Antimicrobial Use and Resistance (AUR) Module

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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 laboratory and/or pharmacy information software providers to configure their system to enable the generation of standard formatted file(s) to be imported into NHSN. The format provided for data submission follows the Health Level (HL7) Clinical Document Architecture (CDA).[7] 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 facilities to report and analyze antimicrobial use and/or resistance as part of local or regional efforts to reduce antimicrobial resistant infections through antimicrobial stewardship efforts or interruption of transmission of resistant pathogens at their facility.[6]

1. Antimicrobial Use (AU) Option

Introduction: Rates of resistance to antimicrobial agents continue to increase at hospitals in the United States.[1] One of the four CDC core initiatives to combat the spread of antimicrobial resistance is improving the use of antimicrobials.[2] Previous studies have shown that feedback of reliable reports of rates of antimicrobial use and resistance to clinicians can improve the appropriateness of antimicrobial usage.[3-5]

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

Methodology: The primary antimicrobial usage metric reported to this module 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); all antimicrobial days for a specific agent administered across a population are summed in aggregate.[8-11] 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 14-6). 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 usage metric for facility-wide inpatient also reported to this module is antimicrobial days per 100 admissions. 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.[7] 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, and inpatient rehabilitation facilities) enrolled in NHSN and using 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 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, facility-wide inpatient (FacWideIN), and select outpatient acute care settings (specifically, outpatient emergency department, pediatric emergency department, and 24-hour observation area) from which the numerator and denominator data 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.

Within NHSN, a CDC-defined designation is given to each patient care area/location 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: An acceptable minimal month of data includes:

1. The facility must indicate the specific locations from which they plan to submit antimicrobial use data on the *Patient Safety Monthly Reporting Plan* (CDC 57.106).
    - 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 contain all data fields outlined in the *Table of Instructions* (Appendix A) for each location of data submitted.
3. Data are uploaded via CDA files for all locations indicated on the Monthly Reporting Plan.

NHSN recommends that data be entered into NHSN for a given calendar month by the end of the subsequent calendar month.

Numerator Data (Antimicrobial Days):

Antimicrobial Days (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.[8-11] 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 emergency department, pediatric emergency department, 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 definitions of drug-specific antimicrobial days and stratification based on route of administration. For example, a patient to whom 1 gram Vancomycin is administered intravenously twice daily for three days will be attributed three "Vancomycin Days (total)" and three "Vancomycin Days (IV)" when stratified by intravenous route of administration. Please note that 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 setting 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 for the calculation of antimicrobial days.

Please note that "zero" should be reported when no aggregate usage occurred during a given reporting period for a specific antimicrobial agent/route (for example, Zanamivir via the respiratory route) at a facility in which the agent/route is used and that agent/route can be accurately captured in the eMAR or BCMA system. Further, "NA" (Not Applicable) should be reported when data are not available for a specific antimicrobial agent/route at a facility (specifically, the agent can't be electronically captured at that facility). A value (specifically, a specific number, "zero", or "NA") must be reported for every antimicrobial agent and route of administration listed in Appendix B.

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

Classification: Route of Administration[a]	**Definition**[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.[c]
Respiratory Tract	A route that begins within the respiratory tract, including the oropharynx and nasopharynx.

[a] Other routes of administration are excluded from the AU Option reporting (for example, antibiotic locks, intraperitoneal, intraventricular, irrigation, topical) and should not be included in either the total antimicrobial days nor the sub-stratification of the routes of administration.
[b] 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.
[c] 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[a]	**IV**	**IM**	**Digestive**[b]	**Respiratory**
Month/ Year Location	Tobramycin	Tobramycin Days (Total)	Tobramycin Days (IV)	Tobramycin Days (IM)	Tobramycin Days (Digestive)	Tobramycin Days (Respiratory)
01/2016 Med Ward		1	1	0	0	1

[a] Drug-specific antimicrobial days (total) attributes one antimicrobial day for any route of administration. For example, a patient to whom Tobramycin was administered intravenously and via a respiratory route on the same day would be attributed "one Tobramycin Day (Total)"; the stratification by route of administration would be "one Tobramycin Day (IV)" and "one Tobramycin Day (Respiratory)".
[b] For purposes of example of route stratification only (Tobramycin is not FDA approved for administration via the digestive route).

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

Data Element	Details
Antimicrobial Agents	Defined as select antimicrobial agents and stratified by route of administration (specifically, intravenous, intramuscular, digestive, and respiratory). Refer to Appendix B for a complete list of antimicrobials. The list of select antimicrobials will evolve with time as new agents become commercially available. *Topical antimicrobial agents are not included in the NHSN AU Option.*
Data source	Antimicrobial days are derived from administered data documented in the eMAR and/or BCMA only. Usage derived from other data sources (for example, pharmacy orders, doses dispensed, doses billed) cannot be submitted.
Location	Antimicrobial days are aggregated for each inpatient location, facility-wide inpatient, and three select outpatient acute-care settings (specifically, outpatient emergency department, pediatric emergency department, and 24-hour observation area) per NHSN location definitions.
Time Unit	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 and admissions (for facility-wide inpatient [FacWideIN] only). The denominators are further defined below.

Days present: Days present are defined as time period during which a given patient is at risk for antimicrobial exposure for a given patient location. The definition of days present differs from conventional 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 patient care location compared to facility-wide inpatient.

For patient care location-specific analyses, days present is calculated as the number of patients who were present, regardless of patient status (for example, inpatient, observation), for any portion of each day of a calendar month for a patient care location. The aggregate measure is calculated by summing up all of the 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 counting of days present:

- A patient admitted to the medical ward on Monday and discharged two days later on Wednesday will be attributed three days present on that medical ward because the patient was 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 will be attributed one day present on the medical critical care unit as well as one day present on the medical ward because the patient was in both locations at some point during that calendar day. Similarly, a patient's time

in the operating room or emergency department will be included in days present for these types of units (if data are submitted from these locations).

- One patient can only account for one day present for a specific location per calendar day (specifically, 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 is calculated as the number of patients who were present in an inpatient location within the facility for any portion of each day of 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.

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***

Metric Collected	Metric Definition	Comments
Patient Care Location-Specific Analyses		
Antimicrobial Days/Days present	Drug-specific antimicrobial days per patient care location per month/Days present per patient care location per month	One patient can contribute only one day present per calendar day for each specific location. Summed total may be higher when compared to facility-wide count (reflecting transfers between locations).

Metric Collected	Metric Definition	Comments
Facility-wide Inpatient Analyses		
Antimicrobial Days/Days present	Drug-specific antimicrobial days for inpatient units in a facility per month/Days present per facility-wide inpatient per month	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. The day present measure for facility-wide inpatient should be lower when compared to sum total from location-specific comparison.
Antimicrobial Days/Admissions	Drug-specific antimicrobial days for inpatient units in a facility per month/Admissions per facility-wide inpatient per month	Only calculated for facility-wide inpatient for the AU Option.

Data Analyses:

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. 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 modules developed by CDC applied to nationally aggregated AU data. The separate predictive models are specific to each of the five antimicrobial use categories. The data used in the predictive models are historical AU data that have been reported to NHSN and aggregated for analytic purposes.

$$\text{SAAR} = \frac{\text{Observed (O) Antimicrobial Use}}{\text{Predicted (P) Antimicrobial Use}}$$

The SAARs are generated for five specific antimicrobial groupings (see Appendix D), each of which can serve as a high value target or high-level indicator for antimicrobial stewardship programs. Future iterations of the SAAR can extend its use as a metric to additional patient care locations when aggregate data are sufficient for those purposes. At present, facilities with locations mapped as adult and pediatric medical, surgical, and medical/surgical critical care units (or ICUs) and wards are able to generate the 16 SAARs outlined below:

SAARs for broad spectrum antibacterial agents predominantly used for hospital-onset/multidrug resistant infections:

1. Adult medical, medical/surgical, and surgical ICUs
2. Adult medical, medical/surgical, and surgical wards
3. Pediatric medical, medical/surgical, and surgical ICUs

4. Pediatric medical, medical/surgical, and surgical wards

SAARs for broad spectrum antibacterial agents predominantly used for community-acquired infections:

5. Adult medical, medical/surgical, and surgical ICUs
6. Adult medical, medical/surgical, and surgical wards
7. Pediatric medical, medical/surgical, and surgical ICUs
8. Pediatric medical, medical/surgical, and surgical wards

SAARs for anti-MRSA antibacterial agents:

9. Adult medical, medical/surgical, and surgical ICUs
10. Adult medical, medical/surgical, and surgical wards
11. Pediatric medical, medical/surgical, and surgical ICUs
12. Pediatric medical, medical/surgical, and surgical wards

SAARs for antibacterial agents predominantly used for surgical site infection prophylaxis:

13. Adult ICUs and wards (medical, medical/surgical, and surgical)
14. Pediatric ICUs and wards (medical, medical/surgical, and surgical)

SAARs for all antibacterial agents:

15. Adult ICUs and wards (medical, medical/surgical, and surgical)
16. Pediatric ICUs and wards (medical, medical/surgical, and surgical)

A high SAAR that achieves statistical significance may indicate excessive antibacterial use. A SAAR that is not statistically different from 1.0 indicates antibacterial use is equivalent to the referent population's antibacterial use. A low SAAR that achieves statistical significance (specifically, different from 1.0) may indicate antibacterial under use. Note: A SAAR alone is not a definitive measure of the appropriateness or judiciousness of antibacterial 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 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 12 select location types: adult medical, medical/surgical, and surgical ICUs and wards; pediatric medical, medical/surgical, and surgical ICUs and wards.

<u>Additional AU Option Analyses</u>

Uploaded AU data can also be displayed in numerous types of other reports: line lists, rates tables, pie charts and bar charts.

Line Lists: Line lists are the most customizable type of 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. Modifications can be made to 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.

Rate Tables: Rate tables are generated 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. The 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.

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.

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

References

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Appendix A. Table of Instructions: Antimicrobial Use Option

Data Field	Data Field Description
Facility OID[a]	Required. Must be assigned to facility and included in the importation file prior to submission to NHSN.
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 exposure for which a specific antimicrobial was administered. These are required to be extracted from electronic medication administration record (eMAR) and/or bar coding medication record (BCMA). Antimicrobials days will be collected for select antimicrobial agents (refer to Appendix B) and stratified by route of administration.
Denominator(s): Days present Admissions	Required. Days present is defined as risk for antimicrobial exposure per time unit of analysis 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 of a calendar month for a patient care location. For facility-wide inpatient analyses, days present is calculated as the number of patients who were present in an inpatient location within the facility for any portion of each day of a calendar month. 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.

[a] 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 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[a]	Antimicrobial Subclass[a]
AMANTADINE	Anti-influenza	M2 ion channel inhibitors	
AMIKACIN	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	
CASPOFUNGIN	Antifungal	Echinocandins	
CEFACLOR	Antibacterial	Cephalosporins	Cephalosporin 2rd generation
CEFADROXIL	Antibacterial	Cephalosporins	Cephalosporin 1st generation
CEFAZOLIN	Antibacterial	Cephalosporins	Cephalosporin 1st generation
CEFDINIR	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFDITOREN	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFEPIME	Antibacterial	Cephalosporins	Cephalosporin 4th generation
CEFIXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFOTAXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFOTETAN	Antibacterial	Cephalosporins	Cephamycin
CEFOXITIN	Antibacterial	Cephalosporins	Cephamycin
CEFPODOXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFPROZIL	Antibacterial	Cephalosporins	Cephalosporin 2rd generation
CEFTAROLINE	Antibacterial	Cephalosporins	Cephalosporins with anti-MRSA activity
CEFTAZIDIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation

Antimicrobial Agent	Antimicrobial Category	Antimicrobial Class[a]	Antimicrobial Subclass[a]
CEFTAZIDIME/ AVIBACTAM	Antibacterial	B-lactam/ B-lactamase inhibitor combination	
CEFTIBUTEN	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFTIZOXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFTOLOZANE/ TAZOBACTAM	Antibacterial	B-lactam/ B-lactamase inhibitor combination	
CEFTRIAXONE	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFUROXIME	Antibacterial	Cephalosporins	Cephalosporin 2rd generation
CEPHALEXIN	Antibacterial	Cephalosporins	Cephalosporin 1st generation
CHLORAMPHENICOL	Antibacterial	Phenicols	
CIPROFLOXACIN	Antibacterial	Fluoroquinolones	
CLARITHROMYCIN	Antibacterial	Macrolides	
CLINDAMYCIN	Antibacterial	Lincosamides	
COLISTIMETHATE	Antibacterial	Polymyxins	
DALBAVANCIN	Antibacterial	Glycopeptides	Lipoglycopeptide
DAPTOMYCIN	Antibacterial	Lipopeptides	
DELAFLOXACIN	Antibacterial	Fluoroquinolones	
DICLOXACILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins
DORIPENEM	Antibacterial	Carbapenems	
DOXYCYCLINE	Antibacterial	Tetracyclines	
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	
LEVOFLOXACIN	Antibacterial	Fluoroquinolones	
LINEZOLID	Antibacterial	Oxazolidinones	

Antimicrobial Agent	Antimicrobial Category	Antimicrobial Class[a]	Antimicrobial Subclass[a]
MEROPENEM	Antibacterial	Carbapenems	
METRONIDAZOLE	Antibacterial	Nitroimidazoles	
MICAFUNGIN	Antifungal	Echinocandins	
MINOCYCLINE	Antibacterial	Tetracyclines	
MOXIFLOXACIN	Antibacterial	Fluoroquinolones	
NAFCILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins
NITROFURANTOIN	Antibacterial	Nitrofurans	
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	
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	
SULFISOXAZOLE	Antibacterial	Folate pathway inhibitors	
TEDIZOLID	Antibacterial	Oxazolidinones	
TELAVANCIN	Antibacterial	Glycopeptides	Lipoglycopeptides
TELITHROMYCIN	Antibacterial	Ketolides	
TETRACYCLINE	Antibacterial	Tetracyclines	
TICARCILLIN/ CLAVULANATE	Antibacterial	B-lactam/ B-lactamase inhibitor combination	
TIGECYCLINE	Antibacterial	Glycylcyclines	
TINIDAZOLE	Antibacterial	Nitroimidazoles	

Antimicrobial Agent	Antimicrobial Category	Antimicrobial Class[a]	Antimicrobial Subclass[a]
TOBRAMYCIN	Antibacterial	Aminoglycosides	
VANCOMYCIN	Antibacterial	Glycopeptides	Glycopeptide
VORICONAZOLE	Antifungal	Azoles	
ZANAMIVIR	Anti-influenza	Neuraminidase inhibitors	

[a] Adapted from CLSI January 2014[12]

Appendix C. Example Calculations of Antimicrobial Days

Example 1. Example eMAR and Calculation of Antimicrobial Days

This example illustrates the calculation of antimicrobial days from a patient receiving Meropenem 1gram intravenously every 8 hours and Amikacin 1000mg 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 upon the administered doses of Meropenem and Amikacin documented in eMAR. Despite receiving three administrations of Meropenem on December 29, the patient only attributes one total Meropenem antimicrobial day per calendar day. 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 1gram 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 by Stratification of Route of Administration	Meropenem Days (IV) = 1 Amikacin Days (IV) = 1	Meropenem Days (IV) = 1 Amikacin Days (IV) = 1	Meropenem Days (IV) = 1 Amikacin Days (IV) = 0

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 calculation of antimicrobial days from a patient receiving Vancomycin 1gram 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 upon the administered doses of Vancomycin documented in eMAR. One Vancomycin day is attributed to both the MICU and the Medical Ward locations since administrations took place in both locations 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 Medical Ward per calendar day. Table 3 illustrates the contribution of this patient's Vancomycin days to the aggregate monthly report per patient care 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 Facility-wide Inpatient (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 1gram 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 by Stratification of 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 calculation of antimicrobial days from a patient receiving Ceftriaxone 1gram 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 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 attribute 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 gram 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 by Stratification of 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: Antimicrobial groupings for SAAR calculations

Broad spectrum antibacterial agents predominantly used for hospital-onset/multi-drug resistant infections

- AMIKACIN
- AZTREONAM
- CEFEPIME
- CEFTAZIDIME
- CEFTAZIDIME/AVIBACTAM
- CEFTOLOZANE/TAZOBACTAM
- COLISTIMETHATE
- DORIPENEM
- GENTAMICIN
- IMIPENEM/CILASTATIN
- MEROPENEM
- PIPERACILLIN
- PIPERACILLIN/TAZOBACTAM
- POLYMYXIN B
- TICARCILLIN/CLAVULANATE
- TIGECYCLINE
- TOBRAMYCIN

Broad spectrum antibacterial agents predominantly used for community-acquired infections

- CEFOTAXIME
- CEFTRIAXONE
- CIPROFLOXACIN
- ERTAPENEM
- GEMIFLOXACIN
- LEVOFLOXACIN
- MOXIFLOXACIN

Anti-MRSA antibacterial agents

- CEFTAROLINE
- DALBAVANCIN
- DAPTOMYCIN
- LINEZOLID
- ORITAVANCIN
- QUINUPRISTIN/DALFOPRISTIN
- TEDIZOLID
- TELAVANCIN
- VANCOMYCIN (Only IV Vancomycin administrations are included in this SAAR calculation)

Antibacterial agents predominantly used for surgical site infection prophylaxis (IV administrations only)

- CEFAZOLIN
- CEFOTETAN
- CEFOXITIN
- CEFUROXIME
- CEPHALEXIN (Only available orally and is not expected to be administered IV)

All antibacterial agents

Includes 74 of 75 antibacterial agents reported into the AU Option including the agents listed in the category specific SAARs. The newly added antibacterial DELAFLOXACIN is not currently included in this SAAR but will be added in the future.

2. Antimicrobial Resistance (AR) Option

Introduction

Common measures of antimicrobial resistance include the proportion of isolates resistant to specific antimicrobial agents. This proportion resistant (%R) is used to aid in clinical decision making (hospital antibiograms) as well as for assessing impact of cross transmission prevention success or antimicrobial stewardship success, although the measure may not be very sensitive to measuring success of efforts in the short term. An additional value of measuring the proportion resistant includes a local or regional assessment of progression or improvement of a particular resistance problem, to guide local or regional cross-transmission prevention efforts. By using standard methodology of aggregating proportion resistant, local and regional assessments of the magnitude of a particular resistance phenotype will be more valid.

Objectives:

1. Facilitate evaluation of antimicrobial resistance data using a standardized approach to:
    a. Provide local practitioners with an improved awareness of a variety of antimicrobial-resistance problems to both 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) which can inform decisions to accelerate transmission prevention efforts and reverse propagation of emerging or established problematic resistant pathogens.
2. Regional and national assessment of resistance of antimicrobial resistant organisms of public health importance including ecologic assessments and infection burden.

Methodology:

Antimicrobial resistance data are reported as a proportion.[1] 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). In healthcare settings where the LIS is directly connected to the electronic health record system (EHRs), laboratory results data from the EHRs can be used to populate the AR Option numerator records submitted to NHSN. The denominators of patient days and admissions can be obtained from the ADT system (or similar system that allows for electronic access of required data elements). The numerator and denominator are further defined below and must adhere to the data format prescribed by the HL7 CDA Implementation Guide developed by the CDC and HL7.[2] Manual data entry is not available for the NHSN 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. 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 AR Option from long term care facilities (specifically, skilled nursing facilities, nursing homes) nor outpatient dialysis facilities.

NHSN strongly encourages reporting specimens from all NHSN defined inpatient locations and three select outpatient locations: Emergency Department (ED), Pediatric Emergency Department, and 24-hour Observation Area at each facility. Implementation experience with the AR Option provides evidence that reporting from all NHSN patient care locations is technically easier than reporting from selected locations. The denominators of patient days and admissions are only reported at the facility-wide inpatient level (FacWideIN).

Requirements:

Each month:

1. The facility must indicate they plan to submit AR Option data on the *Patient Safety Monthly Reporting Plan* (CDC 57.106).
   - For reporting AR Option data from inpatient locations, FacWideIN is added to the plan. Individual inpatient locations do not need to be listed in the AR Option plan.
   - For reporting AR Option data from the three select outpatient locations, each outpatient location must be listed separately.
2. Two record types must be reported for each month of surveillance.
   - One file for each isolate-based report
     - Isolate is defined as a population of a single organism observed in a culture obtained from a patient specimen.
   - One file for the denominator data report (facility-wide inpatient[FacWideIN])

NHSN recommends that AR Option data be submitted to NHSN for a given calendar month by the end of the subsequent calendar month.

Isolate-based report

Report all required data each month for each eligible isolate-based report (See Appendix E). Only specimens collected in an inpatient or select outpatient location (ED, pediatric ED, and 24-hour observation) of the reporting facility should be considered for eligibility.

All eligible isolates that meet the reporting guidelines outlined in this protocol should be reported to NHSN regardless of the antimicrobial resistance of the isolated organism. This means that even isolates that are susceptible to all required antimicrobials should be considered 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 drugs tested, should be considered eligible to be reported into NHSN. For example, if a *Staphlococcus aureus* isolate was tested for the non-required drug, Oritavancin, and none of the other 23 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. Further, non-culture based organism identification results 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 another invasive source Antimicrobial Resistance (AR) Event is entered 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, another positive culture from an invasive source with that specific organism can be reported as an AR Event. For example, if a positive blood culture was obtained from the 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. **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 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, 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*
- *Citrobacter freundii*
- All *Enterobacter* species
- *Enterococcus faecalis*
- *Enterococcus faecium*
- *Enterococcus* spp. (when not specified to the species level)
- *Escherichia coli*
- Group B *Streptococcus*
- *Klebsiella oxytoca*
- *Klebsiella pneumoniae*
- *Morganella morganii*

- *Proteus mirabilis*
- *Pseudomonas aeruginosa*
- *Serratia marcescens*
- *Staphylococcus aureus*
- *Stenotrophomonas maltophilia*
- *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. Only those organisms listed with an "X" in the ARO Pathogen column of the Pathogen Codes 2018 tab should be reported.

B. Specimen Sources

Facilities and vendors should refer to the IDM found in the Antimicrobial Resistance Toolkit for the complete list of eligible specimens and their associated SNOMED codes. Only those SNOMED codes listed in the AR Specimen Source value set on the Specimen Source tab in the IDM should be reported (specifically, do not include SNOMED children specimen types unless specifically listed).

1. Eligible invasive specimen sources include cerebrospinal fluid (CSF) and blood specimens.

   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.

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	*Staphylococcus aureus* isolated from blood culture	Yes	Patient's first blood culture of inpatient admission; *Staphylococcus aureus* is isolated; AR Event is reported into NHSN.
January 4	*Staphylococcus aureus* isolated from blood culture	No	It has been less than 14 days since the last positive culture (January 1) from the patient isolating *Staphylococcus aureus*.

Date	Lab Result	Reported to NHSN?	Justification
January 16	*Staphylococcus aureus* isolated from CSF culture	No	It has been less than 14 days since the last positive culture (January 4) from the patient isolating *Staphylococcus aureus*.
January 31	*Staphylococcus aureus* isolated from blood culture	Yes	It has more than 14 days since the last positive culture (January 16) from the patient isolating *Staphylococcus aureus*; AR Event is reported into NHSN.

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

All isolate test results are evaluated 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 another invasive source AR Event is entered into NHSN for the patient and specific organism (Figure 1). Based on the 14 day rule, at a maximum, there would be no more than three invasive isolates per specific organism reported per patient per month.
- For eligible non-invasive specimens, all first non-invasive isolates (chronologically) per patient, per month, per organism are reported as an AR event (Figure 2).

C. Required Data

Required data include data available from the laboratory information system, electronic health record, 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 F.

- 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 E)

- Antimicrobial susceptibility data
  - Antimicrobial (Appendix E)
  - PBP2a-agglutination (only if *Staphylococcus aureus*)
  - PCR mec-gene (only if *Staphylococcus aureus*)
  - E-test sign
  - E-test value & unit of measure
  - Interpretation of E-test
  - MIC sign
  - MIC value & unit of measure
  - Interpretation of MIC test
  - Disk diffusion (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 to be included 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 'Unknown' or 'Not Tested' for these specific tests as long as the final interpretation result can be provided for each antimicrobial tested. Facilities should not employ manual means of data collection to report AR Option data to NHSN.

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
  - N = Not Tested
  - Specific to Gentamicin and Streptomycin results for *Enterococcus* testing:
    - S = Susceptible/Synergistic
    - R = Resistant/Not Synergistic
- Only final or corrected susceptibility testing should be reported 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.

D. Removal of Same Day Duplicates

Multiple isolates of the same organism from the same specimen may be processed and produce conflicting results. Only one isolate should be reported to NHSN, retaining the unique nature of the test results. Rules must be in place to ensure duplicate isolate reports are removed. Duplicates are defined as same specific species or same genus, when identification to species level is not provided, from same patient on same day. Isolates must be of the same source type (specifically, invasive or non-invasive) to be considered duplicates.

Select the isolate to report to NHSN based on these rules:

- 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 the same specific test is performed on the same isolate but they produce conflicting results, report the final interpretation provided by the laboratory. If no final interpretation is provided by the laboratory, then report the most resistant interpretation (NS > R > I > S-DD > S > NT).
    - For example, if two E-tests are performed for the same drug on the same isolate and one produces "Intermediate" and the other produces "Susceptible", report "Intermediate" as the final interpretation for that specific drug susceptibility.
- If specific antimicrobial tests are performed on the same isolate and 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 > NT).
    - For example, if drug susceptibility results produced MIC = Resistant and E-Test = Intermediate but not final interpretation was provided, report "Resistant" as the final interpretation for that specific drug susceptibility.
- 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 > NT). If a final interpretation was not provided by the lab, report the isolate with the higher amount of drug resistance based on the number antimicrobials testing "NS" or "R". If it cannot be determined which isolate is the most resistant, report the isolate that was the first entered into the LIS.
    - For example, *Candida albicans* was isolated from two blood specimens collected from the same patient on the same calendar day and no final interpretation was provided by the lab. The first isolate tested "R" to three of the eight antimicrobials tested and the second isolate tested "R" to four of the

eight antimicrobials tested. Report the second isolate to NHSN since it showed the higher amount of resistance.

Denominator Data

For each month, report combined denominator data for all inpatient locations within the facility (facility-wide inpatient [FacWideIN]): (See Appendix G 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 day nor admissions denominators will 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 MDRO & CDI Module, further information on counting patient days and admissions can be found in Appendix 2 of the NHSN MDRO & CDI Module Protocol: NHSN MDRO & CDI Module Protocol.

Minimizing Bias & Bypassing Suppression
The ultimate source of antimicrobial susceptibility test results should be the hospital laboratory information system (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 may be needed to obtain antimicrobial resistance data for purposes of reporting to NHSN that might be suppressed from clinical end users, a practice referred to as suppression. 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.[4] Suppression can lead to significant biases in the antimicrobial resistance data available for surveillance or infection control. As a result, every effort should be made to report all antimicrobial resistance data that meets the NHSN protocol requirements, regardless of whether those data are suppressed from clinical end users.

Data Analyses:
AR option data will be expressed using several metrics at the monthly, quarterly, semi-annual, or annual time frame depending on how rare the isolates occurred (see Table 2). A facility-wide antibiogram table is available in NHSN that displays the calculated percent non-susceptible for each organism-antimicrobial combination. The antibiogram table can be stratified by specimen source, time period, and/or by specific antimicrobial or organism.

A line list can also be generated 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 default line list shows each AR Event reported to NHSN, the patientID, NHSN assigned Event ID, specimen collection date, specimen type, organism identified, antimicrobial tested, and the final interpretation. Modifications can be made to the line list to show specific months, locations,

organisms, and specific test results. The line list is the most helpful AR Option report when validating the data.

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

Additional reports and analysis reports will be available in future releases. Requests for additional reports can be sent to: NHSN@cdc.gov.

Table 2. ***Current Resistance Metrics***

Metric	Definition
Facility-wide inpatient: standard report for facility and group user	
% non-susceptible	Calculated for each* organism-antimicrobial pairing: (Total # of organisms that tested resistant or intermediate for a pathogen / Total # of organisms tested for that pathogen) *exceptions 1. *Staphylococcus aureus* test results for Oxacillin or Cefoxitin: non-susceptible isolates are only those that tested resistant. 2. *Enterococcus faecalis*, *Enterococcus faecium*, and *Enterococcus spp.* tested for Vancomycin: non-susceptible isolates for this pairing are only those that tested resistant. 3. *Escherichia coli, Klebsiella oxytoca, Klebsiella pneumonia*, *Enterobacter 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).

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

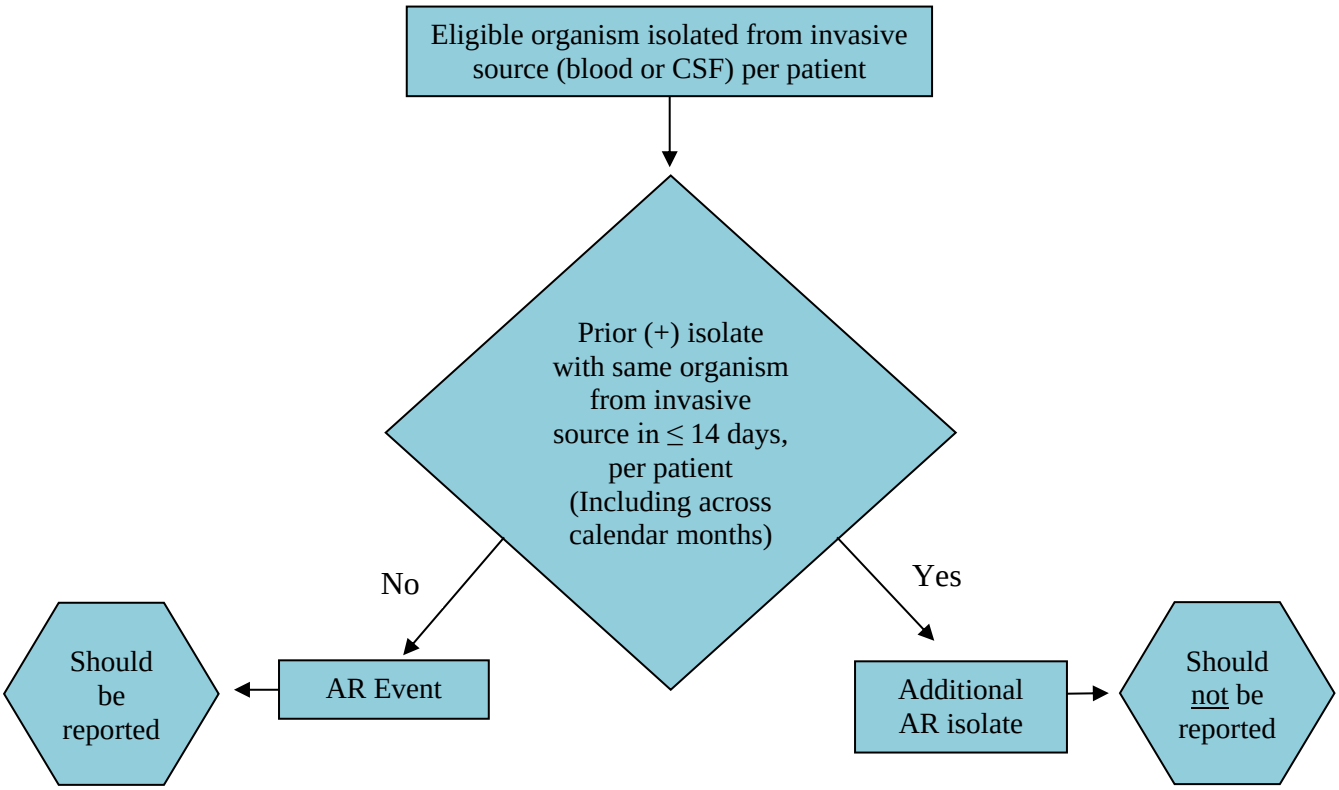
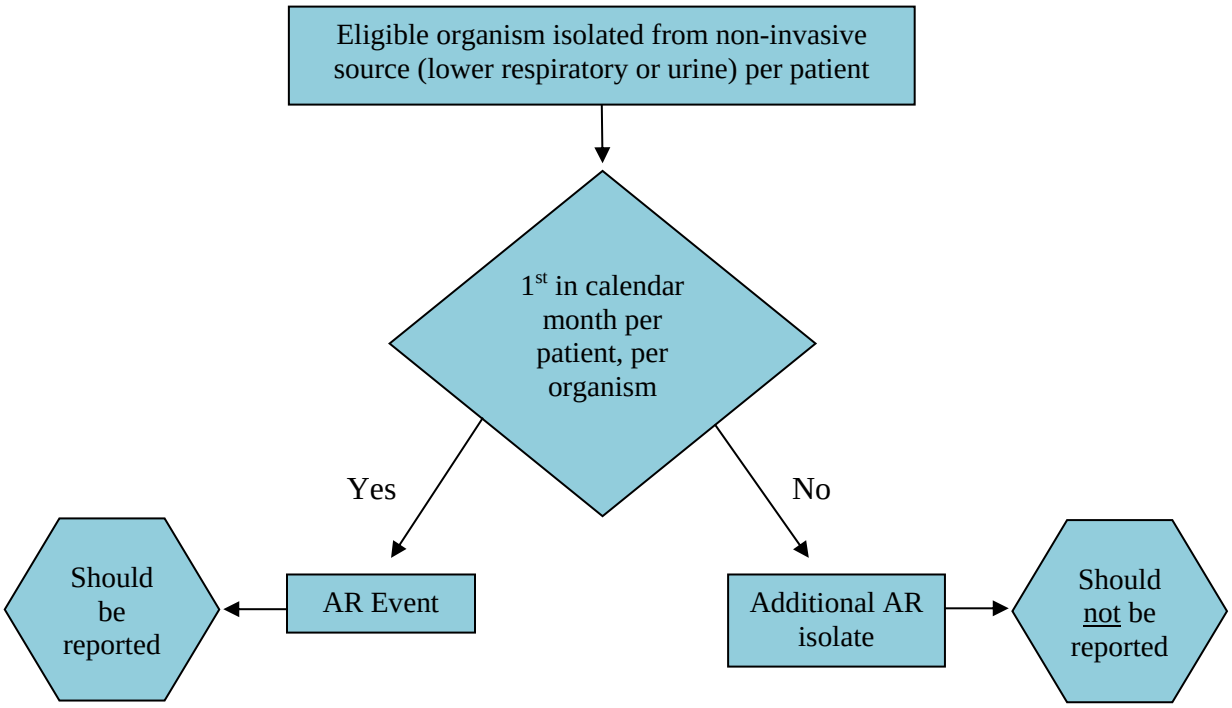


Figure 2. ***Test Result Algorithm for Non-Invasive Specimen Reporting***



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Appendix E. List of Eligible Organisms for the NHSN AR Option[3]

Please note that mapping of standardized terminology (SNOMED) 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
Acinetobacter (All *Acinetobacter* 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 Doxycycline Gentamicin Imipenem with Cilastatin Levofloxacin Meropenem Minocycline Piperacillin Piperacillin-tazobactam Tetracycline Ticarcillin-clavulanate Tobramycin Trimethoprim-sulfamethoxazole
	Additional Agents for Urine	None
Candida albicans *Candida auris* *Candida glabrata*	Blood, Urine, CSF Note: Lower respiratory will not be collected for Candida spp.	Anidulafungin Caspofungin Fluconazole Flucytosine Itraconazole Micafungin Posaconazole Voriconazole
	Additional Agents for Urine	None

Organism	Specimen Type	Antimicrobial Agents
Citrobacter freundii *Enterobacter* *(*All *Enterobacter* species noted in the IDM/Pathogen Codes tab listed in the ARO Pathogen column) *Escherichia coli* *Klebsiella oxytoca* *Klebsiella pneumoniae* *Morganella morganii* *Proteus mirabilis* *Serratia marcescens*	Blood, Urine, Lower Respiratory, CSF	Amikacin Amoxicillin-clavulanic acid Ampicillin Ampicillin-sulbactam Aztreonam Cefazolin Cefepime Cefotaxime Cefoxitin Ceftazidime Ceftriaxone Cefuroxime Chloramphenicol Ciprofloxacin Doripenem Ertapenem Gentamicin Imipenem with Cilastatin Levofloxacin Meropenem Piperacillin Piperacillin-tazobactam Tetracycline Ticarcillin-clavulanic acid Trimethoprim-sulfamethoxazole Tobramycin
	Additional Agents for Urine	Cephalothin Lomefloxacin Nitrofurantoin Norfloxacin Ofloxacin Sulfisoxazole Trimethoprim

Organism	Specimen Type	Antimicrobial Agents
Enterococcus faecalis *Enterococcus faecium* *Enterococcus* spp. (When not otherwise specified; excluding *E. faecalis*, *E. faecium*, and other identified species)	Blood, Urine, Lower Respiratory, CSF	Ampicillin Daptomycin Gentamicin Linezolid Penicillin[a] Quinupristin/dalfopristin Rifampin Streptomycin Vancomycin Note: For Gentamicin and Streptomycin only: Synergistic = Susceptible Non-synergistic = Resistant
	Additional Agents for Urine Note: Exclude Gentamicin and Streptomycin	Ciprofloxacin Levofloxacin Nitrofurantoin Norfloxacin Tetracycline
Pseudomonas aeruginosa	Blood, Urine, Lower Respiratory, CSF	Amikacin Aztreonam Cefepime Ceftazidime Ciprofloxacin Gentamicin Imipenem with Cilastatin Levofloxacin Meropenem Piperacillin Piperacillin-tazobactam Ticarcillin Tobramycin
	Additional Agents for Urine	Lomefloxacin Norfloxacin Ofloxacin

Organism	Specimen Type	Antimicrobial Agents
Staphylococcus aureus	Blood, Urine, Lower Respiratory, CSF	Azithromycin Cefoxitin Chloramphenicol Ciprofloxacin Clarithromycin Clindamycin Daptomycin Doxycycline Erythromycin Gentamicin Levofloxacin Linezolid Minocycline Moxifloxacin Ofloxacin Oxacillin or Nafcillin[b] Penicillin[a] Quinupristin-dalfoprisin Rifampin Telithromycin Tetracycline Trimethoprim-sulfamethoxazole Vancomycin
	Additional Agents for Urine	Lomefloxacin Nitrofurantoin Norfloxacin Sulfisoxazole Trimethoprim
Stenotrophomonas maltophilia	Blood, Urine, Lower Respiratory, CSF	Ceftazidime Chloramphenicol Levofloxacin Minocycline Ticarcillin-clavulanate Trimethoprim-sulfamethoxazole
	Additional Agents for Urine	None

Organism	Specimen Type	Antimicrobial Agents
Streptococcus pneumoniae	Blood, Urine, Lower Respiratory, CSF	Amoxicillin Amoxicillin-clavulanic acid Azithromycin Cefepime Cefotaxime (meningitis or non-meningitis breakpoint)[c] Ceftriaxone (meningitis or non-meningitis breakpoint)[c] Cefuroxime Chloramphenicol Clindamycin Ertapenem Erythromycin Gemifloxacin Imipenem with Cilastatin Levofloxacin Linezolid Meropenem Moxifloxacin Ofloxacin Penicillin[a] (meningitis or non-meningitis breakpoint)[c] Penicillin V[a] (oral breakpoint) Rifampin Telithromycin Tetracycline Trimethoprim-sulfamethoxazole Vancomycin
	Additional Agents for Urine	None
Group B *Streptococcus*	Blood, Urine, Lower Respiratory, CSF	Ampicillin Cefazolin Cefotaxime Cefoxitin Ciprofloxacin Clindamycin Daptomycin Erythromycin Levofloxacin Linezolid Penicillin[a] Tetracycline Vancomycin
	Additional Agents for Urine	None

[a] 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 (N).

[b] For *Staphylococcus aureus* susceptibility testing, if the LIS tests Nafcillin instead of Oxacillin, report Nafcillin susceptibility results as Oxacillin.

[c] 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 F. Isolate Based Report Variables

NAME	DESCRIPTION OF FIELD	CODE VALUE LIST	LEVEL OF REQUIREMENT
Facility OID[a]	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. Note – use the encounter date if event occurred in an outpatient location.		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.		Required
Organism	Organism identified from specimen collected (Appendix E).	SNOMED	Required
Antimicrobial[b]	Antimicrobial(s) tested for susceptibility (Appendix E will define agents by organism and specimen source)	RxNorm	Required
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[c]	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

NAME	DESCRIPTION OF FIELD	CODE VALUE LIST	LEVEL OF REQUIREMENT
Interpretation of E-test	Interpretation result of the E-test susceptibility test performed		Required
MIC sign[c]	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[c]	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

[a] 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.

[b] 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.

[c] 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 to be included in the CDA report, facilities unable to electronically obtain these results may still participate by using ‘Unknown’ or ‘Not Tested’. Facilities should not employ manual means of data collection.

Appendix G. Denominator Data Variables

	DESCRIPTION OF FIELD	LEVEL OF REQUIREMENT
Facility Wide Inpatient Denominator		
Facility OID[a]	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

[a] 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.