSA)
  - Narrow spectrum beta-lactam agents
  - Antibacterial agents posing the highest risk for CDI (not mutually exclusive, agents may overlap with other categories)
  - Antifungal agents predominantly used for invasive candidiasis
- Pediatric SAAR antimicrobial agent categories
  - All antibacterial agents
  - Broad spectrum antibacterial agents predominantly used for hospital-onset infections
  - Broad spectrum antibacterial agents predominantly used for community-acquired infections





- Antibacterial agents predominantly used for resistant Gram-positive infections (e.g., MRSA)
  - Narrow spectrum beta-lactam agents
  - Azithromycin
  - Antibacterial agents posing the highest risk for CDI (not mutually exclusive, agents may overlap with other categories)
  - Antifungal agents predominantly used for invasive candidiasis
- Neonatal SAAR antimicrobial agent categories
    - All neonatal antibacterial agents
    - Vancomycin predominantly used for treatment of late-onset sepsis
    - Broad spectrum antibacterial agents predominantly used for hospital-onset infections
    - Third generation Cephalosporins
    - Ampicillin predominantly used for treatment of early-onset sepsis
    - Aminoglycosides predominantly used for treatment of early-onset and late-onset sepsis
    - Fluconazole predominantly used for candidiasis

At present, SAARs are available to facilities that have submitted AU data from one of the 17 eligible adult, pediatric, and neonatal SAAR location types included in [Table 5](#). In the future, as more facilities submit AU data, the NHSN Team plans to develop SAARs for additional location types.

**Table 5. Location types able to generate SAARs**

CDC Location Type	CDC Location Code	NSHN Healthcare Service Location (HL7) Code
<b>Adult Locations</b>		
Medical Critical Care	IN:ACUTE:CC:M	1027-2
Surgical Critical Care	IN:ACUTE:CC:S	1030-6
Medical-Surgical Critical Care	IN:ACUTE:CC:MS	1029-8
Medical Ward	IN:ACUTE:WARD:M	1060-3
Surgical Ward	IN:ACUTE:WARD:S	1072-8
Medical-Surgical Ward	IN:ACUTE:WARD:MS	1061-1
ONC General Hematology-Oncology Ward	IN:ACUTE:WARD:ONC_HONC	1232-8
Adult Step Down Unit	IN:ACUTE:STEP	1099-1
<b>Pediatric Locations</b>		
Pediatric Medical Critical Care	IN:ACUTE:CC:M:PED	1044-7
Pediatric Medical-Surgical Critical Care	IN:ACUTE:CC:MS_PED	1045-4
Pediatric Medical Ward	IN:ACUTE:WARD:M_PED	1076-9



CDC Location Type	CDC Location Code	NSHN Healthcare Service Location (HL7) Code
Pediatric Surgical Ward	IN:ACUTE:WARD:S_PED	1086-8
Pediatric Medical-Surgical Ward	IN:ACUTE:WARD:MS_PED	1081-9
<b>Neonatal Locations</b>		
Step down Neonatal Nursery	IN:ACUTE:STEP:NURS	1041-3
Neonatal Critical Care (Level II/III)	IN:ACUTE:CC_STEP:NURS	1039-7
Neonatal Critical Care (Level III)	IN:ACUTE:CC:NURS	1040-5
Neonatal Critical Care (Level IV)	IN:ACUTE:CC:NURS_IV	1269-0

A high SAAR that achieves statistical significance (specifically, a SAAR value statistically significantly larger than 1.0) may indicate antimicrobial over-use. A SAAR that is not statistically different from 1.0 indicates antimicrobial use is equivalent to the referent population's antimicrobial use. A low SAAR that achieves statistical significance may indicate antimicrobial under-use. Please note, a SAAR alone is not a definitive measure of the appropriateness or judiciousness of antimicrobial use, and any SAAR may warrant further investigation. For example, a SAAR above 1.0 that does not achieve statistical significance may be associated with meaningful excess of antimicrobial use and further investigation may be needed. Also, a SAAR that is statistically different from 1.0 does not mean that further investigation will be productive.

SAARs can be produced by month, quarter, half year, or year or cumulative time periods. The SAAR report can be modified to show SAARs by a specific location or a subset of location types. However, keep in mind that SAARs can only be generated and/or modified to show data for the 17 select location types listed above in [Table 5](#).

### Rates:

As a supplement to the SAARs, rate tables showing the pooled mean rates and percentile distributions of specific antimicrobials for specific adult, pediatric and neonatal locations are available. Adult and pediatric SAAR location types can generate rates for antimicrobials predominantly used for extensively antimicrobial resistant bacteria. This rate table shows the antimicrobial days per 1,000 days present for a grouping of five specific drugs (listed in [Appendix E](#)) along with the pooled mean rate and percentile distributions for the 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, and 90<sup>th</sup> percentiles based on the 2017 baseline adult and pediatric AU data. Rates can also be generated for well baby and step down neonatal nurseries for select antimicrobial groupings. These rate tables show the antimicrobial days per 1,000 days present for specific antimicrobial groupings (listed in [Appendix E](#)) along with the pooled mean rate and percentile distributions for the 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, and 90<sup>th</sup> percentiles based on the 2018 baseline neonatal AU data.

Additionally, users can generate basic rate tables as incidence density rates of antimicrobial days per 1,000 days present stratified by patient care location and facility-wide inpatient. A rate of antimicrobial days per 100 admissions can also be generated for facility-wide inpatient only.



Default rate tables can be generated by antimicrobial category (specifically, antibacterial, antifungal, anti-influenza) and class (for example, aminoglycosides, carbapenems, cephalosporins) for the most recent month of data submitted or all months of data submitted for FacWideIN or each individual location. Modifications can be made to any rate table to show specific months or locations. Specific rate tables can also be modified to produce a rate per individual antimicrobial, select antimicrobials within the same class, and select antimicrobials within different classes.

### **Descriptive analysis:**

**Line Lists:** Line lists are the most customizable AU Option analysis report. The default line lists show the total antimicrobial days and the sub-stratification of routes of administration for each antimicrobial as well as the days present and admissions for each month and location of data submitted. Default line lists can be generated for the most recent month of data submitted or all months of data submitted, for FacWideIN or each individual location. Users can modify any line list to show specific months, locations, antimicrobials, and/or routes of administration. The line lists are the most helpful AU Option report when validating the data.

**Pie Charts & Bar Charts:** Pie charts and bar charts provide visualizations of the antimicrobial use within a facility. Default pie charts and bar charts can be generated for the most recent month of data submitted or all months of data submitted for FacWideIN or each individual location. There is also a bar chart that shows selected agent distribution by month.

All AU Option data analysis reports can be exported from NHSN in various formats (for example, CSV, SAS, and Microsoft Access).

### **NHSN Group Analysis:**

NHSN Group users can visualize and analyze AU data shared with them by member facilities using NHSN analysis reports. In addition to the Analysis Quick Reference Guides (QRGs) referenced in the Additional Analysis Resources section below, Groups can find Group-specific resources on the [NHSN Group Users](#) page.

### **Additional Analysis Resources**

Analysis QRGs are short 3-4 page documents that highlight how to modify and interpret NHSN analysis reports. QRGs are available for all AU Option analysis reports and can be found in the Antimicrobial Use and Resistance Module Reports section of the [Analysis Quick Reference Guide](#) page.

Additionally, users can find recorded training sessions and Quick Learn videos highlighting AU Option analysis reports in the Training section of the [AUR Module](#) page.



## References

1. Weiner LM, Webb AK, Limbago B, et al. Antimicrobial-resistant pathogens associated with healthcare-associated infections: summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2011-2014. *Infect Control Hosp Epidemiol* 2016;37:1288-1301.
2. Centers for Disease Control and Prevention. Antibiotic Resistance Threats in the United States, 2013. Available at: <https://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf>.
3. Davey P, Marwick CA, Scott CL, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. *Cochrane Database Syst Rev* 2017;2:CD003543.
4. Ansari F, Gray K, Nathwani D, et al. Outcomes of an intervention to improve hospital antibiotic prescribing; interrupted time series with segmented regression analysis. *J Antimicrob Chemother* 2003;52:842-8.
5. Solomon DH, Van Houten L, Glynn RJ. Academic detailing to improve use of broad-spectrum antibiotics at an academic medical center. *Arch Inter Med* 2001;161:1897-902.
6. Dellit TH, Owens RC, McGowan JE, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America Guidelines for Developing an Institutional Program to Enhance Antimicrobial Stewardship. *Clin Infect Dis* 2007;44:159-77.
7. National Healthcare Safety Network (NHSN) Patient Safety Component: Clinical Document Architecture. <http://www.cdc.gov/nhsn/cdaportal/index.html>
8. Schwartz DN, Evans RS, Camins B, et al. Deriving measures of intensive care unit antimicrobial use from computerized pharmacy data: methods, validation, and overcoming barriers. *Infect Control Hosp Epidemiol* 2011;32:472-80.
9. Polk RE, Fox C, Mahoney A, Letcavage J, MacDougall C. Measurement of adult Antibacterial Drug Use in 130 US Hospitals: Comparison of Defined Daily Dose and Days of Therapy. *Clin Infect Dis* 2007;44:664-70.
10. Kuster SP, Ledergerber B, Hintermann A, et al. Quantitative antibiotic use in hospitals: comparison of measurements, literature review, and recommendations for standards of reporting. *Infection* 2008; 6:549-59.
11. Berrington A. Antimicrobial prescribing in hospitals: be careful what you measure. *J Antimicrob Chemother* 2010;65:163-168.
12. CLSI. Analysis and Presentation of Cumulative Antimicrobial Susceptibility Test Data; Approved Guideline—Fourth Edition. CLSI document M39-A4. Wayne, PA: Clinical and Laboratory Standards Institute; 2014.



## **Appendix A. Table of Instructions: Antimicrobial Use Option**

<b>Data Field</b>	<b>Data Field Description</b>
Facility OID <sup>a</sup>	Required. Must be assigned to facility and included in the CDA data file prior to submission to NHSN.
Application OID <sup>b</sup>	Optional in years $\leq 2020$ . Required in 2021. Must be assigned to a vendor's software application and included in the AU CDA data file prior to submission to NHSN. The Application OID should be obtained by the software vendor and is distinct from the Facility OID.
SDS Validation ID	Optional in years $\leq 2020$ . Required in 2021. The Synthetic Data Set (SDS) Validation ID will be provided to the AU CDA vendor by the AUR Module Team upon confirmation that the AU Summary SDS Excel file passed validation as part of the AU SDS initiative. <sup>c</sup>
Vendor Software Name	Optional. Vendor software name is the name of the software application that generates the AU CDA file. NHSN collects this information to more effectively troubleshoot CDA files when needed.
Software Version	Optional. Software version is the version of the software application that generates the AU CDA file. NHSN collects this information to more effectively troubleshoot CDA files when needed.
Vendor Name	Optional. Vendor name is the name of the vendor that owns the software application that generates the AU CDA file. NHSN collects this information to more effectively troubleshoot CDA files when needed.
Month	Required. Record the 2-digit month during which the data were collected for this location.
Year	Required. Record the 4-digit year during which the data were collected for this location.
Location	Required. The patient care location for which the data are being uploaded.
Numerator: Antimicrobial days per month per location	Required. Antimicrobial days are defined as the aggregate sum of the days of therapy for which a <u>specific</u> antimicrobial was administered. These are required to be extracted from electronic medication administration record (eMAR) and/or bar coding medication record (BCMA). Antimicrobial days are collected for select antimicrobial agents (refer to <a href="#">Appendix B</a> ) and stratified by route of administration.
Denominator(s):	Required.
Days present	Days present are defined as risk for antimicrobial exposure per each day of the calendar month stratified by location. For patient care location-specific analyses, days present is calculated as the number of patients who were present for any portion of each day during a calendar month for a patient care location. For facility-wide inpatient analyses, days present are calculated as the number of patients who were present in an inpatient location within the facility for any portion of each day during a calendar month.
Admissions	Admissions are defined as the aggregate number of patients admitted to an inpatient location within the facility (facility-wide inpatient) starting on first day of each calendar month through the last day of the calendar month. In the AU Option, admissions are only reported for facility-wide inpatient.



- <sup>a</sup> Facilities interested in submitting data to NHSN via CDA must obtain a Facility OID (object identifier). More information on how to obtain an OID for your facility can be found on the [CDA Submission Support Portal](#).
- <sup>b</sup> Starting in 2021, AU CDA files will be required to include an Application OID (object identifier) as part of the AU Option Synthetic Data Set initiative. More information on how to obtain an Application OID can be found on the [Vendor \(Application\) Objected Identifier \(OID\)](#) page.
- <sup>c</sup> More detailed information about the AU Synthetic Data Set validation process can be found on the [CDA Submission Support Portal's Innovation Tools](#) page.





## Appendix B. List of Antimicrobials

Please note that mapping of standardized terminology (RXNORM) are provided in the Information Data Model (IDM) found in the [Antimicrobial Use Toolkit](#). The list of NHSN drug codes as well as the drug values used for the development of the CDA files can be found here: [Eligible Antimicrobials](#).

Antimicrobial Agent	Antimicrobial Category	Antimicrobial Class <sup>a</sup>	Antimicrobial Subclass <sup>a</sup>
AMANTADINE	Anti-influenza	M2 ion channel inhibitors	
AMIKACIN	Antibacterial	Aminoglycosides	
AMIKACIN LIPOSOMAL <sup>b</sup>	Antibacterial	Aminoglycosides	
AMOXICILLIN	Antibacterial	Penicillins	Aminopenicillin
AMOXICILLIN/CLAVULANATE	Antibacterial	B-lactam/ B-lactamase inhibitor combination	
AMPHOTERICIN B	Antifungal	Polyenes	
AMPHOTERICIN B LIPOSOMAL	Antifungal	Polyenes	
AMPICILLIN	Antibacterial	Penicillins	Aminopenicillin
AMPICILLIN/SULBACTAM	Antibacterial	B-lactam/ B-lactamase inhibitor combination	
ANIDULAFUNGIN	Antifungal	Echinocandins	
AZITHROMYCIN	Antibacterial	Macrolides	
AZTREONAM	Antibacterial	Monobactams	
BALOXAVIR MARBOXIL	Anti-influenza	Polymerase acidic endonuclease inhibitors	
CASPOFUNGIN	Antifungal	Echinocandins	
CEFACLOX	Antibacterial	Cephalosporins	Cephalosporin 2 <sup>nd</sup> generation
CEFADROXIL	Antibacterial	Cephalosporins	Cephalosporin 1 <sup>st</sup> generation
CEFAZOLIN	Antibacterial	Cephalosporins	Cephalosporin 1 <sup>st</sup> generation
CEFDINIR	Antibacterial	Cephalosporins	Cephalosporin 3 <sup>rd</sup> generation
CEFEPIME	Antibacterial	Cephalosporins	Cephalosporin 4 <sup>th</sup> generation
CEFIXIME	Antibacterial	Cephalosporins	Cephalosporin 3 <sup>rd</sup> generation
CEFOTAXIME	Antibacterial	Cephalosporins	Cephalosporin 3 <sup>rd</sup> generation
CEFOTETAN	Antibacterial	Cephalosporins	Cephameycin
CEFOXITIN	Antibacterial	Cephalosporins	Cephameycin
CEFPODOXIME	Antibacterial	Cephalosporins	Cephalosporin 3 <sup>rd</sup> generation
CEFPROZIL	Antibacterial	Cephalosporins	Cephalosporin 2 <sup>nd</sup> generation



Antimicrobial Agent	Antimicrobial Category	Antimicrobial Class <sup>a</sup>	Antimicrobial Subclass <sup>a</sup>
CEFTAROLINE	Antibacterial	Cephalosporins	Cephalosporins with anti-MRSA activity
CEFTAZIDIME	Antibacterial	Cephalosporins	Cephalosporin 3 <sup>rd</sup> generation
CEFTAZIDIME/ AVIBACTAM	Antibacterial	B-lactam/ B-lactamase inhibitor combination	
CEFTOLOZANE/ TAZOBACTAM	Antibacterial	B-lactam/ B-lactamase inhibitor combination	
CEFTRIAZONE	Antibacterial	Cephalosporins	Cephalosporin 3 <sup>rd</sup> generation
CEFUROXIME	Antibacterial	Cephalosporins	Cephalosporin 2 <sup>nd</sup> generation
CEPHALEXIN	Antibacterial	Cephalosporins	Cephalosporin 1 <sup>st</sup> generation
CHLORAMPHENICOL	Antibacterial	Phenicol	
CIPROFLOXACIN	Antibacterial	Fluoroquinolones	
CLARITHROMYCIN	Antibacterial	Macrolides	
CLINDAMYCIN	Antibacterial	Lincosamides	
COLISTIMETHATE	Antibacterial	Polymyxins	
COLISTIN <sup>c</sup>	Antibacterial	Polymyxins	
DALBAVANCIN	Antibacterial	Glycopeptides	Lipoglycopeptide
DAPTOMYCIN	Antibacterial	Lipopeptides	
DELAFLORACIN	Antibacterial	Fluoroquinolones	
DICLOXACILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins
DORIPENEM	Antibacterial	Carbapenems	
DOXYCYCLINE	Antibacterial	Tetracyclines	
ERAVACYCLINE	Antibacterial	Tetracyclines	Fluorocycline
ERTAPENEM	Antibacterial	Carbapenems	
ERYTHROMYCIN	Antibacterial	Macrolides	
ERYTHROMYCIN/ SULFISOXAZOLE	Antibacterial	Folate pathway inhibitors	
FIDAXOMICIN	Antibacterial	Macrocyclic	
FLUCONAZOLE	Antifungal	Azoles	
FOSFOMYCIN	Antibacterial	Fosfomycins	
GEMIFLOXACIN	Antibacterial	Fluoroquinolones	
GENTAMICIN	Antibacterial	Aminoglycosides	
IMIPENEM/ CILASTATIN	Antibacterial	Carbapenems	
ISAVUCONAZONIUM	Antifungal	Azoles	
ITRACONAZOLE	Antifungal	Azoles	



Antimicrobial Agent	Antimicrobial Category	Antimicrobial Class <sup>a</sup>	Antimicrobial Subclass <sup>a</sup>
LEVOFLOXACIN	Antibacterial	Fluoroquinolones	
LINEZOLID	Antibacterial	Oxazolidinones	
MEROPENEM	Antibacterial	Carbapenems	
MEROPENEM/ VABORBACTAM	Antibacterial	B-lactam/ B-lactamase inhibitor combination	
METRONIDAZOLE	Antibacterial	Nitroimidazoles	
MICAFUNGIN	Antifungal	Echinocandins	
MINOCYCLINE	Antibacterial	Tetracyclines	
MOXIFLOXACIN	Antibacterial	Fluoroquinolones	
NAFCILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins
NITROFURANTOIN	Antibacterial	Nitrofurans	
OMADACYCLINE	Antibacterial	Tetracyclines	Aminomethylcycline
ORITAVANCIN	Antibacterial	Glycopeptides	Lipoglycopeptide
OSELTAMIVIR	Anti-influenza	Neuraminidase inhibitors	
OXACILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins
PENICILLIN G	Antibacterial	Penicillins	Penicillin
PENICILLIN V	Antibacterial	Penicillins	Penicillin
PERAMIVIR	Anti-influenza	Neuraminidase inhibitors	
PIPERACILLIN	Antibacterial	Penicillins	Ureidopenicillin
PIPERACILLIN/ TAZOBACTAM	Antibacterial	B-lactam/ B-lactamase inhibitor combination	
PLAZOMICIN	Antibacterial	Aminoglycosides	
POLYMYXIN B	Antibacterial	Polymyxins	
POSACONAZOLE	Antifungal	Azoles	
QUINUPRISTIN/ DALFOPRISTIN	Antibacterial	Streptogramins	
RIFAMPIN	Antibacterial	Rifampin	
RIMANTADINE	Anti-influenza	M2 ion channel inhibitors	
SULFAMETHOXAZOLE/ TRIMETHOPRIM	Antibacterial	Folate pathway inhibitors	
TEDIZOLID	Antibacterial	Oxazolidinones	
TELAVANCIN	Antibacterial	Glycopeptides	Lipoglycopeptides
TETRACYCLINE	Antibacterial	Tetracyclines	



Antimicrobial Agent	Antimicrobial Category	Antimicrobial Class <sup>a</sup>	Antimicrobial Subclass <sup>a</sup>
TIGECYCLINE	Antibacterial	Glycylcyclines	
TINIDAZOLE	Antibacterial	Nitroimidazoles	
TOBRAMYCIN	Antibacterial	Aminoglycosides	
VANCOMYCIN	Antibacterial	Glycopeptides	Glycopeptide
VORICONAZOLE	Antifungal	Azoles	
ZANAMIVIR	Anti-influenza	Neuraminidase inhibitors	

<sup>a</sup> Adapted from CLSI January 2014<sup>12</sup>

<sup>b</sup> While reported separately in the CDA file, Amikacin Liposomal will be rolled up and reported in the NHSN AU Option analysis reports with Amikacin.

<sup>c</sup> While reported separately in the CDA file, Colistin will be rolled up and reported in the NHSN AU Option analysis reports with Colistimethate.



## Appendix C. Example Calculations of Antimicrobial Days

### Example 1. Example eMAR and Calculation of Antimicrobial Days

This example illustrates the antimicrobial days calculation for a patient receiving 1 gram Meropenem intravenously every 8 hours and 1000mg Amikacin intravenously every 24 hours in the medical ward. Table 1 provides an example of administered doses for this patient documented in eMAR. Table 2 illustrates the calculation of Meropenem and Amikacin days by antimicrobial (total) and stratified by route of administration based on the administered doses of Meropenem and Amikacin documented in eMAR. Table 3 illustrates the contribution of this patient's antimicrobial days to the aggregate monthly report per patient care location.

**Table 1. Example eMAR for patient housed in Medical Ward**

Medical Ward	Monday December 28	Tuesday December 29	Wednesday December 30
Meropenem 1g intravenously every 8 hours	Given: 2300	Given: 0700 Given: 1500 Given: 2300	Given: 0700
Amikacin 1000mg intravenously every 24 hours	Given: 2300	Given: 2300	

**Table 2. Example of calculation of antimicrobial days**

Calculation	Monday December 28	Tuesday December 29	Wednesday December 30
Drug-specific Antimicrobial Days (total)	Meropenem Days = 1 Amikacin Days = 1	Meropenem Days = 1 Amikacin Days = 1	Meropenem Days = 1 Amikacin Days = 0
Drug-specific Antimicrobial Days Stratified by Route of Administration	Meropenem Days (IV) = 1 Amikacin Days (IV) = 1	Meropenem Days <sup>a</sup> (IV) = 1 Amikacin Days (IV) = 1	Meropenem Days (IV) = 1 Amikacin Days (IV) = 0

<sup>a</sup> Please note, despite receiving three administrations of Meropenem on December 29, the patient only contributed one total Meropenem antimicrobial day per calendar day.

**Table 3. Example of antimicrobial days per month per patient care location**

Month/ Year- Location	Antimicrobial Agent	Drug-specific Antimicrobial Days				
		Total	IV	IM	Digestive	Respiratory
December Medical Ward	Meropenem	3	3	0	0	0
December Medical Ward	Amikacin	2	2	0	0	0



## Example 2. Differences in Calculations for Patient Care Location and Facility-Wide Inpatient for a Patient Transferred Between Patient Care Locations

This example illustrates the antimicrobial days calculation for a patient receiving 1 gram Vancomycin every 8 hours that was transferred from the MICU to a medical ward on December 1. Table 1 provides an example of doses documented in eMAR administered to this patient in the MICU and Medical Ward. Table 2 illustrates the calculation of Vancomycin days by antimicrobial (total) and stratified by route of administration based on the administered doses of Vancomycin documented in eMAR. One Vancomycin day is attributed to both the MICU and Medical Ward locations since administrations took place in both units during the calendar day. Further, despite receiving two administrations of Vancomycin in the Medical Ward, the patient only attributes one total Vancomycin antimicrobial day for the Medical Ward per calendar day. Table 3 shows the contribution of this patient's Vancomycin days to the aggregate monthly report per location and facility-wide inpatient. Note that while the patient attributes one total Vancomycin day for both the MICU and the Medical Ward on December 1, only one total Vancomycin day can be attributed to the FacWideIN count that calendar day.

**Table 1. Example eMAR for patient transferred from MICU to Medical Ward on December 1**

eMAR	Tuesday December 1 Location: MICU	Tuesday December 1 Location: Medical Ward
Vancomycin 1g intravenously every 8 hours	Given: 0700	Given: 1500 Given: 2300

**Table 2. Example of calculation of antimicrobial days for December 1**

Calculation	Tuesday December 1 Location: MICU	Tuesday December 1 Location: Medical Ward
Drug-specific Antimicrobial Days (total)	Vancomycin Days = 1	Vancomycin Days = 1
Drug-specific Antimicrobial Days Stratified by Route of Administration	Vancomycin Days (IV) = 1	Vancomycin Days (IV) = 1

**Table 3. Example of antimicrobial days per month per patient care location and facility-wide inpatient contributed from December 1**

Month/ Year- Location	Antimicrobial Agent	Drug-specific Antimicrobial Days				
		Total	IV	IM	Digestive	Respiratory
December MICU	Vancomycin	1	1	0	0	0
December Medical Ward	Vancomycin	1	1	0	0	0
December Facility-wide inpatient	Vancomycin	1	1	0	0	0





### Example 3. Calculation of Antimicrobial Days for a Patient Care Location when a Patient Admission extends over Two Different Months

This example illustrates the antimicrobial days calculation for a patient receiving 1 gram Ceftriaxone intravenously every 24 hours for two days in the Surgical Ward (but spanning different months). Table 1 provides an example of administered doses for this patient documented in eMAR. Table 2 illustrates the calculation of Ceftriaxone days by antimicrobial (total) and stratification of route of administration based upon the administered doses of Ceftriaxone documented in eMAR. Table 3 illustrates the contribution of this patient's Ceftriaxone days to the aggregate monthly report per patient care location.

Note: The patient's FacWideIN admission (denominator) would be attributed to the month the patient was first admitted to an inpatient location within the facility. In the scenario highlighted here, the patient would attribute 1 admission to December and no admission to January (specifically, the patient would not be counted in the total January admissions count). The patient would continue to contribute one day present for each day the patient was in the location/facility.

**Table 1. Example eMAR for patient housed in Surgical Ward**

eMAR	Thursday December 31 Location: Surgical Ward	Friday January 1 Location: Surgical Ward
Ceftriaxone 1g intravenously every 24 hours	Given: 0800	Given: 0800

**Table 2. Example of calculation of antimicrobial days**

Calculation	Thursday December 31 Location: Surgical Ward	Friday January 1 Location: Surgical Ward
Drug-specific Antimicrobial Days (total)	Ceftriaxone Day = 1	Ceftriaxone Day = 1
Drug-specific Antimicrobial Days Stratified by Route of Administration	Ceftriaxone Day (IV) = 1	Ceftriaxone Day (IV) = 1

**Table 3. Example of antimicrobial days per month per patient care location**

Month/ Year- Location	Antimicrobial Agent	Drug-specific Antimicrobial Days				
		Total	IV	IM	Digestive	Respiratory
December/ Surgical Ward	Ceftriaxone	1	1	0	0	0
January/ Surgical Ward	Ceftriaxone	1	1	0	0	0



## Appendix D: List of SAARs<sup>a</sup>

**Table 1. Adult SAARs**

SAAR Antimicrobial Agent Category	Locations	SAAR Type in NHSN
All antibacterial agents	All Adult SAAR Locations	Adult_All-Antibacterial_2017
Broad spectrum antibacterial agents predominantly used for hospital-onset infections	Adult Medical, Medical-Surgical, Surgical ICUs	Adult_BSHO_ICU_2017
	Adult Medical, Medical-Surgical, Surgical Wards	Adult_BSHO_Ward_2017
	Adult Step Down Units	Adult_BSHO_Step_2017
	Adult General Hematology-Oncology Wards	Adult_BSHO_ONC_2017
Broad spectrum antibacterial agents predominantly used for community-acquired infections	Adult Medical, Medical-Surgical, Surgical ICUs	Adult_BSCA_ICU_2017
	Adult Medical, Medical-Surgical, Surgical Wards	Adult_BSCA_Ward_2017
	Adult Step Down Units	Adult_BSCA_Step_2017
	Adult General Hematology-Oncology Wards	Adult_BSCA_ONC_2017
Antibacterial agents predominantly used for resistant Gram-positive infections (e.g., MRSA)	Adult Medical, Medical-Surgical, Surgical ICUs	Adult_GramPos_ICU_2017
	Adult Medical, Medical-Surgical, Surgical Wards	Adult_GramPos_Ward_2017
	Adult Step Down Units	Adult_GramPos_Step_2017
	Adult General Hematology-Oncology Wards	Adult_GramPos_ONC_2017
Narrow spectrum beta-lactam agents	Adult Medical, Medical-Surgical, Surgical ICUs	Adult_NSBL_ICU_2017
	Adult Medical, Medical-Surgical, Surgical Wards	Adult_NSBL_Ward_2017
	Adult Step Down Units	Adult_NSBL_Step_2017
	Adult General Hematology-Oncology Wards	Adult_NSBL_ONC_2017
Antibacterial agents posing the highest risk for CDI	Adult Medical, Medical-Surgical, Surgical ICUs	Adult_CDI_ICU_2017
	Adult Medical, Medical-Surgical, Surgical Wards	Adult_CDI_Ward_2017
	Adult Step Down Units	Adult_CDI_Step_2017
	Adult General Hematology-Oncology Wards	Adult_CDI_ONC_2017
Antifungal agents predominantly used for invasive candidiasis	Adult Medical, Medical-Surgical, Surgical ICUs	Adult_Antifungal_ICU_2017
	Adult Medical, Medical-Surgical, Surgical Wards	Adult_Antifungal_Ward_2017
	Adult Step Down Units	Adult_Antifungal_Step_2017
	Adult General Hematology-Oncology Wards	Adult_Antifungal_ONC_2017



**Table 2: Pediatric SAARs**

SAAR Antimicrobial Agent Category	Locations	SAAR Type in NHSN
All antibacterial agents	All Pediatric locations	Ped_All-Antibacterial_2017
Broad spectrum antibacterial agents predominantly used for hospital-onset infections	Pediatric Medical and Medical-Surgical ICUs	Ped_BSHO_ICU_2017
	Pediatric Medical, Medical-Surgical, Surgical Wards	Ped_BSHO_Ward_2017
Broad spectrum antibacterial agents predominantly used for community-acquired infections	Pediatric Medical and Medical-Surgical ICUs	Ped_BSCA_ICU_2017
	Pediatric Medical, Medical-Surgical, Surgical Wards	Ped_BSCA_Ward_2017
Antibacterial agents predominantly used for resistant Gram-positive infections (e.g., MRSA)	Pediatric Medical and Medical-Surgical ICUs	Ped_GramPos_ICU_2017
	Pediatric Medical, Medical-Surgical, Surgical Wards	Ped_GramPos_Ward_2017
Narrow spectrum beta-lactam agents	Pediatric Medical and Medical-Surgical ICUs	Ped_NSBL_ICU_2017
	Pediatric Medical, Medical-Surgical, Surgical Wards	Ped_NSBL_Ward_2017
Azithromycin	Pediatric Medical and Medical-Surgical ICUs	Ped_Azith_ICU_2017
	Pediatric Medical, Medical-Surgical, Surgical Wards	Ped_Azith_Ward_2017
Antibacterial agents posing the highest risk for CDI	Pediatric Medical and Medical-Surgical ICUs	Ped_CDI_ICU_2017
	Pediatric Medical, Medical-Surgical, Surgical Wards	Ped_CDI_Ward_2017
Antifungal agents predominantly used for invasive candidiasis	Pediatric Medical and Medical-Surgical ICUs	Ped_Antifungal_ICU_2017
	Pediatric Medical, Medical-Surgical, Surgical Wards	Ped_Antifungal_Ward_2017

**Table 3: Neonatal SAARs**

SAAR Antimicrobial Agent Category	Locations	SAAR Type in NHSN
All antibacterial agents	Step down Neonatal Nursery, Neonatal Critical Care (Level II/III), Neonatal Critical Care (Level III), Neonatal Critical Care (Level IV)	Neo_All-antibacterial_2018
Vancomycin predominantly used for treatment of late-onset sepsis	Step down Neonatal Nursery, Neonatal Critical Care (Level II/III), Neonatal Critical Care (Level III), Neonatal Critical Care (Level IV)	Neo_Vancomycin_2018



SAAR Antimicrobial Agent Category	Locations	SAAR Type in NHSN
Broad spectrum antibacterial agents predominantly used for hospital-onset infections	Step down Neonatal Nursery, Neonatal Critical Care (Level II/III), Neonatal Critical Care (Level III), Neonatal Critical Care (Level IV)	Neo_BSHO_2018
Third generation Cephalosporins	Step down Neonatal Nursery, Neonatal Critical Care (Level II/III), Neonatal Critical Care (Level III), Neonatal Critical Care (Level IV)	Neo_3G-Cephalosporins_2018
Ampicillin predominantly used for treatment of early-onset sepsis	Step down Neonatal Nursery, Neonatal Critical Care (Level II/III), Neonatal Critical Care (Level III), Neonatal Critical Care (Level IV)	Neo_Ampicillin_2018
Aminoglycosides predominantly used for treatment of early-onset and late-onset sepsis	Step down Neonatal Nursery, Neonatal Critical Care (Level II/III), Neonatal Critical Care (Level III), Neonatal Critical Care (Level IV)	Neo_Aminoglycosides_2018
Fluconazole predominantly used for candidiasis	Neonatal Critical Care (Level II/III), Neonatal Critical Care (Level III), Neonatal Critical Care (Level IV)	Neo_Fluconazole_2018

<sup>a</sup> Users interested in the 2014 baseline SAAR details can find them in this [document](#).



## **Appendix E: Antimicrobial Groupings for SAAR & Rate Table Calculations<sup>a</sup>**

### **Adult SAAR Antimicrobial Agent Categories**

#### **Adult All antibacterial agents**

All antibacterial agents in the AUR protocol except:

- DELAFLOXACIN
- MEROPENEM/VABORBACTAM
- PIPERACILLIN
- TICARCILLIN/CLAVULANATE

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

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

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

- CEFACLOX
- CEFDINIR
- CEFIXIME
- CEFOTAXIME
- CEFPODOXIME
- CEFPROZIL
- CEFTRIAXONE
- CIPROFLOXACIN
- CEFUROXIME
- ERTAPENEM
- GEMIFLOXACIN
- LEVOFLOXACIN
- MOXIFLOXACIN

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

- CEFTAROLINE
- DALBAVANCIN
- DAPTOMYCIN
- LINEZOLID



- ORITAVANCIN
- QUINUPRISTIN/DALFOPRISTIN
- 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.

- CEFDINIR
- CEFEPIME
- CEFIXIME
- CEFOTAXIME
- CEFPODOXIME
- CEFTAZIDIME
- CEFTRIAZONE
- CIPROFLOXACIN
- CLINDAMYCIN
- GEMIFLOXACIN
- LEVOFLOXACIN
- MOXIFLOXACIN

**Adult Antifungal agents predominantly used for invasive candidiasis**

- ANIDULAFUNGIN
- CASPOFUNGIN
- FLUCONAZOLE
- MICAFUNGIN





## Adult Rate Table

### Adult Antibacterial agents predominantly used for extensively antibiotic resistant bacteria

- CEFTAZIDIME/AVIBACTAM
- CEFTOLOZANE/TAZOBACTAM
- COLISTIMETHATE (IV only)
- POLYMYXIN B (IV only)
- TIGECYCLINE

## Pediatric SAAR Antimicrobial Agent Categories

### Pediatric All antibacterial agents

All antibacterial agents in the AUR protocol except:

- DELAFLOXACIN
- MEROPENEM/VABORBACTAM
- PIPERACILLIN
- TICARCILLIN/CLAVULANATE

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

- AMIKACIN (IV only)
- AZTREONAM (IV only)
- CEFEPIME
- CEFTAZIDIME
- CIPROFLOXACIN
- DORIPENEM
- ERTAPENEM
- GEMIFLOXACIN
- 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
- CEFACLOX
- CEFDINIR
- CEFIXIME
- CEFOTAXIME
- CEFPODOXIME
- CEFPROZIL
- CEFTRIAZONE



- CEFUROXIME

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

- CEFTAROLINE
- CLINDAMYCIN
- DALBAVANCIN
- DAPTOMYCIN
- LINEZOLID
- ORITAVANCIN
- QUINUPRISTIN/DALFOPRISTIN
- 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.

- CEFDINIR
- CEFEPIME
- CEFIXIME
- CEFOTAXIME
- CEFPODOXIME
- CEFTAZIDIME
- CEFTRIAZONE
- CLINDAMYCIN
- CIPROFLOXACIN
- GEMIFLOXACIN
- LEVOFLOXACIN
- MOXIFLOXACIN



**Pediatric Antifungal agents predominantly used for invasive candidiasis**

- ANIDULAFUNGIN
- CASPOFUNGIN
- FLUCONAZOLE
- MICAFUNGIN

**Pediatric Rate Table**

**Pediatric Antibacterial agents predominantly used for extensively antibiotic resistant bacteria**

- CEFTAZIDIME/AVIBACTAM
- CEFTOLOZANE/TAZOBACTAM
- COLISTIMETHATE (IV only)
- POLYMYXIN B (IV only)
- TIGECYCLINE

**Neonatal SAAR Antimicrobial Agent Categories**

**Neonatal All antibacterial agents**

All antibacterial agents in the AUR protocol except:

- CHLORAMPHENICOL
- DALBAVACIN
- DELAFLOXICIN
- DORIPENEM
- DOXYCYCLINE
- ERYTHROMYCIN/SULFISOXAZOLE
- GEMIFLOXACIN
- MEROPENEM/VABORBACTAM
- MINOCYCLINE
- ORITIVANCIN
- PIPERACILLIN
- TETRACYCLINE
- TIGECYCLINE

**Neonatal Vancomycin predominantly used for treatment of late-onset sepsis**

- VANCOMYCIN (IV only)

**Neonatal Broad spectrum antibacterial agents predominantly used for hospital-onset infections**

- 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)
- CEFTRIAZONE (IV only)

**Neonatal Ampicillin predominantly used for treatment of early-onset sepsis**

- AMPICILLIN (IV only)

**Neonatal Aminoglycosides predominantly used for treatment of early-onset and late-onset sepsis**

- AMIKACIN (IV only)
- GENTAMICIN (IV only)
- TOBRAMYCIN (IV only)

**Neonatal Fluconazole predominantly used for candidiasis**

- FLUCONAZOLE (IV and oral only)

**Neonatal Rate Tables**

**Fluconazole predominantly used for candidiasis used in Level II step down neonatal nurseries**

- FLUCONAZOLE

**Ampicillin predominantly used for treatment of early-onset sepsis used in well baby nurseries**

- AMPICILLIN (IV only)

**Aminoglycosides predominantly used for treatment of early-onset and late-onset sepsis used in well baby nurseries**

- AMIKACIN (IV Only)
- GENTAMICIN (IV Only)
- TOBRAMYCIN (IV Only)

<sup>a</sup> Users interested in the 2014 baseline SAAR details can find them in this [document](#).



## 2. Antimicrobial Resistance (AR) Option

### Introduction

The proportion of isolates resistant to specific antimicrobial agents is a common measure of antimicrobial resistance. Proportion resistant (%R) can aid in clinical decision making (hospital antibiograms) and assessing the impact of transmission prevention and antimicrobial stewardship success, although the measure may not be very sensitive to measuring success of short-term efforts. Proportion resistant also facilitates local or regional assessment of progression or improvement of a particular resistance problem to guide local or regional transmission prevention efforts. Validity of local and regional assessments of the magnitude of a particular resistance phenotype can be improved by using standardized methodology for aggregating proportion resistant.

### Objectives:

1. Facilitate antimicrobial resistance data evaluation using a standardized approach to:
  - a. Provide local practitioners with an improved awareness of a variety of antimicrobial resistance problems to aid in clinical decision making and prioritize transmission prevention efforts.
  - b. Provide facility-specific measures in context of a regional and national perspective (specifically, benchmarking) that can inform decisions to accelerate transmission prevention efforts and reverse propagation of emerging or established resistant pathogens.
2. Allow regional and national assessment of antimicrobial resistant organisms of public health importance, including ecologic and infection burden assessment.

### Methodology:

The AR Option reports antimicrobial resistance data as a proportion.<sup>1</sup> The proportion resistant is defined as the number of resistant isolates divided by the number of isolates tested for the specific antimicrobial agent being evaluated. For each facility, the numerator (specifically, number of resistant isolates) is derived from isolate-level reports submitted. The ultimate source of the isolate data included in these reports is the laboratory information system (LIS). Laboratory results data from the electronic health record system (EHRs) can be used to populate the AR Option numerator records submitted to NHSN in healthcare settings where the LIS is directly connected to the EHRs. The AR Option obtains denominators of patient days and admissions from the ADT system (or similar system that allows for electronic access of required data elements). The sections below further define the numerator and denominator, which must adhere to the data format prescribed by the Health Level 7 (HL7) [CDA Implementation Guide](#) developed by the CDC and HL7.<sup>2</sup> Manual data entry is not available for the AR Option.

### Settings:

All inpatient facilities (for example, general acute care hospitals, critical access hospitals, children's hospitals, oncology hospitals, long term acute care hospitals, and inpatient rehabilitation facilities) enrolled in NHSN and using the Patient Safety Component can participate in the AR Option. Participating facilities must be able to collect the numerator and



denominator data electronically and upload those data into NHSN using the required CDA specifications. NHSN does not currently support AR Option data submission from long term care facilities (specifically, skilled nursing facilities and nursing homes) nor outpatient dialysis facilities.

NHSN strongly encourages reporting specimens at each facility from all NHSN defined inpatient locations (including inpatient procedural areas like operating rooms) and three select outpatient locations: Emergency Department (ED), Pediatric ED, and 24-hour Observation Area. The AR Option does not accept specimens collected in other outpatient location types, such as outpatient clinics. The denominators of patient days and admissions are only reported at the facility-wide inpatient level (FacWideIN). Denominator data are not reported for outpatient locations. Previous experience with AUR Module implementation suggests that reporting from all NHSN patient care locations is easier than reporting from selected locations.

### **Requirements:**

#### Each month:

1. The facility must indicate they plan to submit AR Option data on the [\*Patient Safety Monthly Reporting Plan\*](#).
  - a. The facility must add FacWideIN to the plan to report AR Option data from inpatient locations. Individual inpatient locations should not be listed in the AR Option plan.
  - b. The facility must add each outpatient location separately to report AR Option data from the three select outpatient locations types.
2. The facility must report two record types for each month of surveillance.
  - a. One event file for each isolate-based report.
    - i. Isolate is defined as a population of a single organism observed in a culture obtained from a patient specimen.
    - ii. Each AR Option event file contains the specific location of specimen collection.
  - b. One summary file for the FacWideIN denominator data report.

NHSN recommends AR Option data be submitted to NHSN for a given calendar month by the end of the subsequent calendar month. However, facilities should wait at least seven calendar days following the end of the month before submitting data to ensure the lab completed all susceptibility testing and reported results back to the EHRs.

#### Isolate-based report

The facility must report all required data each month for each eligible isolate-based report (See [\*Appendix F\*](#)). The facility should only consider specimens collected in an inpatient or select outpatient location (ED, pediatric ED, and 24-hour observation) for eligibility. Additionally, the facility should only report specimens to the AR Option with susceptibility testing. For example, if a facility isolates *Candida albicans* from a urine specimen but does not perform susceptibility testing on that isolate, the isolate is not eligible for reporting to the AR Option.





The facility should report all eligible isolates that meet the reporting guidelines outlined in this protocol to NHSN regardless of the antimicrobial resistance of the isolated organism. This means that even isolates that are susceptible to all required antimicrobials are eligible to be reported to the AR Option. Additionally, isolates in which all of the *NHSN required* antimicrobials were not tested, but at least one non-required drug was tested, are eligible to be reported into NHSN. For example, if a facility tested a *Staphylococcus aureus* isolate for the non-required drug Telithromycin and none of the other 26 NHSN required antimicrobials were tested, that isolate would still be considered eligible for reporting to the AR Option. This should be consistent with CLSI M39 Guidance on reporting cumulative susceptibility test results. Non-culture based organism identification results (for example, T2 Magnetic Resonance [T2MR] or Karius Test) should not be submitted.

Two distinct events should be reported on the basis of specimens obtained in inpatient and select outpatient locations with susceptibility testing performed:

1. **Each** eligible organism isolated from an invasive source (blood or cerebrospinal fluid [CSF]) per patient, per 14 day period even across calendar months:
  - a. There should be 14 days with no positive culture result from the laboratory for the patient and specific organism before the facility enters another invasive source AR Event into NHSN for the patient and specific organism. NOTE: The date of specimen collection is considered Day 1.
  - b. After >14 days have passed with no positive culture results for that specific organism, the facility can report another positive culture from an invasive source with that specific organism as an AR Event. For example, if a facility obtained a positive blood culture from a patient on January 1, the earliest another invasive specimen could be reported to NHSN for that same patient and organism would be January 15 (assuming there were no positive blood or CSF cultures in the interim).
2. The **first** eligible organism isolated from any eligible non-invasive culture source (lower respiratory or urine), per patient, per month.
  - a. Only one AR event is allowed per calendar month for the same patient/organism for lower respiratory or urine specimens.

Note: The AR Option 14 day rule starts with the day of specimen collection and applies only to those specimens collected in an inpatient location or select outpatient location (ED, pediatric ED, or 24-hour observation area) in the reporting facility. Outpatient locations other than the ED, pediatric ED, and 24-hour observation area (for example, wound clinic or outpatient laboratory) should not be included in the 14 day rule. Further, cultures obtained while the patient was at *another* healthcare facility should not be included in the 14 day calculations.

A. Eligible organisms include:

- All *Acinetobacter* species
- *Candida albicans*
- *Candida auris*
- *Candida glabrata*
- *Candida parapsilosis*



- *Candida tropicalis*
- *Citrobacter amalonaticus*
- *Citrobacter freundii*
- *Citrobacter koseri* (*Citrobacter diversus*)
- All *Enterobacter* species
- *Enterococcus faecalis*
- *Enterococcus faecium*
- *Enterococcus* spp. (when not specified to the species level)
- *Escherichia coli*
- *Klebsiella aerogenes* (*Enterobacter aerogenes*)
- *Klebsiella oxytoca*
- *Klebsiella pneumoniae*
- *Morganella morganii*
- *Proteus mirabilis*
- *Proteus penneri*
- *Proteus vulgaris*
- *Pseudomonas aeruginosa*
- *Serratia marcescens*
- *Staphylococcus aureus*
- *Stenotrophomonas maltophilia*
- *Streptococcus agalactiae* (Group B *Streptococcus*)
- *Streptococcus pneumoniae*

Facilities and vendors should refer to the Information Data Model (IDM) found in the [Antimicrobial Resistance Toolkit](#) for the complete list of eligible organisms for AR Option reporting and their associated SNOMED codes. Facilities should only report those organisms listed with an “X” in the ARO Pathogen column of the Pathogen Codes tab.

## B. Specimen Sources

Eligible specimen source groups include blood, CSF, urine, and lower respiratory. Facilities and vendors should refer to the IDM found in the [Antimicrobial Resistance Toolkit](#) for the complete list of eligible specimen sources and their associated SNOMED codes. Facilities should only report those SNOMED codes listed in the AR Specimen Source value set on the Specimen Source tab in the IDM. Do not include SNOMED children specimen types unless specifically listed. Wound specimens are not eligible for reporting into the AR Option.

1. Eligible invasive specimen sources include cerebrospinal fluid (CSF) and blood specimens. ([Table 1](#))

Note: Report blood or CSF cultures growing the same eligible specific organism (genus and species or genus only if the species has not been identified) only if the patient had no positive blood or CSF culture result with that specific organism (genus and species or



genus only if the species has not been identified) within the last 14 days, even across calendar months.

2. Eligible non-invasive specimen sources include lower respiratory (for example, sputum, endotracheal, bronchoalveolar lavage) and urine specimens.

**Table 1: Example of 14 day rule for a specific organism from a single patient in an inpatient location**

Date	Lab Result	Reported to NHSN?	Justification
January 1	<i>Staphylococcus aureus</i> isolated from blood culture	Yes	Patient's first blood culture of inpatient admission; <i>Staphylococcus aureus</i> is isolated; facility reports AR Event into NHSN.
January 4	<i>Staphylococcus aureus</i> isolated from blood culture	No	It has been less than 14 days since the last positive culture (January 1) from the patient isolating <i>Staphylococcus aureus</i> .
January 16	<i>Staphylococcus aureus</i> isolated from CSF culture	No	It has been less than 14 days since the last positive culture (January 4) from the patient isolating <i>Staphylococcus aureus</i> .
January 31	<i>Staphylococcus aureus</i> isolated from blood culture	Yes	It has more than 14 days since the last positive culture (January 16) from the patient isolating <i>Staphylococcus aureus</i> ; facility reports AR Event into NHSN.

The facility should evaluate all isolate test results using either the algorithm in [Figure 1](#) (Invasive specimens) or [Figure 2](#) (Non-invasive specimens) to determine reportable AR events for each calendar month.

- For eligible invasive specimens, there should be 14 days with no positive culture result from the laboratory for the patient and specific organism before the facility enters another invasive source AR Event into NHSN for the patient and specific organism ([Figure 1](#)). Based on the 14 day rule, at a maximum, a patient would have no more than three invasive isolates per specific organism reported per month.
- For eligible non-invasive specimens, the facility should report all first non-invasive isolates (chronologically) per patient, per month, per organism as an AR Event ([Figure 2](#)).

### C. Required Data

Required data include data available from the LIS, EHRs, and administrative data systems. The set of variables for each isolate consists of a variable to identify the NHSN facility, specimen-/patient-related data, and antimicrobial susceptibility data as outlined below.



For additional information on each variable please see [Appendix G](#).

- Facility identifier
  - Unique NHSN Facility ID (Object Identifier [OID] is used in the CDA)
- Specimen-/Patient-related data
  - Patient identifier
  - Date of birth
  - Gender
  - Date admitted to facility (use the encounter date if event occurred in outpatient location)
  - Specimen collection date
  - Specimen source
  - Location code (mapped to CDC location codes)
  - Isolate identifier (unique isolate ID in the electronic laboratory report)
  - Organism ([Appendix F](#))
- Antimicrobial susceptibility data
  - Antimicrobial ([Appendix F](#))
  - Penicillin-binding protein 2a-agglutination (PBP2a) (required only if *Staphylococcus aureus*)
  - Polymerase chain reaction (PCR) *mec*-gene (required only if *Staphylococcus aureus*)
  - E-test sign
  - E-test value & unit of measure
  - Interpretation of E-test
  - Minimum Inhibitory Concentration (MIC) sign
  - MIC value & unit of measure
  - Interpretation of MIC test
  - Disk diffusion (Kirby-Bauer or KB) test sign
  - Disk diffusion (KB) test value & unit of measure
  - Interpretation of disk diffusion (KB) test
  - Final interpretation result

Note: While many of these fields are required in the CDA report, facilities unable to electronically obtain the results of the individual laboratory tests (specifically, E-test, MIC, Disk diffusion [KB]) may still report AR Option data by using “NA” to indicate “Not Tested” for these specific tests as long as the final interpretation result can be provided for each antimicrobial tested. Facilities unable to electronically obtain the results of the PBP2a-agglutination and/or PCR *mec*-gene tests for *Staphylococcus aureus* may report “Unknown” for these specific tests. Facilities should not employ manual means of data collection to report AR Option data to NHSN.



#### D. Reporting Guidelines

- Interpretation of test results (E-test, MIC test, Disk diffusion [KB] test) includes the following results:
  - S = Susceptible
  - S-DD = Susceptible-Dose Dependent
  - I = Intermediate
  - R = Resistant
  - NS = Non-Susceptible
  - NA = Not Tested
    - Note: After upload into NHSN, Not Tested values appear as “N”.
  - Specific to Gentamicin and Streptomycin results for *Enterococcus* testing:
    - S = Susceptible/Synergistic
    - R = Resistant/Not Synergistic
- Facilities should only report final or corrected susceptibility testing to NHSN. No preliminary laboratory results should be used for NHSN AR Option reporting.
- In circumstances where different breakpoints are required, rely on the specimen source to determine which susceptibility results to report.
  - If the specimen source is CSF, report the meningitis breakpoint susceptibility.
  - If the specimen source is blood, urine, or lower respiratory, report the non-meningitis breakpoint susceptibility.

#### E. Removal of Same Day Duplicates

Multiple isolates of the same organism from the same specimen may produce conflicting results. Facilities should only report one isolate to NHSN, retaining the unique nature of the test results. Facilities must follow the rules listed below to ensure removal of duplicate isolate reports. Duplicates are defined as same species or genus, when identification to species level is not provided, isolated from the same source type (specifically, invasive or non-invasive) from the same patient on the same day.

Select the isolate to report to NHSN based on these rules (see [Figure 3](#)):

- For invasive source isolate selection, CSF isolates should be selected over blood isolates.
- For non-invasive source isolate selection, lower respiratory isolates should be selected over urine isolates.
- Eliminate isolates on same day without susceptibility test results as only isolates with complete/final laboratory testing should be reported to NHSN.
- Do not merge test results across multiple isolates (specifically, don’t summarize results across different isolates tested on same day).
- If two isolates from the same day have conflicting susceptibilities to the panel of antimicrobials tested, report the isolate with the most resistant final interpretation (NS > R > I > S-DD > S > NA). If susceptibility results of both isolates were validated by the lab but the lab did not provide a final interpretation, report the isolate with the higher amount of drug resistance based on the number of antimicrobials testing “NS”



- or “R”. If two or more isolates have the same number of antimicrobials testing “NS” or “R”, report the isolate that was the first entered into the LIS.
  - For example, a facility isolated *Candida albicans* from two blood specimens collected from the same patient on the same calendar day and the susceptibility results from both isolates were validated by the lab. The first isolate tested “R” to three of the eight antimicrobials and the second isolate tested “R” to four of the eight antimicrobials. The facility should report the second isolate to NHSN because it showed the higher amount of resistance.
- If the lab performs the same test on the same isolate but the two tests produce conflicting results, report the final interpretation provided by the lab. If no final interpretation is provided by the lab, then report the most resistant interpretation (NS > R > I > S-DD > S > NA) for that specific antimicrobial.
  - For example, if a facility performs two E-tests for the same drug on the same isolate and one produces “Intermediate” while the other produces “Susceptible”, report “Intermediate” as the final interpretation for that specific drug susceptibility.
- If the lab performs specific antimicrobial tests on the same isolate, they produce conflicting susceptibility interpretations, and the laboratory did not provide a final summary interpretation, report the most resistant specific test interpretation as the final interpretation (NS > R > I > S-DD > S > NA) for that specific antimicrobial.
  - For example, if drug susceptibility results produced MIC = Resistant and E-Test = Intermediate but the lab did not provide a final interpretation, report “Resistant” as the final interpretation for that specific antimicrobial susceptibility.

### Denominator Data

For each month, report combined denominator data for all inpatient locations within the facility (facility-wide inpatient [FacWideIN]): (See [Appendix H](#) for details)

1. Patient Days: Number of patients present in the facility at the same time on each day of the month, summed across all days in the month.
2. Admissions: Number of patients admitted to an inpatient location in the facility each month.

Note: Neither the patient days nor admissions denominators should include the counts from outpatient locations (ED, pediatric ED, and 24-hour observation area). No denominator record is required for the three outpatient locations.

Since the same definitions are used for the NHSN Multidrug-Resistant Organism & *Clostridioides difficile* Infection (MDRO/CDI) Module, Appendix 2 of the [NHSN MDRO & CDI Module Protocol](#) contains further information on counting patient days and admissions.

### **Minimizing Bias & Bypassing Suppression**

The ultimate source of antimicrobial susceptibility test results should be the hospital LIS, but in some healthcare facilities not all susceptibility results acquired or stored in a LIS are readily





available for reporting to NHSN. Concerted efforts are needed to obtain antimicrobial resistance data for purposes of reporting to NHSN that, due to a practice referred to as suppression, might be withheld from clinical end users. This practice can serve to control costs or to prevent overuse of some antimicrobial agents, but it also can exert an adverse impact on antimicrobial resistance reporting to public health surveillance systems and infection control programs.<sup>4</sup> Suppression can lead to significant biases in the antimicrobial resistance data available for surveillance or infection control. Facilities should make every effort to report all antimicrobial resistance data that meet the NHSN protocol requirements, regardless of whether those data are suppressed from clinical end users.

### Data Analyses:

All AR Option data reported to NHSN can be analyzed. After generating analysis datasets within NHSN, users can view all reported data in the NHSN analysis reports. The data in NHSN can be visualized and analyzed in various ways. For example, descriptive analysis reports such as line lists and bar charts are available. In addition, measures of antimicrobial resistance are available in rate tables and antibiogram reports.

## Types of AR Option Analysis Reports

### Facility-wide Antibiogram:

The facility-wide antibiogram table displays the calculated percent non-susceptible (see [Table 2](#)) for each organism-antimicrobial combination. Users can stratify the antibiogram table by specimen source, time period, and/or by specific antimicrobial or organism. Note: A facility must have tested and reported at least 30 isolates for a specific organism/antimicrobial combination in the given time period for results to appear in the NHSN antibiogram report.

**Table 2. Facility-wide Antibiogram**

Facility-wide: standard report for facility and group user
<p>% non-susceptible is calculated for each* organism-antimicrobial pairing:</p> $\%NS = \frac{\text{Total isolates I} + \text{Total isolates R} + \text{Total isolates NS}}{\text{Total \# of isolates tested}}$ <p>*Exceptions</p> <ol style="list-style-type: none"> <li>1. <i>Staphylococcus aureus</i> test results for Oxacillin or Cefoxitin: non-susceptible isolates are only those that tested resistant.</li> <li>2. <i>Enterococcus faecalis</i>, <i>Enterococcus faecium</i>, and <i>Enterococcus</i> spp. tested for Vancomycin: non-susceptible isolates for this pairing are only those that tested resistant.</li> <li>3. <i>Escherichia coli</i>, <i>Klebsiella oxytoca</i>, <i>Klebsiella pneumoniae</i>, <i>Klebsiella aerogenes</i>, <i>Enterobacter</i> spp. test results for Cefepime: non-susceptible isolates for these pairings include those isolates that tested resistant, susceptible dose-dependent (S-DD) [Note S-DD may be reported as intermediate], or non-susceptible (NS).</li> </ol>





## **Antimicrobial Resistance (AR) Events**

Two reports list the AR Events reported into the NHSN AR Option.

**Line List:** Users can generate a line list to show all AR Events reported into NHSN for a given time period. The line list is the most customizable type of AR Option analysis report. The line list is also the most helpful AR Option report for data validation.

**Bar Chart:** Users can generate a bar chart to show all AR Events reported into NHSN for a given time period. By default the bar chart will show the number of AR Events by organism over the most recent 12 month time period. Users can modify the bar chart to show the number of Antimicrobial Resistant Organisms based on the AR Option phenotype definitions ([Appendix I](#)).

## **Antimicrobial Resistant (AR) Organisms**

Three reports use the AR Option phenotype definitions ([Appendix I](#)) to determine Antimicrobial Resistant Organisms.

**Line List:** Users can generate a line list to show all AR Organisms that meet the AR Option phenotype definitions for a given time period. The default line list shows each AR Organism reported to NHSN, patient information, specimen collection date, and the location where the specimen was collected.

**Frequency Table:** Users can generate a frequency table to show the number of AR Events meeting the AR Option phenotype definitions in a given time period. While the table default is to display events by month, modifications can be made to display the data by quarter, half year, year or cumulative time periods.

**Rate Table:** Users can generate a rate table to display the percent of resistant isolates by AR Option phenotype. The percent resistant is calculated by dividing the number of resistant isolates over the number of isolates tested multiplied by 100.

Users can also export AR Option data from NHSN in various formats (for example, CSV, SAS, and Microsoft Access).

Additional analysis reports will be available in future releases. Requests for additional reports can be sent to: [NHSN@cdc.gov](mailto:NHSN@cdc.gov).

## **NHSN Group Analysis:**

NHSN Group users can visualize and analyze AR data shared with them by member facilities using NHSN analysis reports. In addition to the Analysis Quick Reference Guides (QRGs) referenced in the Additional Analysis Resources section below, Groups can find Group-specific resources on the [NHSN Group Users](#) page.

## **Additional Analysis Resources**

Analysis QRGs are short 3-4 page documents that highlight how to modify and interpret NHSN analysis reports. QRGs are available for all AR Option analysis reports and can be found in the



Antimicrobial Use and Resistance Module Reports section of the [Analysis Quick Reference Guide](#) page.

Additionally, users can find recorded training sessions and Quick Learn videos highlighting AR Option analysis reports in the Training section of the [AUR Module](#) page.



Figure 1. *Test Result Algorithm for Invasive Specimen Reporting*

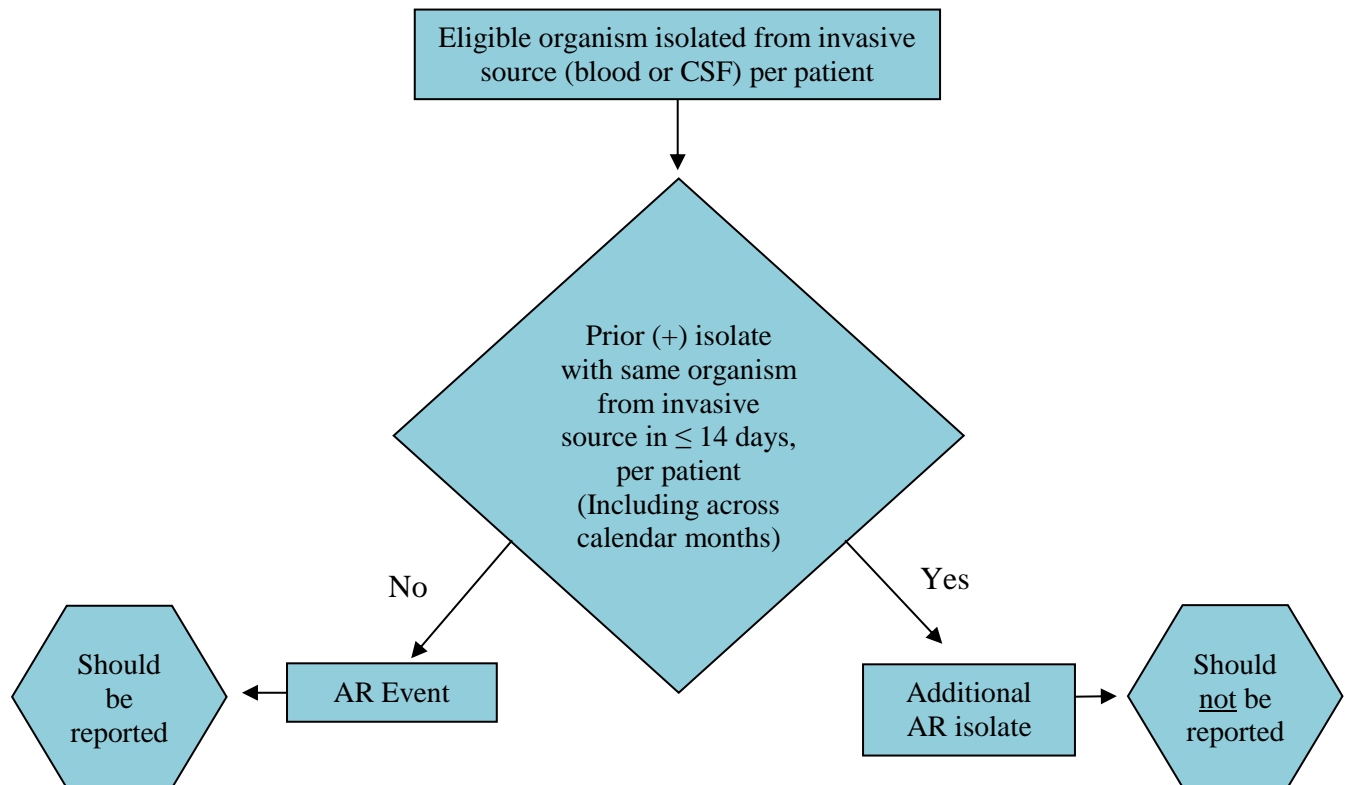




Figure 2. *Test Result Algorithm for Non-Invasive Specimen Reporting*

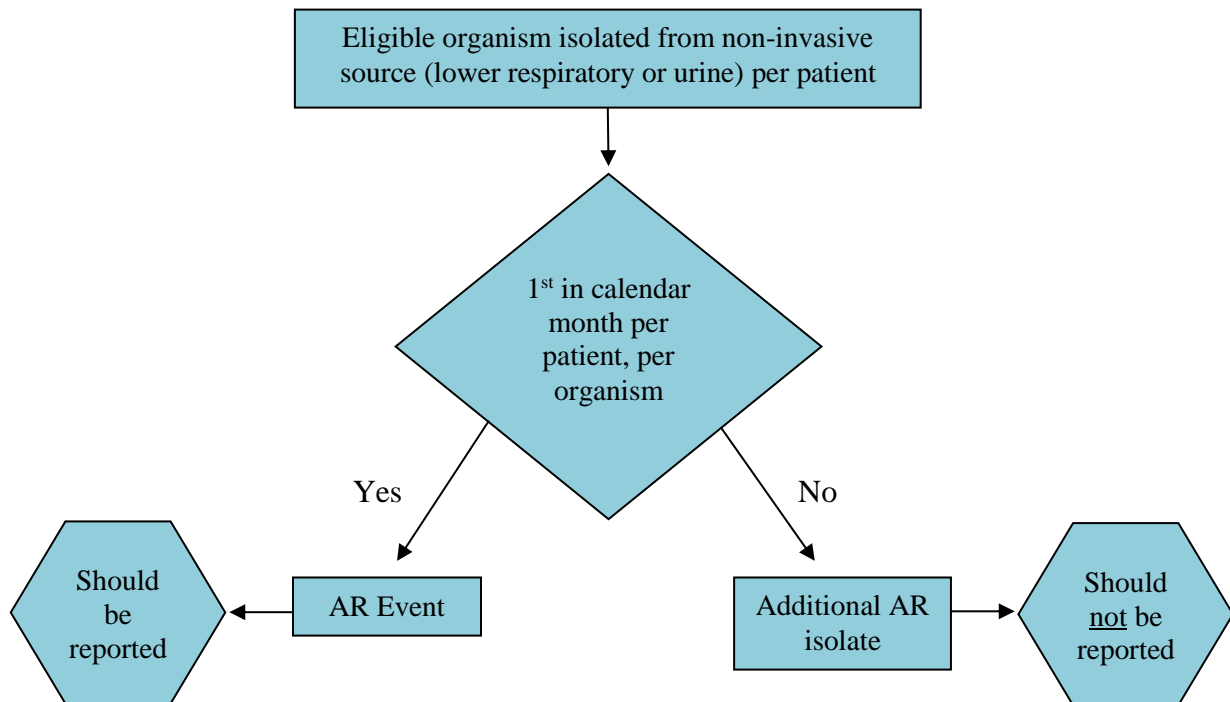
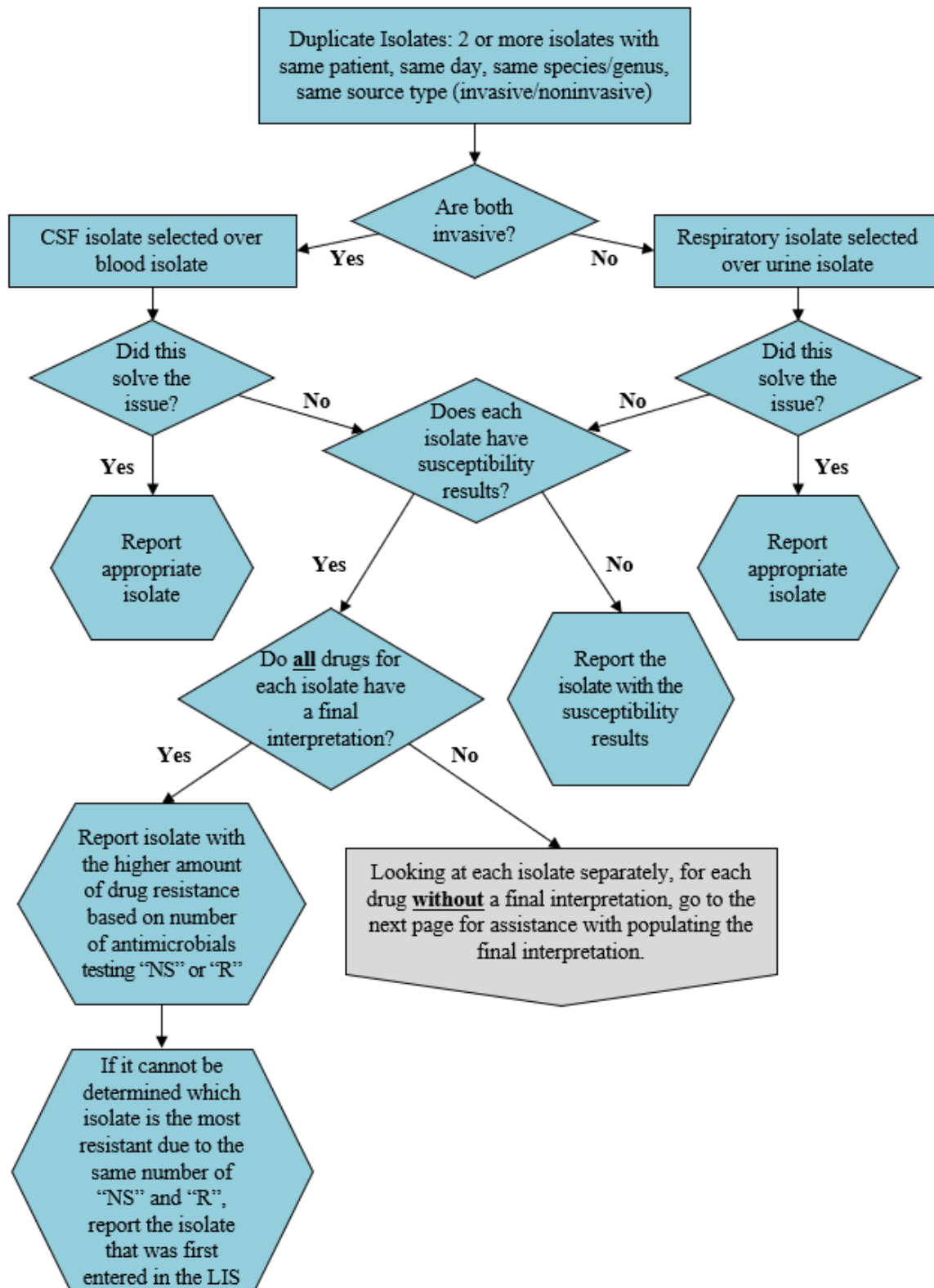
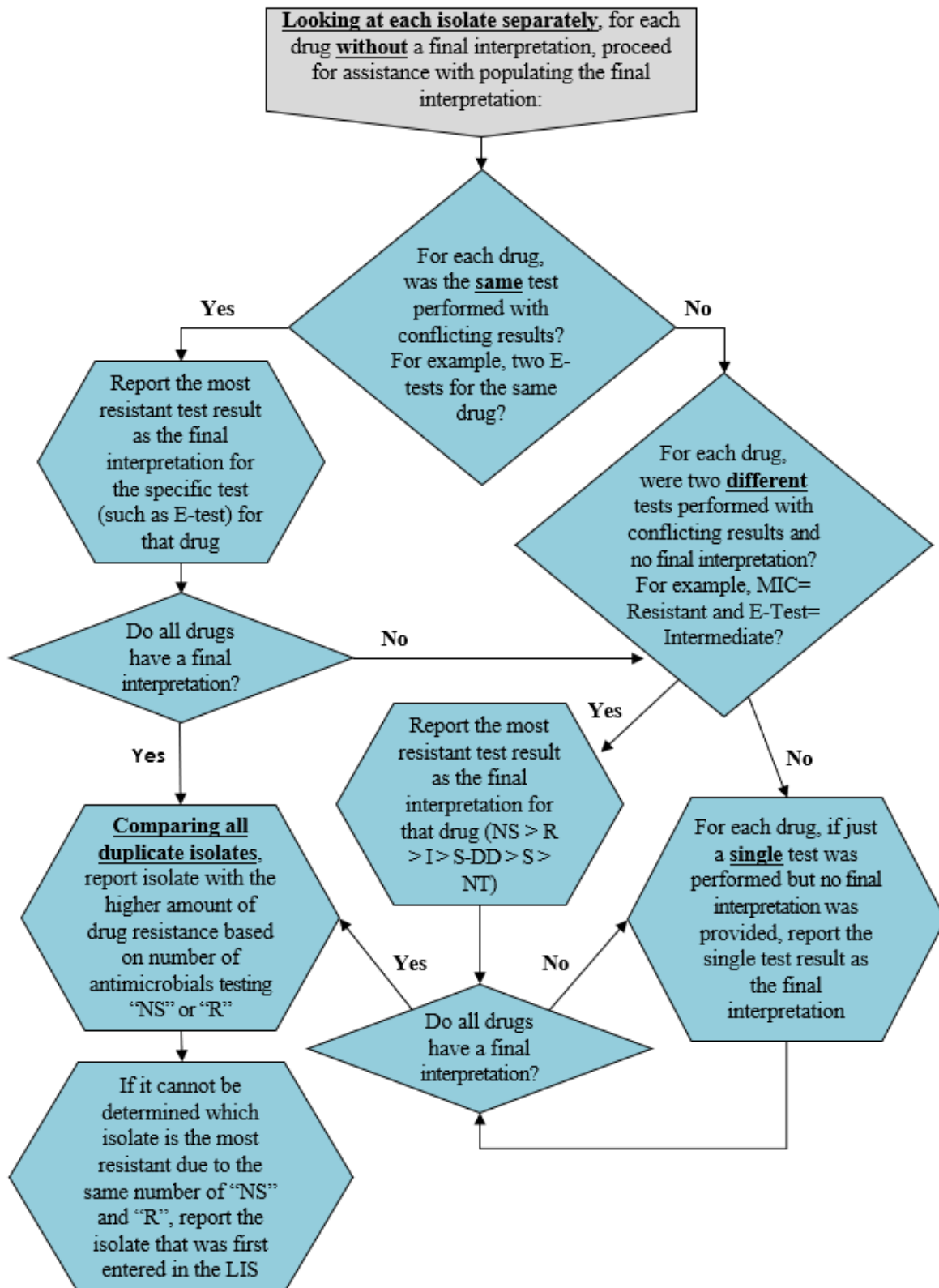




Figure 3. *Reporting Algorithm for Same Day Duplicates*







## References

1. Schwaber MJ, De-Medina T, and Carmeli Y. Epidemiological interpretation on antibiotic resistance studies – what are we missing? *Nat Rev Microbiol* 2004;2:979-83.
2. National Healthcare Safety Network (NHSN) Patient Safety Component: Clinical Document Architecture. <http://www.cdc.gov/nhsn/cdaportal/index.html>
3. CLSI. Analysis and Presentation of Cumulative Antimicrobial Susceptibility Test Data; Approved Guideline – Third Edition. CLSI document M39-A3. Wayne, PA: Clinical and Laboratory Standards; 2009.
4. Council of State and Territorial Epidemiologists (CSTE). Recommendations for strengthening public health surveillance of antimicrobial resistance in the United States. <https://cdn.ymaws.com/www.cste.org/resource/resmgr/PS/13-SI-01.pdf>. Accessed October 1, 2015.





### **Appendix F. List of Eligible Organisms for the NHSN AR Option**

Please note that standardized terminology (SNOMED) mappings are provided in the Information Data Model (IDM) found in the [Antimicrobial Resistance Toolkit](#). Testing methods should follow most recent CLSI guidance as appropriate.

Organism	Specimen Type	Antimicrobial Agents
<i>Acinetobacter</i> (All <i>Acinetobacter</i> species noted in the IDM/Pathogen Codes tab listed in the ARO Pathogen column)	Blood, Urine, Lower Respiratory, CSF	Amikacin Ampicillin-sulbactam Cefepime Cefotaxime Ceftazidime Ceftriaxone Ciprofloxacin Colistin Doripenem Doxycycline Gentamicin Imipenem with Cilastatin Levofloxacin Meropenem Minocycline Piperacillin-tazobactam Polymyxin B Tobramycin Trimethoprim-sulfamethoxazole
	Additional Agents for Urine	Tetracycline
<i>Candida albicans</i> <i>Candida auris</i> <i>Candida glabrata</i> <i>Candida parapsilosis</i> <i>Candida tropicalis</i>	Blood, Urine, CSF Note: Lower respiratory will not be collected for <i>Candida</i> spp.	Anidulafungin Caspofungin Fluconazole Flucytosine Itraconazole Micafungin Posaconazole Voriconazole
	Additional Agents for Urine	None

*Continued on the next page*



Organism	Specimen Type	Antimicrobial Agents
<i>Citrobacter amalonaticus</i> <i>Citrobacter freundii</i> <i>Citrobacter koseri</i> <i>(Citrobacter diversus)</i> <i>Enterobacter</i> (All <i>Enterobacter</i> species noted in the IDM/Pathogen Codes tab listed in the ARO Pathogen column) <i>Escherichia coli</i> <i>Klebsiella aerogenes</i> <i>Klebsiella oxytoca</i> <i>Klebsiella pneumoniae</i> <i>Morganella morganii</i> <i>Proteus mirabilis</i> <i>Proteus penneri</i> <i>Proteus vulgaris</i> <i>Serratia marcescens</i>	Blood, Urine, Lower Respiratory, CSF	Amikacin Amoxicillin-clavulanic acid Ampicillin Ampicillin-sulbactam Aztreonam Cefazolin (urine or non-urine breakpoints) <sup>a</sup> Cefepime Cefotaxime Cefotetan Cefoxitin Ceftazidime Ceftazidime-avibactam Ceftolozane-tazobactam Ceftriaxone Cefuroxime Chloramphenicol Ciprofloxacin Colistin Doripenem Ertapenem Gentamicin Imipenem with Cilastatin Levofloxacin Meropenem Piperacillin-tazobactam Polymyxin B Tetracycline Trimethoprim-sulfamethoxazole Tobramycin
	Additional Agents for Urine	Fosfomycin Nitrofurantoin Sulfisoxazole Trimethoprim

*Continued on the next page*



Organism	Specimen Type	Antimicrobial Agents
<i>Enterococcus faecalis</i> <i>Enterococcus faecium</i> <i>Enterococcus</i> spp. (When not otherwise specified; excluding <i>E. faecalis</i> , <i>E. faecium</i> , and other identified species)	Blood, Urine, Lower Respiratory, CSF	Ampicillin Dalbavancin Daptomycin Gentamicin Linezolid Oritavancin Penicillin <sup>b</sup> Streptomycin Tedizolid Telavancin Vancomycin  Note: For Gentamicin and Streptomycin only: Synergistic = Susceptible Non-synergistic = Resistant
	Additional Agents for Urine Note: Exclude Gentamicin and Streptomycin	Ciprofloxacin Fosfomycin Levofloxacin Nitrofurantoin Tetracycline
<i>Pseudomonas aeruginosa</i>	Blood, Urine, Lower Respiratory, CSF	Amikacin Aztreonam Cefepime Ceftazidime Ceftazidime-avibactam Ceftolozane-tazobactam Ciprofloxacin Colistin Doripenem Gentamicin Imipenem with Cilastatin Levofloxacin Meropenem Piperacillin-tazobactam Polymyxin B Tobramycin
	Additional Agents for Urine	None

*Continued on the next page*



Organism	Specimen Type	Antimicrobial Agents
<i>Staphylococcus aureus</i>	Blood, Urine, Lower Respiratory, CSF	Azithromycin Cefoxitin Ceftaroline Chloramphenicol Ciprofloxacin Clarithromycin Clindamycin Dalbavancin Daptomycin Doxycycline Erythromycin Gentamicin Levofloxacin Linezolid Minocycline Moxifloxacin Oritavancin Oxacillin or Nafcillin <sup>c</sup> Penicillin <sup>b</sup> Rifampin Tedizolid Telavancin Tetracycline Trimethoprim-sulfamethoxazole Vancomycin
	Additional Agents for Urine	Nitrofurantoin Sulfisoxazole Trimethoprim
<i>Stenotrophomonas maltophilia</i>	Blood, Urine, Lower Respiratory, CSF	Ceftazidime Chloramphenicol Levofloxacin Minocycline Trimethoprim-sulfamethoxazole
	Additional Agents for Urine	None

*Continued on the next page*



Organism	Specimen Type	Antimicrobial Agents
<i>Streptococcus agalactiae</i> (Group B <i>Streptococci</i> )	Blood, Urine, Lower Respiratory, CSF	Ampicillin Cefepime Cefotaxime Ceftaroline Ceftriaxone Chloramphenicol Clindamycin Dalbavancin Daptomycin Erythromycin Levofloxacin Linezolid Oritavancin Penicillin <sup>b</sup> Tedizolid Telavancin Vancomycin
	Additional Agents for Urine	None
<i>Continued on the next page</i>		



Organism	Specimen Type	Antimicrobial Agents
<i>Streptococcus pneumoniae</i>	Blood, Urine, Lower Respiratory, CSF	Amoxicillin Amoxicillin-clavulanic acid Cefepime (meningitis or non-meningitis breakpoints) <sup>d</sup> Cefotaxime (meningitis or non-meningitis breakpoint) <sup>d</sup> Ceftaroline Ceftriaxone (meningitis or non-meningitis breakpoint) <sup>d</sup> Cefuroxime (parenteral breakpoint) Chloramphenicol Clindamycin Doxycycline Ertapenem Erythromycin Gemifloxacin Imipenem with Cilastatin Levofloxacin Linezolid Meropenem Moxifloxacin Penicillin <sup>b</sup> (meningitis or non-meningitis breakpoint) <sup>d</sup> Penicillin V <sup>b</sup> (oral breakpoint) Rifampin Tetracycline Trimethoprim-sulfamethoxazole Vancomycin
	Additional Agents for Urine	None

<sup>a</sup> If the LIS produces urine and non-urine breakpoint results, rely on the specimen source to determine which susceptibility results to report. If the specimen source is urine, report the urine breakpoint susceptibility. If the specimen source is blood, CSF, or lower respiratory, report the non-urine breakpoint susceptibility.

<sup>b</sup> If the LIS does not differentiate between Penicillin G and Penicillin V, list susceptibility results under Penicillin G and indicate that Penicillin V was not tested (NA).

<sup>c</sup> For *Staphylococcus aureus* susceptibility testing, if the LIS tests Nafcillin instead of Oxacillin, report Nafcillin susceptibility results as Oxacillin.

<sup>d</sup> If the LIS produces meningitis and non-meningitis breakpoint results, rely on the specimen source to determine which susceptibility results to report. If the specimen source is CSF, report the meningitis breakpoint susceptibility. If the specimen source is blood, urine, or lower respiratory, report the non-meningitis breakpoint susceptibility.



## Appendix G. Technical and Isolate Based Report Variables

NAME	DESCRIPTION OF FIELD	CODE VALUE LIST	LEVEL OF REQUIREMENT
Facility OID <sup>a</sup>	Must be assigned to facility and included in the importation file prior to submission to NHSN.		Required
Patient ID	Alphanumeric patient ID assigned by the hospital and may consist of any combination of numbers and/or letters. This should be an ID that remains the same for the patient across all visits and admissions.		Required
Date of Birth	The date of the patient's birth including month, day, and year.		Required
Gender	M (Male), F (Female), O (Other) to indicate the gender of the patient.		Required
Date admitted to facility	Date patient was admitted to the inpatient facility including month, day, and year. Notes: <ul style="list-style-type: none"> <li>Use the encounter date if event occurred in an outpatient location.</li> <li>If patient was discharged from the ED then later admitted on a subsequent calendar day, any specimens collected during the first ED visit should use the original encounter date as the admission date for that AR Event.</li> </ul>		Required
Specimen collection date	Date the specimen was collected including month, day, and year.		Required
Specimen source	Specimen source from which the isolate was recovered (urine, lower respiratory, blood, CSF).	SNOMED	Required
Location	Patient care area where patient was located when the laboratory specimen was collected. Use patient location obtained from administrative data system (ADT).	CDC Location Codes	Required
Isolate identifier	Isolate identifier unique for each isolate within laboratory. Also referred to as the accession number.		Required
Organism	Organism identified from specimen ( <a href="#">Appendix E</a> ).	SNOMED	Required
Antimicrobial <sup>b</sup>	Antimicrobial(s) tested for susceptibility ( <a href="#">Appendix F</a> defines agents by organism and specimen source)	RxNorm	Required





NAME	DESCRIPTION OF FIELD	CODE VALUE LIST	LEVEL OF REQUIREMENT
PBP2a-agglutination	Result for PBP2a-agglutination (only if SA) Pos/Neg/Unk		Conditional (for Staph aureus)
PCR mec-gene	Result for PCR mec-gene (only if SA) Pos/Neg/Unk		Conditional (for Staph aureus)
E-test sign <sup>c</sup>	E-test sign		Optionally Required
E-test value/units of measure	E-test (Value in micrograms/liter). Use '.' as decimal delimiter, for example, 0.25		Optionally Required
Interpretation of E-test	Interpretation result of the E-test susceptibility test performed		Required
MIC sign <sup>c</sup>	MIC sign		Optionally Required
MIC value/units of measure	MIC (Value in micrograms/liter). Use '.' as decimal delimiter, for example, 0.25		Optionally Required
Interpretation of MIC test	Interpretation result of the MIC susceptibility test performed		Required
Disk diffusion (KB) sign <sup>c</sup>	Disk diffusion (KB) sign		Optionally Required
Disk diffusion (KB) value/units of measure	Disk diffusion (KB) value in millimeters		Optionally Required
Interpretation of Disk diffusion (KB) test	Interpretation result of the disk diffusion (KB) susceptibility test performed		Required
Final Interpretation result	Final interpretation result of all different susceptibility tests performed		Required

<sup>a</sup> Facilities interested in submitting data to NHSN via CDA must obtain a Facility OID (object identifier). More information on how to obtain an OID for your facility can be found on the [CDA Submission Support Portal](#).

<sup>b</sup> At this time, the R1 Norm Implementation Guide uses RxNorm codes to report antimicrobials for the AR Option. NHSN plans to move to antimicrobial/test expressed as LOINC codes in a future version of the Implementation Guide used for the AR Option.

<sup>c</sup> Refer to the HL7 Implementation Guide for specifics on how to code these values in the CDA report.

Note: While many of these specific test results (specifically, E-test, MIC, Disk diffusion [KB]) are required in the CDA report, facilities unable to electronically obtain these results may still participate by using 'NA' to signify 'Not Tested'. Facilities should not employ manual means of data collection.



## Appendix H. Denominator Data Variables

	DESCRIPTION OF FIELD	LEVEL OF REQUIREMENT
<b>Facility Wide Inpatient Denominator</b>		
Facility OID <sup>a</sup>	Must be assigned to facility and included in the importation file prior to submission to NHSN.	Required
Location	FacWideIN	Required
Month	2-Digit month	Required
Year	4-Digit year	Required
Patient Days	For facility wide inpatient locations enter the total number of patient days collected at the same time each day combined for the month. All of the facility's inpatient locations with an overnight stay should be included where denominators can be accurately collected.	Required
Admission Count	Enter the total number of admissions for all facility inpatient locations combined for the month. All the facility's inpatient locations with an overnight stay where denominators can be accurately collected should be included.	Required

<sup>a</sup> Facilities interested in submitting data to NHSN via CDA must obtain a Facility OID (object identifier). More information on how to obtain an OID for your facility can be found on the [CDA Submission Support Portal](#).



## Appendix I. NHSN AR Option Phenotype Definitions

Phenotype Name	Phenotype Code	Phenotype Definition
Methicillin-resistant <i>Staphylococcus aureus</i>	MRSA_AR	<i>Staphylococcus aureus</i> that has tested Resistant (R) to at least one of the following: oxacillin or ceftazidime
Carbapenem-resistant Enterobacteriaceae (expanded)	CREexpanded_AR	Any <i>Citrobacter amalonaticus</i> , <i>Citrobacter freundii</i> , <i>Citrobacter koseri</i> , <i>Enterobacter</i> spp., <i>E. coli</i> , <i>Klebsiella aerogenes</i> , <i>Klebsiella oxytoca</i> , <i>Klebsiella pneumoniae</i> , and <i>Serratia marcescens</i> that has tested Resistant (R) to at least one of the following: imipenem, meropenem, doripenem, or ertapenem OR Any <i>Proteus mirabilis</i> , <i>Proteus penneri</i> , <i>Proteus vulgaris</i> , and <i>Morganella morganii</i> that has tested Resistant (R) to at least one of the following: meropenem, doripenem, or ertapenem
Carbapenem-resistant Enterobacteriaceae ( <i>E. coli</i> , <i>Klebsiella</i> , or <i>Enterobacter</i> )	CREall_AR	Any <i>Escherichia coli</i> , <i>Klebsiella aerogenes</i> , <i>Klebsiella oxytoca</i> , <i>Klebsiella pneumoniae</i> , or <i>Enterobacter</i> spp. that has tested Resistant (R) to at least one of the following: imipenem, meropenem, doripenem, or ertapenem
Carbapenem-resistant <i>E.coli</i>	CREecoli_AR	Any <i>Escherichia coli</i> that has tested Resistant (R) to at least one of the following: imipenem, meropenem, doripenem, or ertapenem
Carbapenem-resistant <i>Enterobacter</i> spp. and <i>Klebsiella aerogenes</i>	CREenterobacter_AR	Any <i>Enterobacter</i> spp. or <i>Klebsiella aerogenes</i> that has tested Resistant (R) to at least one of the following: imipenem, meropenem, doripenem, or ertapenem
Carbapenem-resistant <i>Klebsiella pneumoniae/oxytoca</i>	CREklebsiella_AR	Any <i>Klebsiella oxytoca</i> or <i>Klebsiella pneumoniae</i> that has tested Resistant (R) to at least one of the following: imipenem, meropenem, doripenem, or ertapenem
Carbapenem-non-susceptible <i>Pseudomonas aeruginosa</i>	carbNS_PA_AR	<i>Pseudomonas aeruginosa</i> that has tested either Intermediate (I) or Resistant (R) to at least one of the following: imipenem, meropenem, or doripenem
Extended-spectrum cephalosporin-resistant <i>E.coli</i>	ESCecoli_AR	Any <i>Escherichia coli</i> that has tested Resistant (R) to at least one of the following: cefepime, ceftazidime, cefotaxime, or ceftazidime.
Extended-spectrum cephalosporin-resistant <i>Klebsiella pneumoniae/oxytoca</i>	ESCKlebsiella_AR	Any <i>Klebsiella oxytoca</i> or <i>Klebsiella pneumoniae</i> that has tested Resistant (R) to at least one of the following: cefepime, ceftazidime, cefotaxime, or ceftazidime.



Phenotype Name	Phenotype Code	Phenotype Definition
Multidrug-resistant <i>Pseudomonas aeruginosa</i>	MDR_PA_AR	<i>Pseudomonas aeruginosa</i> that has tested either Intermediate (I) or Resistant (R) to at least one drug in at least three of the following five categories: <ol style="list-style-type: none"> <li>1. Extended-spectrum cephalosporin (cefepime, ceftazidime)</li> <li>2. Fluoroquinolones (ciprofloxacin, levofloxacin)</li> <li>3. Aminoglycosides (amikacin, gentamicin, tobramycin)</li> <li>4. Carbapenems (imipenem, meropenem, doripenem)</li> <li>5. Piperacillin/tazobactam</li> </ol>
Carbapenem-non-susceptible <i>Acinetobacter</i> spp.	carbNS_Acine_AR	Any <i>Acinetobacter</i> spp. that has tested either Intermediate (I) or Resistant (R) to at least one of the following: imipenem, meropenem, or doripenem
Multidrug-resistant <i>Acinetobacter</i> spp.	MDR_Acine_AR	Any <i>Acinetobacter</i> spp. that has tested either Intermediate (I) or Resistant (R) to at least one drug in at least three of the following six categories: <ol style="list-style-type: none"> <li>1. Extended-spectrum cephalosporin (cefepime, ceftazidime, ceftriaxone, cefotaxime)</li> <li>2. Fluoroquinolones (ciprofloxacin, levofloxacin)</li> <li>3. Aminoglycosides (amikacin, gentamicin, tobramycin)</li> <li>4. Carbapenems (imipenem, meropenem, doripenem)</li> <li>5. Piperacillin/tazobactam</li> <li>6. Ampicillin/sulbactam</li> </ol>
Vancomycin-resistant <i>Enterococcus faecalis</i>	VREfaecalis_AR	<i>Enterococcus faecalis</i> that has tested Resistant (R) to vancomycin
Vancomycin-resistant <i>Enterococcus faecium</i>	VREfaecium_AR	<i>Enterococcus faecium</i> that has tested Resistant (R) to vancomycin
Fluconazole-resistant <i>Candida albicans/auris/glabrata/parapsilosis/tropicalis</i>	FR_Candi_AR	Any <i>Candida albicans</i> , <i>Candida auris</i> , <i>Candida glabrata</i> , <i>Candida parapsilosis</i> , or <i>Candida tropicalis</i> that has tested Resistant (R) to fluconazole
Drug-resistant <i>Streptococcus pneumoniae</i>	DR_SP_AR	<i>Streptococcus pneumoniae</i> that has tested either Resistant (R) to at least one of the antimicrobials listed in the NHSN AR Option defined drug panel