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.

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] The two main reasons for this increase are patient-to-patient transmission of resistant organisms and selection of resistant organisms because of antimicrobial exposure.[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 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 1000 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); 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 to a patient care location or facility anytime throughout a day during a calendar month (refer to Denominator Data Section). For each facility, the numerator (i.e., antimicrobial days) is aggregated by month for each patient care location and overall for inpatient areas facility-wide (i.e., facility-wide inpatient). Similarly, the denominator (i.e., 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]

Settings: NHSN encourages submission of all NHSN-defined inpatient locations, facility-wide inpatient, and select outpatient acute-care settings (i.e., outpatient emergency department, pediatric emergency department, 24-hour observation area) at each facility (Table 1). The patient care areas may include adult, pediatric, or neonatal units as defined by NHSN Codes (Chapter 15 CDC Locations and Descriptions). A comprehensive submission will enable a facility to optimize inter- and/or intra-facility comparisons among specific wards, combined wards, and hospital-wide data. The optional and minimal requirements for participation in the Antimicrobial Use option are listed in Table 1.

The minimal requirement for participation is submission of data for all four of the following location types (if applicable to facility): 1) all medical critical care units(s) and surgical critical care units(s) [if combined units, then report as medical/surgical critical care unit(s)]; 2) all medical ward(s) and surgical ward(s) [if combined wards, then report as medical/surgical ward(s)]; 3) at least one specialty care area; and 4) facility-wide inpatient (both days present and admissions must be reported for this location).

Table 1. ***CDC Location[a]: Optional and Minimal Requirements for the AU Option***

Inpatient Locations	Minimal Submission Requirements (if applicable for facility)
Adult Critical Care Units	**Requirement**: For facilities with only adult critical care unit(s): submit all medical critical care unit(s) and surgical critical care units(s) [if combined units, then report as medical/surgical critical care unit(s)]. For facilities with adult and pediatric critical care unit(s), the minimum requirement is the submission of data from all adult and pediatric critical care locations.
Pediatric Critical Care Units	**Requirement**: For facilities with only pediatric critical care unit(s): submit all medical critical care unit(s) and surgical critical care units(s) [if combined units, then report as medical/surgical critical care unit(s)]. For facilities with adult and pediatric critical care unit(s), the minimum requirement is the submission of data from all adult and pediatric critical care locations.
Neonatal Units	Optional (i.e., no minimal submission requirement)
Inpatient Specialty Care Areas	**Requirement:** At least one Specialty Care Area.
Inpatient Adults Wards	**Requirement:** For facilities with only adult medical and surgical ward(s), submit all medical ward(s) and surgical ward(s) [if combined wards, then report as medical/surgical ward(s)]. For facilities with adult and pediatric medical and surgical ward(s), the minimum requirement is the submission of data from all adult and pediatric medical and surgical ward locations.
Inpatient Pediatric Wards	**Requirement:** For facilities with only pediatric medical and surgical ward(s), submit all medical ward(s) and surgical ward(s) [if combined wards, then report as medical/surgical ward(s)]. For facilities with adult and pediatric medical and surgical ward(s), the minimum requirement is the submission of data from all adult and pediatric medical and surgical ward locations.
Step Down Units	Optional (i.e., no minimal submission requirement)
Operating Rooms	Optional (i.e., no minimal submission requirement)
Chronic Care	Optional (i.e., no minimal submission requirement)
Facility-Wide	**Minimal Submission Requirements (if applicable for facility)**
Facility-wide inpatient	**Requirement:** Facility-wide inpatient

Outpatient Locations	Minimal Submission Requirements (if applicable for facility)
Select Outpatient Acute Care Settings	Optional (i.e., no minimal submission requirement) Includes outpatient emergency department, pediatric emergency department, and 24-hour observation area.

[a]**CDC Location:** A CDC-defined designation given to a patient care area where patients who have similar disease conditions or are receiving care for similar medical or surgical specialties. Each facility location that is monitored is "mapped" to one CDC Location. The specific CDC Location code is determined by the type of patients cared for in that area according to the **80% Rule**. That is, if 80% of patients are of a certain type (e.g., pediatric patients with orthopedic problems), then that area is designated as that type of location (in this case, an Inpatient Pediatric Orthopedic Ward). See Locations chapter for more information regarding location mapping.

Requirements: An acceptable minimal month of data includes:

1. Each month, the facility must choose to monitor antimicrobial use data on the *Patient Safety Monthly Reporting Plan* (CDC 57.106).
2. Data submitted for all four of the following locations (if applicable to facility): 1) all medical critical care unit(s) and surgical critical care unit(s) [if combined units, then report as medical/surgical critical care unit(s)]; 2) all medical ward(s) and surgical ward(s) [if combined wards, then report as medical/surgical ward(s)]; 3) at least one specialty care area; and 4) facility-wide inpatient (both days present and admissions must be reported for this location).
3. All data fields outlined in the *Table of Instructions* (Appendix A) for the AU option are completed via CDA for each location.

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, and select outpatient acute care settings (e.g., outpatient emergency department, pediatric emergency department, 24-hour observation area) for select antimicrobial agents and stratified by route of administration (e.g., intravenous, intramuscular, digestive and respiratory). Refer to Table 2 and Table 3 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. Appendix C provides additional examples for the calculation of antimicrobial days. Table 4 summarizes the data elements for numerator calculation.

Please note that "zero" should be recorded when no aggregate usage occurred during a given reporting period for a specific antimicrobial agent at a facility in which the agent is used, while "not applicable" should be recorded when data are not available for a specific antimicrobial agent at a facility (e.g., the agent can't be electronically captured at that facility). A value (e.g., a specific number, "zero", or "not applicable") must be reported for every antimicrobial agent listed in Appendix B.

Table 2. ***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.
Respiratory Tract	A route that begins within the respiratory tract, including the oropharynx and nasopharynx.

[a] Other routes of administration are excluded in this module (e.g., antibiotic locks, intraperitoneal, intraventricular, irrigation, topical).
[b] Definitions per SNOMED Reference Terminology

Table 3. ***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)

[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 not FDA approved for administration via the digestive route).

Table 4. ***Data Elements for Antimicrobial Days***

Data Element	Antimicrobial Days
Antimicrobial Agents	Defined as select antimicrobial agents and stratified by route of administration (i.e., 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 (e.g., pharmacy orders, doses dispensed, doses billed) cannot be submitted.
Location	Antimicrobial days are aggregated for inpatient locations, facility-wide inpatient, and select outpatient acute-care settings (i.e., outpatient emergency department, pediatric emergency department, 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 as well as admissions (for facility-wide inpatient only). The denominators are further defined below.

Days present: 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 and that recommended by the SHEA/HIPAC guidance for surveillance of multidrug-resistant organisms.[12] 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 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. For example, 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. Another example, 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. Similarly, a patient's exposure to the operating room or emergency department will be included in days present for these types of units. However, one patient can account for only one day present for a specific location per calendar day (e.g., 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 analyses, days present is calculated as the number of patients who were present for any portion of each day of a calendar month at the facility-wide inpatient location; 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, because transfers between wards can account for multiple location "days present" for a given patient. Therefore, the individual summing of days present for location-specific analyses to achieve facility-wide inpatient is not permissible. The calculation must be a separate summation for facility-wide inpatient analyses.

Admissions: Admissions are defined as the aggregate number of patients admitted to the facility (i.e., 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 utilized in the NHSN MDRO/CDI Module. In the AU option, admissions are reported only for facility-wide inpatient.

Table 5. ***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 measure (reflecting transfers between locations).
Facility-wide Inpatient Analyses		
Antimicrobial Days/Days present	Drug-specific antimicrobial days for 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 an entire facility. The day present measure for facility-wide inpatient may be lower when compared to sum total from location-specific comparison.
Antimicrobial Days/Admissions	Drug-specific antimicrobial days for a facility per month/Admissions per facility-wide inpatient per month	Only calculated for facility-wide inpatient for AU Option.

Data Analyses:
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 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 (i.e., 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.

Additionally, antimicrobial use data are expressed as incidence density rates of antimicrobial days per days present stratified by patient care location and facility-wide inpatient. Antimicrobials may be grouped during analysis by route of administration, spectrum of activity, or drug classification.

A secondary metric, antimicrobial days per admissions, will also be analyzed for facility-wide inpatient.

References

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Appendix A. Table of Instructions: Antimicrobial Use

Data Field	Instructions for CDA of Antimicrobial Use Data
Facility identifier	Required. Must be assigned to facility and included in the importation file prior to submission to CDC.
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. Record location; must be (if applicable to facility): 1) all medical critical care unit(s) and surgical critical care unit(s) [if combined units, then report as medical/surgical critical care unit(s)]; 2) all medical ward(s) and surgical ward(s) [if combined wards, then report as medical/surgical ward(s)]; 3) at least one specialty care area; and 4) facility-wide inpatient.
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: 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 for any portion of each day of a calendar month at the facility-wide inpatient location Admissions are defined as the aggregate number of patients admitted to the facility (i.e., 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.

Appendix B. List of Antimicrobials

Please note that mapping of standardized terminology (RXNORM) are provided via PHIN Vocabulary Access and Distribution System (VADS). 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	
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	
MEROPENEM	Antibacterial	Carbapenems	

Antimicrobial Agent	Antimicrobial Category	Antimicrobial Class[a]	Antimicrobial Subclass[a]
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	
TOBRAMYCIN	Antibacterial	Aminoglycosides	

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

[a] Adapted from CLSI January 2014

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 drug-specific (total) and stratified by route of administration based upon 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 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 Calculation 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 drug-specific (total) and stratified by route of administration based upon the administered doses of vancomycin documented in eMAR. Table 3 illustrates the contribution of this patient's vancomycin days to the aggregate monthly report per patient care location and facility-wide inpatient.

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 drug-specific (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.

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

Antibacterial agents predominantly used for surgical site infection prophylaxis

- CEFAZOLIN
- CEFOTETAN
- CEFOXITIN
- CEFUROXIME
- CEPHALEXIN

All antibacterial agents

Includes all antibacterial agents reported into the AU Option including the agents listed in the category specific SAARs.

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 (i.e., 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 and rate in this module.[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. In comparison, the antimicrobial resistance rate is defined as the number of resistant isolates per 1000 patient days. For each facility, the numerator (i.e., 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]

Settings:

NHSN encourages reporting specimens from all NHSN-defined inpatient locations at each facility. The denominators of patient days and admissions are only reported at the facility-wide

inpatient level (FacWideIN). Eligible facilities include any facility using the Patient Safety Component of NHSN.

Requirements:

Each month:

1. The facility must choose to monitor antimicrobial resistance data on the *Patient Safety Monthly Reporting Plan* (CDC 57.106).
2. Two record types must be reported for each month of surveillance.
   - One 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 for the denominator data report (facility-wide inpatient-FacWideIN)

NHSN recommends that antimicrobial resistance 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 A). Only isolates collected in an inpatient location of the reporting facility should be considered for eligibility. Eligible isolate-based reports must have had susceptibility testing performed. This should be consistent with CLSI M39 Guidance on reporting cumulative susceptibility test results.

Note: All cultures of the eligible organisms that meet the reporting guidelines outlined below should be reported to NHSN regardless of the antimicrobial resistance of the isolated organism (i.e., even isolates that are susceptible to all required antimicrobials as well as isolates in which all of the required antimicrobials were not tested should be reported into NHSN).

Two distinct events should be reported on the basis of specimens obtained in inpatient locations:

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.
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.

A. Eligible organisms include:
- All *Acinetobacter* species
- *Candida albicans*
- *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*

B. Specimen Sources (Appendix B)

Facilities and vendors should refer to the Information Data Model (IDM) provided by the NHSN CDA Team (NHSNCDA@cdc.gov) for the complete list of valid specimens.

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/species) only if the patient had no positive blood or CSF culture result with that specific organism (genus/species) within the last 14 days, even across calendar months with no intervening positive blood or CSF.

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.*
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 (e.g., 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).

Note: The AR Option protocol and associated 14 day rule applies only to those cultures collected at an inpatient location in the reporting facility. The 14 day rule starts with the day of specimen collection occurring in an inpatient location within the reporting facility. Outpatient locations should not be included in the 14 day rule as cultures collected in outpatient locations cannot be reported to the NHSN AR Option at this time. Further, cultures obtained while the patient was at another healthcare facility should not be included in the 14 day calculations.

Use SNOMED codes to identify eligible specimen types to be included in identification of isolate-based report. Only those SNOMED codes listed in Appendix B should be reported (i.e., do not include SNOMED children specimen types unless specifically listed in Appendix B).

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, isolate/patient related data, and antimicrobial susceptibility data as outlined below.

For additional information on each variable please see Appendix C.

- Facility identifier
  - Unique NHSN Facility ID (Object Identifier [OID] is used in the CDA)

- Isolate / Patient related data
  - Patient identifier
  - Date of birth
  - Gender
  - Date admitted to facility
  - Specimen collection date
  - Specimen source (Appendix B)
  - Location code (mapped to CDC location codes)
  - Isolate identifier (unique isolate ID in the electronic laboratory report)
  - Organism (Appendix A)

- Antimicrobial susceptibility data
  - Antimicrobial (Appendix A)
  - 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
  - Zone sign
  - Zone value & unit of measure
  - Interpretation of zone test (disk diffusion)
  - 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 (i.e., E-test, MIC, Zone) may still report antimicrobial resistance 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 antimicrobial resistance data to NHSN.

Reporting Guidelines

- Interpretation of test results (E-test, MIC test, Zone 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. Remove Same Day Duplicates

Multiple isolates of the same species 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 (i.e., 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 (i.e., 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 (i.e., NS > R > I > S-DD > S > NT).

- 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 (i.e., NS > R > I > S-DD > S > NT).
- If two isolates from the same day have conflicting susceptibilities to the panel of antimicrobials tested, report the isolate with the most resistant interpretation (i.e., NS > R > I > S-DD > S > NT). If it cannot be determined which isolate is the most resistant, report the isolate that was the first entered into the LIS.

Denominator data report

For each month, report facility-wide denominator data: (See Appendix D)

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

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. 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:

Antimicrobial resistance 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.

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

Metric	Definition
Facility-wide inpatient: standard output 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, intermediate, susceptible dose-dependent (S-DD), or non-susceptible (NS).

A line list of antimicrobial resistant events is also currently available. Additional reports and analysis output options will be available in future releases. Requests for additional reports can be sent to: NHSN@cdc.gov.

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

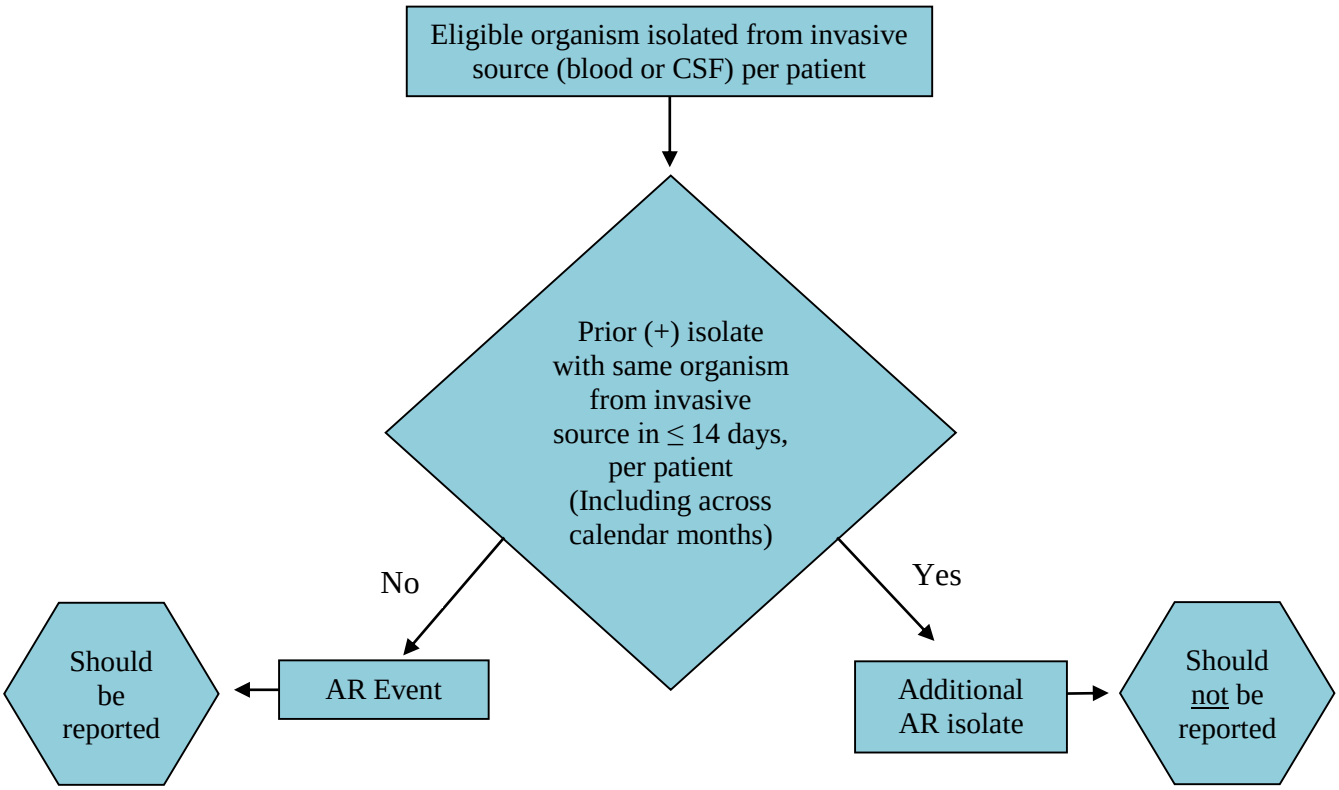
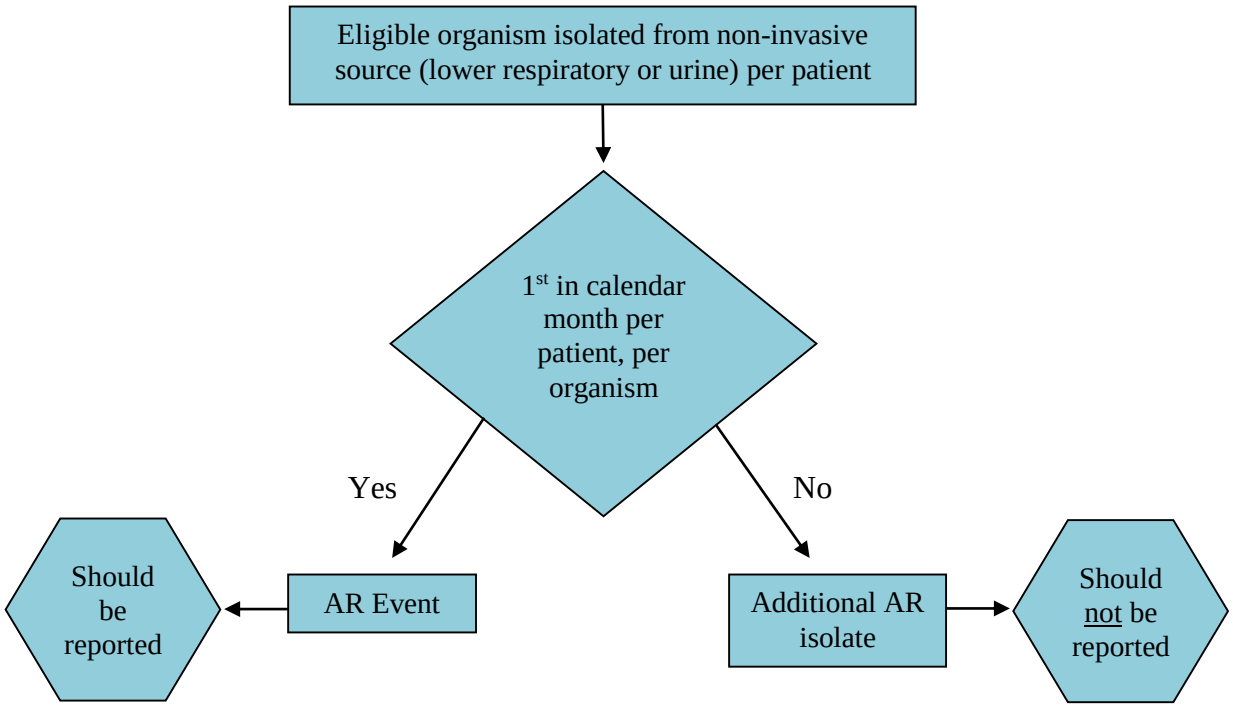


Figure 2. ***Test Result Algorithm for Non-Invasive Specimen Reporting***



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4. Council of State and Territorial Epidemiologists (CSTE). Recommendations for strengthening public health surveillance of antimicrobial resistance in the United States. http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/PS/13-SI-01.pdf. Accessed October 1, 2015.

Appendix A. List of Organisms for Antimicrobial Resistance[3]

Please note that mapping of standardized terminology (SNOMED) are provided upon request to the NHSN CDA Team at NHSNCDA@cdc.gov. Testing methods should follow most recent CLSI guidance as appropriate.

Organism	Specimen Type	Antimicrobial Agents
Acinetobacter (All *Acinetobacter* species noted in the IDM/pathogen tab shall be reported as *Acinetobacter* spp.)	Blood, Urine, Lower Respiratory, CSF	Amikacin Ampicillin-sulbactam Cefepime Cefotaxime Ceftazidime Ceftriaxone Ciprofloxacin Doxcycline Gentamicin Imipenem with Cilastatin Levofloxacin Meropenem Minocycline Piperacillin Piperacillin-tazobactam Tetracycline Ticarcillin-clavulanate Tobramycin Trimethoprim-sulfamethoxazole
	Additional Agents for Urine	None
Candida albicans *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 tab shall be reported as *Enterobacter* spp.) *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 B. SNOMED Codes to Identify Eligible Specimen Types

Please note that mapping of standardized terminology for specimen type are provided upon request to the NHSN CDA Team at NHSNCDA@cdc.gov.

Specimen Type	Description	SNOMED CT Code
Blood	Blood specimen (specimen)	119297000
Urine	Urinary specimen (specimen)	122575003
Cerebral Spinal Fluid	Cerebrospinal fluid sample (specimen)	258450006
Lower Respiratory Specimens	coughed sputum specimen (specimen)	119335007
	specimen from trachea (specimen)	119390000
	specimen from lung obtained by bronchial washing procedure (specimen)	122609004
	specimen from lung obtained by biopsy (specimen)	122610009
	specimen from lung obtained by fiberoptic bronchoscopic biopsy (specimen)	122611008
	upper respiratory fluid specimen obtained by tracheal aspiration (specimen)	122877000
	tissue specimen from bronchus (specimen)	128158009
	tissue specimen from trachea (specimen)	128173005
	bronchial fluid sample (specimen)	258446004
	sputum specimen obtained by aspiration (specimen)	258608003
	sputum specimen obtained by aspiration from trachea (specimen)	258609006
	sputum specimen obtained by sputum induction (specimen)	258610001
	sputum specimen obtained from sputum suction trap (specimen)	258611002
	lower respiratory tissue sample (specimen)	309170008
	lower respiratory fluid sample (specimen)	309171007
	transbronchial lung biopsy sample (specimen)	309173005
	bronchial biopsy sample (specimen)	309174004
	bronchial brushings sample (specimen)	309176002
	tissue specimen from lung (specimen)	399492000
	specimen obtained by bronchial aspiration (specimen)	441903006
	specimen obtained by bronchioloalveolar lavage procedure (specimen)	441917002
	specimen from trachea obtained by aspiration (specimen)	445447003
	specimen obtained by bronchial trap (specimen)	446838005
	bronchial fluid specimen obtained from bronchial trap (specimen)	447345009
	sputum specimen (specimen)	119334006
	specimen from bronchus (specimen)	119391001

Specimen Type	Description	SNOMED CT Code
	specimen from lung (specimen)	127458004
	lower respiratory sample (specimen)	258606004
	bronchoalveolar lavage fluid sample (specimen)	258607008
	tracheal biopsy sample (specimen)	309169007

Appendix C. Isolate Based Report Variables

NAME	DESCRIPTION OF FIELD	CODE VALUE LIST	LEVEL OF REQUIREMENT
Facility ID	NHSN-assigned facility ID number	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.		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 (e.g. 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 A).	SNOMED	Required
Antimicrobial[a]	Antimicrobial(s) tested for susceptibility (Appendix A 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	E-test sign[b]		Optionally Required
E-test value/units of measure	E-test (Value in micrograms/liter). Use '.' as decimal delimiter, e.g. 0.25		Optionally Required
Interpretation of E-test	Interpretation result of the E-test susceptibility test performed		Required

NAME	DESCRIPTION OF FIELD	CODE VALUE LIST	LEVEL OF REQUIREMENT
MIC sign	MIC sign[b]		Optionally Required
MIC value/units of measure	MIC (Value in micrograms/liter). Use '.' as decimal delimiter, e.g. 0.25		Optionally Required
Interpretation of MIC test	Interpretation result of the MIC susceptibility test performed		Required
Zone sign	Zone sign[b]		Optionally Required
Zone value/units of measure	Zone value in millimeters		Optionally Required
Interpretation of Zone test	Interpretation result of the zone susceptibility test performed		Required
Final Interpretation result	Final interpretation result of all different susceptibility tests performed		Required

[a] 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.

[b] 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 (i.e., E-test, MIC, Zone) 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 D. Denominator Data Variables

	DESCRIPTION OF FIELD	CODE VALUE LIST	LEVEL OF REQUIREMENT
Facility Wide Denominator			
Facility ID	NHSN –assigned facility ID number	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	For facility wide inpatients, 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 should be included where denominators can be accurately collected.		Required