



## Antimicrobial Use and Resistance (AUR) Module

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### **Introduction**

This module contains two options, one focused on antimicrobial usage 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 \(CDA\)](#).<sup>7</sup> Manual data entry is not available for the AUR Module.

### **Purpose:**

The goal of this National Healthcare Safety Network (NHSN) AUR Module is to provide 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.<sup>6</sup>



## 1. Antimicrobial Use (AU) Option

### Introduction

Rates of resistance to antimicrobial agents continue to increase at hospitals in the United States.<sup>1</sup> The two main reasons for this increase are patient-to-patient transmission of resistant organisms and selection of resistant organisms because of antimicrobial exposure.<sup>2</sup> 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.<sup>3-5</sup>

**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.<sup>8-11</sup> 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 1000 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](#).<sup>7</sup>

**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 locations (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<sup>a</sup>: Optional and Minimal Requirements for AU Option**

| <b>Inpatient Locations</b>            | <b>Minimal Submission Requirements (if applicable for facility)</b>   |
|---------------------------------------|---|
| <b>Adult Critical Care Units</b>      | <p><b>Requirement:</b><br/>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)].</p> <p>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.</p>     |
| <b>Pediatric Critical Care Units</b>  | <p><b>Requirement:</b><br/>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)].</p> <p>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.</p> |
| <b>Neonatal Units</b>                 | Optional (i.e., no minimal submission requirement)  |
| <b>Inpatient Specialty Care Areas</b> | <b>Requirement:</b> At least one Specialty Care Area  |
| <b>Inpatient Adults Wards</b>         | <p><b>Requirement:</b><br/>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)].</p> <p>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.</p>                      |
| <b>Inpatient Pediatric Wards</b>      | <p><b>Requirement:</b><br/>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)].</p> <p>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.</p>                  |
| <b>Step Down Units</b>                | Optional (i.e., no minimal submission requirement)  |
| <b>Operating Rooms</b>                | Optional (i.e., no minimal submission requirement)  |
| <b>Long Term Care</b>                 | Optional (i.e., no minimal submission requirement)  |



|  |   |
|--|---|
| <b>Inpatient Locations</b>   | <b>Minimal Submission Requirements (if applicable for facility)</b> |
| <b>Facility-Wide</b>   | <b>Minimal Submission Requirements (if applicable for facility)</b> |
| <b>Facility-wide-inpatient</b>   | <b>Requirement:</b> Facility-wide-inpatient                         |
| <b>Outpatient Locations</b>  | <b>Minimal Submission Requirements (if applicable for facility)</b> |
| <b>Select Acute Care Settings</b><br>Outpatient Emergency<br>Department<br>Pediatric Emergency<br>Department<br>24-Hour Observation Area | Optional (i.e., no minimal submission requirement)                  |

<sup>a</sup>**CDC Location:** A CDC-defined designation given to a patient-care area housing patients who have similar disease conditions or who 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:

- a. 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).
- b. Each month, the facility must choose to monitor antimicrobial use data on the [Patient Safety Monthly Reporting Plan](#) (CDC 57.106)
- c. All data fields outlined in the *Table of Instructions* ([Appendix A](#)) for the AU option are completed via CDA for each location.

**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.<sup>8-11</sup> Appendix B provides a list of antimicrobial agents. 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”) should be reported for every antimicrobial agent listed in [Appendix B](#).

**Table 2. Classification and Definitions of Route of Administrations for Antimicrobial Days**

| <b>Classification:<br/>Route of Administration<sup>a</sup></b> | <b>Definition<sup>b</sup></b>  |
|--|--|
| Intravenous  | An intravascular route that begins with a vein.  |
| Intramuscular  | 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.  |

<sup>a</sup> Other routes of administration are excluded in this module (e.g., antibiotic locks, intraperitoneal, intraventricular, irrigation, topical).

<sup>b</sup> Definitions per SNOMED Reference Terminology

**Table 3. Example Stratification of Antimicrobial Days by Route of Administration**

| <b>Month/<br/>Year-<br/>Location</b> | <b>Antimicrobial<br/>Agent</b> | <b>Drug-specific Antimicrobial Days</b> |                            |                            |                                   |                                     |
|--------------------------------------|--------------------------------|---|----------------------------|----------------------------|-----------------------------------|-------------------------------------|
|                                      |                                | <b>Total<sup>a</sup></b>                | <b>IV</b>                  | <b>IM</b>                  | <b>Digestive<sup>b</sup></b>      | <b>Respiratory</b>                  |
| Month-<br>Year/<br>Location          | Tobramycin                     | Tobramycin<br>Days<br>(Total)           | Tobramycin<br>Days<br>(IV) | Tobramycin<br>Days<br>(IM) | Tobramycin<br>Days<br>(Digestive) | Tobramycin<br>Days<br>(Respiratory) |

<sup>a</sup> 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)”.

<sup>b</sup> 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**

|                             | <b>Antimicrobial Days</b>   |
|-----------------------------|---|
| <b>Antimicrobial Agents</b> | 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 antimicrobial agents. The list of select antimicrobial agents will evolve with time as new agents become commercially available. <i>Topical antimicrobial agents are not included in this module option.</i> |
| <b>Data source</b>          | 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.  |
| <b>Location</b>             | 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.  |
| <b>Time Unit</b>            | Antimicrobial days for a specific antimicrobial agent and stratification by route of administration are aggregated monthly per location.  |

**Denominator Data (Days Present and Admissions):** The numerator will be analyzed against the denominator of days present and also 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.<sup>12</sup> 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 days present. 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 1 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  |
|--|---|---|
| <b>Inpatient Care Location-Specific Analyses</b> |   |   |
| 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).  |
| <b>Facility-wide-inpatient Analyses</b>          |   |   |
| 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:**

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, therapeutic indication, 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:<br><br>Antimicrobial days per month per location | Required.<br><br>Antimicrobial days are defined as the aggregate sum of the days of exposure for which a <u>specific</u> antimicrobial was administered. These are required to be extracted from electronic medication administration record (eMAR) and/or bar coding medication record (BCMA). Antimicrobials days will be collected for select antimicrobial agents (refer to <a href="#">Appendix B</a> ) <u>and</u> stratified by route of administration.  |
| Denominator:<br><br>Days present                            | Required.<br><br>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  | 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 AUR Use Option, admissions are only reported for facility-wide-inpatient.   |



**Appendix B. List of Antimicrobials**

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

| Antimicrobial Agent         | Antimicrobial Category | Antimicrobial Class <sup>a</sup> | Antimicrobial Subclass <sup>a</sup>         |
|-----------------------------|------------------------|----------------------------------|---|
| AMANTADINE                  | Anti-influenza         | M2 ion channel inhibitors        |   |
| AMIKACIN                    | Antibacterial          | Aminoglycosides                  |   |
| AMOXICILLIN                 | Antibacterial          | Penicillins                      | Aminopenicillin                             |
| AMOXICILLIN/<br>CLAVULANATE | Antibacterial          | Penicillins                      | B-lactam/ B-lactamase inhibitor combination |
| AMPHOTERICIN B              | Antifungal             | Polyenes                         |   |
| AMPHOTERICIN B<br>LIPOSOMAL | Antifungal             | Polyenes                         |   |
| AMPICILLIN                  | Antibacterial          | Penicillins                      | Aminopenicillin                             |
| AMPICILLIN/<br>SULBACTAM    | Antibacterial          | Penicillins                      | B-lactam/ B-lactamase inhibitor combination |
| ANIDULAFUNGIN               | Antifungal             | Echinocandins                    |   |
| AZITHROMYCIN                | Antibacterial          | Macrolides                       |   |
| AZTREONAM                   | Antibacterial          | Monobactams                      |   |
| CASPOFUNGIN                 | Antifungal             | Echinocandins                    |   |
| CEFACLOR                    | Antibacterial          | Cephalosporins                   | Cephalosporin 2 <sup>rd</sup> generation    |
| CEFADROXIL                  | Antibacterial          | Cephalosporins                   | Cephalosporin 1 <sup>st</sup> generation    |
| CEFAZOLIN                   | Antibacterial          | Cephalosporins                   | Cephalosporin 1 <sup>st</sup> generation    |
| CEFDINIR                    | Antibacterial          | Cephalosporins                   | Cephalosporin 3 <sup>rd</sup> generation    |
| CEFDITOREN                  | Antibacterial          | Cephalosporins                   | Cephalosporin 3 <sup>rd</sup> generation    |
| CEFEPIME                    | Antibacterial          | Cephalosporins                   | Cephalosporin 4 <sup>th</sup> generation    |
| CEFIXIME                    | Antibacterial          | Cephalosporins                   | Cephalosporin 3 <sup>rd</sup> generation    |
| CEFOTAXIME                  | Antibacterial          | Cephalosporins                   | Cephalosporin 3 <sup>rd</sup> generation    |
| CEFOTETAN                   | Antibacterial          | Cephalosporins                   | Cephamycin                                  |
| CEFOXITIN                   | Antibacterial          | Cephalosporins                   | Cephamycin                                  |
| CEFPODOXIME                 | Antibacterial          | Cephalosporins                   | Cephalosporin 3 <sup>rd</sup> generation    |
| CEFPROZIL                   | Antibacterial          | Cephalosporins                   | Cephalosporin 2 <sup>rd</sup> generation    |
| CEFTAROLINE                 | Antibacterial          | Cephalosporins                   | Cephalosporin 5 <sup>th</sup> generation    |
| CEFTAZIDIME                 | Antibacterial          | Cephalosporins                   | Cephalosporin 3 <sup>rd</sup> generation    |
| CEFTIBUTEN                  | Antibacterial          | Cephalosporins                   | Cephalosporin 3 <sup>rd</sup> generation    |
| CEFTIZOXIME                 | Antibacterial          | Cephalosporins                   | Cephalosporin 3 <sup>rd</sup> generation    |
| CEFTRIAZONE                 | Antibacterial          | Cephalosporins                   | Cephalosporin 3 <sup>rd</sup> generation    |



| Antimicrobial Agent            | Antimicrobial Category | Antimicrobial Class <sup>a</sup>           | Antimicrobial Subclass <sup>a</sup>      |
|--------------------------------|------------------------|--|--|
| CEFUROXIME                     | Antibacterial          | Cephalosporins                             | Cephalosporin 2 <sup>rd</sup> generation |
| CEPHALEXIN                     | Antibacterial          | Cephalosporins                             | Cephalosporin 1 <sup>st</sup> generation |
| CHLORAMPHENICOL                | Antibacterial          | Phenicol                                   |  |
| CIPROFLOXACIN                  | Antibacterial          | Fluoroquinolones                           |  |
| CLARITHROMYCIN                 | Antibacterial          | Macrolides                                 |  |
| CLINDAMYCIN                    | Antibacterial          | Lincosamides                               |  |
| COLISTIMETHATE                 | Antibacterial          | Polymyxins                                 |  |
| DAPTOMYCIN                     | Antibacterial          | Lipopeptides                               |  |
| DICLOXACILLIN                  | Antibacterial          | Penicillins                                | Penicillinase-stable penicillins         |
| DORIPENEM                      | Antibacterial          | Carbapenems                                |  |
| DOXYCYCLINE                    | Antibacterial          | Tetracyclines                              |  |
| ERTAPENEM                      | Antibacterial          | Carbapenems                                |  |
| ERYTHROMYCIN                   | Antibacterial          | Macrolides                                 |  |
| ERYTHROMYCIN/<br>SULFISOXAZOLE | Antibacterial          | Folate pathway inhibitors/<br>Sulfonamides |  |
| FIDAXOMICIN                    | Antibacterial          | Macrocyclic                                |  |
| FLUCONAZOLE                    | Antifungal             | Azoles                                     |  |
| FOSFOMYCIN                     | Antibacterial          | Fosfomycins                                |  |
| GEMIFLOXACIN                   | Antibacterial          | Fluoroquinolones                           |  |
| GENTAMICIN                     | Antibacterial          | Aminoglycosides                            |  |
| IMIPENEM/<br>CILASTATIN        | Antibacterial          | Carbapenems                                |  |
| ITRACONAZOLE                   | Antifungal             | Azoles                                     |  |
| LEVOFLOXACIN                   | Antibacterial          | Fluoroquinolones                           |  |
| LINEZOLID                      | Antibacterial          | Oxazolidinones                             |  |
| MEROPENEM                      | Antibacterial          | Carbapenems                                |  |
| METRONIDAZOLE                  | Antibacterial          | Nitroimidazoles                            |  |
| MICAFUNGIN                     | Antifungal             | Echinocandins                              |  |
| MINOCYCLINE                    | Antibacterial          | Tetracyclines                              |  |
| MOXIFLOXACIN                   | Antibacterial          | Fluoroquinolones                           |  |
| NAFCILLIN                      | Antibacterial          | Penicillins                                | Penicillinase-stable penicillins         |
| NITROFURANTOIN                 | Antibacterial          | Nitrofurans                                |  |
| OSELTAMIVIR                    | Anti-influenza         | Neuraminidase inhibitors                   |  |
| OXACILLIN                      | Antibacterial          | Penicillins                                | Penicillinase-stable                     |



| Antimicrobial Agent               | Antimicrobial Category | Antimicrobial Class <sup>a</sup> | Antimicrobial Subclass <sup>a</sup>         |
|-----------------------------------|------------------------|----------------------------------|---|
|                                   |                        |                                  | penicillins                                 |
| PENICILLIN G                      | Antibacterial          | Penicillins                      | Penicillin                                  |
| PENICILLIN V                      | Antibacterial          | Penicillins                      | Penicillin                                  |
| PIPERACILLIN                      | Antibacterial          | Penicillins                      | Ureidopenicillin                            |
| PIPERACILLIN/<br>TAZOBACTAM       | Antibacterial          | Penicillins                      | B-lactam/ B-lactamase inhibitor combination |
| POLYMYXIN B                       | Antibacterial          | Polymyxins                       |   |
| POSACONAZOLE                      | Antifungal             | Azoles                           |   |
| QUINUPRISTIN/<br>DALFOPRISTIN     | Antibacterial          | Streptogramins                   |   |
| RIFAMPIN                          | Antibacterial          | Rifampin                         |   |
| RIMANTADINE                       | Anti-influenza         | M2 ion channel inhibitors        |   |
| SULFAMETHOXAZOLE/<br>TRIMETHOPRIM | Antibacterial          | Folate pathway inhibitors        |   |
| SULFISOXAZOLE                     | Antibacterial          | Folate pathway inhibitors        |   |
| TELAVANCIN                        | Antibacterial          | Lipo-glycopeptides               |   |
| TELITHROMYCIN                     | Antibacterial          | Ketolides                        |   |
| TETRACYCLINE                      | Antibacterial          | Tetracyclines                    |   |
| TICARCILLIN/<br>CLAVULANATE       | Antibacterial          | Penicillins                      | B-lactam/ B-lactamase inhibitor combination |
| TIGECYCLINE                       | Antibacterial          | Glycylcyclines                   |   |
| TINIDAZOLE                        | Antibacterial          | Nitroimidazoles                  |   |
| TOBRAMYCIN                        | Antibacterial          | Aminoglycosides                  |   |
| VANCOMYCIN                        | Antibacterial          | Glycopeptides                    |   |
| VORICONAZOLE                      | Antifungal             | Azoles                           |   |
| ZANAMIVIR                         | Anti-influenza         | Neuraminidase inhibitors         |   |

<sup>a</sup> Adapted from CLSI January 2010



**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<br>December 28 | Tuesday<br>December 29                    | Wednesday<br>December 30 |
|--|-----------------------|---|--------------------------|
| Meropenem 1gram intravenously every 8 hours  | Given: 2300           | Given: 0700<br>Given: 1500<br>Given: 2300 | Given: 0700              |
| Amikacin 1000mg intravenously every 24 hours | Given: 2300           | Given: 2300                               |                          |

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

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

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

| Month/<br>Year-<br>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.**

|  | <b>Tuesday<br/>December 1<br/>Location: MICU</b> | <b>Tuesday<br/>December 1<br/>Location: Medical Ward</b> |
|--|--|--|
| Vancomycin 1gram intravenously every 8 hours | Given: 0700                                      | Given: 1500<br>Given: 2300                               |

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

| <b>Calculation</b>  | <b>Tuesday,<br/>December 1<br/>Location: MICU</b> | <b>Tuesday<br/>December 1<br/>Location:<br/>Medical Ward</b> |
|---|---|--|
| 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**

| <b>Month/<br/>Year-<br/>Location</b>    | <b>Antimicrobial<br/>Agent</b> | <b>Drug-specific Antimicrobial Days</b> |           |           |                  |                    |
|---|--------------------------------|---|-----------|-----------|------------------|--------------------|
|   |                                | <b>Total</b>                            | <b>IV</b> | <b>IM</b> | <b>Digestive</b> | <b>Respiratory</b> |
| December<br>MICU                        | Vancomycin                     | 1                                       | 1         | 0         | 0                | 0                  |
| December<br>Medical Ward                | Vancomycin                     | 1                                       | 1         | 0         | 0                | 0                  |
| December<br>Facility-wide-<br>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**

|   | <b>Thursday<br/>December 31<br/>Location: Surgical Ward</b> | <b>Friday<br/>January 1<br/>Location: Surgical Ward</b> |
|---|---|---|
| Ceftriaxone gram intravenously every 24 hours | Given: 0800   | Given: 0800   |

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

| <b>Calculation</b>  | <b>Thursday<br/>December 31<br/>Location: Surgical Ward</b> | <b>Friday<br/>January 1<br/>Location: Surgical Ward</b> |
|---|---|---|
| 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**

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



## 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 utilizing 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.<sup>1</sup> The proportion resistant is defined as the number of resistant isolates divided by the number of isolates tested for the specific antimicrobial agent being evaluated. 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 denominators of patient days and admissions can be obtained from the ADT system. 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.<sup>2</sup>

### Settings:

NHSN encourages reporting specimens from all NHSN-defined inpatient locations and select outpatient acute-care settings (i.e., outpatient emergency department, pediatric emergency department, 24-hour observation area) at each facility. The denominators of patient days and admissions are only required 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
  - One for the denominator data report (facility-wide inpatient-FacWideIN)

### Specimen sources

1. Eligible non-invasive specimen sources include lower respiratory (e.g., sputum, endotracheal, bronchoalveolar lavage) and urine specimens.
2. Eligible invasive specimen sources include cerebrospinal fluid (CSF) and blood specimens.

### Isolate-based report

Report all required data each month for each eligible isolate-based report (See [Appendix A](#)). Eligible isolate-based reports must have had susceptibility testing performed. This should be consistent with CLSI M39 Guidance on reporting cumulative susceptibility test results. Two distinct events should be reported.

1. **Each** eligible organism isolated from invasive source per patient, per 14 day period even across calendar months (i.e., report all *unique* invasive sources).
  - a. There should be 14 days with no positive culture result from the laboratory for the patient and organism before another invasive source Antimicrobial Resistance (AR) Event is entered into NHSN for the patient and 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 organism can be reported as an AR Event.
2. **First** eligible organism isolated from any eligible non-invasive culture source, per patient, per month.

#### A. Eligible organisms include:

- *Acinetobacter*
- *Candida albicans*
- *Candida glabrata*
- *Citrobacter freundii*
- *Enterobacter*
- *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](#))

- Eligible non-invasive sources (one per patient, per organism, per month) include:
  - Lower respiratory (e.g., sputum, endotracheal, bronchoalveolar lavage)
  - Urine
  
- Unique invasive source (one per patient, per organism, per >14 days) (i.e., should be 14 days with no positive culture result from the laboratory for the patient and organism before another invasive source AR Event is entered into NHSN for the patient and organism):
  - Cerebrospinal fluid (CSF)
  - Blood
  
  - Important:
    - Report blood or CSF cultures growing same eligible organism with no intervening positive blood or CSF culture (with same eligible organism) within 14 days.
    - In a patient who already has a blood or CSF culture isolate-based report for a specific organism, only report an additional blood or CSF culture if there is no prior positive blood or CSF culture for the same genus/species within 14 days, even across calendar months.
    - There should be a full 14 days with no positive blood or CSF culture result with the same genus/species from the same patient before another unique invasive source is reported (e.g., there should be >14 days since previous isolation).
  
    - EXAMPLE: On January 1, a patient has a positive MRSA blood culture which is entered into NHSN. On January 4, the same patient has another MRSA positive blood culture which is not entered into NHSN because it has not been 14 days since the original positive MRSA blood culture. On January 16, the same patient has another positive MRSA blood culture. While it has been more than 14 days since the initial positive MRSA blood



culture from the same patient was entered into NHSN (January 1), it has not been >14 days since the patient's most recent positive MRSA blood culture (January 4). Therefore, the positive blood culture for January 16 is not entered into NHSN. On January 31, the patient has another positive MRSA blood culture. Since it has been >14 days since the patient's most recent positive culture (January 16), this event is entered into NHSN.

All isolate test results are evaluated using either the algorithm in [Figure 1](#) (Non-invasive specimens) or [Figure 2](#) (Invasive specimens) to determine reportable AR events for each calendar 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 1](#)). For eligible invasive specimens, there should be 14 days with no positive culture result from the laboratory for the patient and organism before another invasive source AR Event is entered into NHSN for the patient and organism ([Figure 2](#)). As a general rule, at a maximum, there should be no more than 3 invasive isolates reported, which would be very rare. Report each AR Event individually.

Use SNOMED codes to identify eligible specimen types to be included in identification of isolate-based report. ([Appendix B](#))

### C. Required Data

Required data includes mostly data available from the laboratory information system and some from 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
  - NHSN Facility ID (facility identifier, unique to NHSN)
  
- Isolate / Patient related data
  - Patient identifier
  - Date of birth
  - Gender
  - Date admitted to facility
  - Specimen collection date
  - Specimen source (SNOMED)
  - Location code – (mapped to CDC location codes)
  - Isolate identifier (unique isolate ID)
  - 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
- Interpretation of E-test
- MIC sign
- MIC value
- Interpretation of MIC test
- Zone sign
- Zone value
- Interpretation of zone test (disk diffusion)
- Final interpretation result

#### 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 and R = Resistant/Not Synergistic.
- On a single isolate if no final interpretation, first double check with the lab to ensure testing is complete. Clarify with the lab why a final interpretation was not provided. Then prioritize test results for “E-test interpretation > MIC interpretation > Zone Interpretation.”
- 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

The goal of this option to capture the first isolate per patient per month from a non-invasive specimen source and in addition, every unique invasive isolate per patient per 14 day period (maximum of three per month per patient). However, frequently multiple isolates of the same species are processed on the same day, often with conflicting results. Only one isolate should be chosen, 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 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. Identify observations reflecting multiple isolates within the same day and select the isolate to report to NHSN based on these rules:

- For non-invasive source isolate selection, lower respiratory isolates should be selected over urine isolates.
- For invasive source isolate selection, CSF isolates should be selected over blood isolates.
- Eliminate isolates on same day without susceptibility test results.



- If the same test is performed the same isolate but they produce conflicting results, report the most resistant result (i.e., R > I > S).
- If two different tests on the same date are performed on the same isolate and produce conflicting susceptibility interpretations, the individual test results should be reported for the separate tests. However, the final interpretation should be populated based on the final laboratory interpretation of the results.
- Do not merge test results across multiple isolates (i.e., don't summarize results across different isolates tested on same day).
- If testing results are indistinguishable or the same test is conducted with the same results, choose isolate test with more complete fields for other variables.
- If two isolates from the same day have conflicting susceptibilities to the panel of antimicrobials tested, considering the protocol states not to merge the susceptibility results of isolates if they are different, pick the first in the sequence of the encounter recorded in the laboratory information system (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.

Further information on counting patient days and admissions can be found in Appendix 2 of the NHSN MDRO & CDI Module Protocol:

[http://www.cdc.gov/nhsn/pscManual/12pscMDRO\\_CDADcurrent.pdf](http://www.cdc.gov/nhsn/pscManual/12pscMDRO_CDADcurrent.pdf).

### **Minimizing Bias**

The source of test results should be from the hospital laboratory information system (LIS). Efforts should be made to reduce selection bias sometimes inherent in systems that have suppression rules in place which prevent test results from being available in the LIS. For example, efforts should be made to obtain resistant results that are withheld from clinicians.

### **Data Analyses:**

Antimicrobial resistance data will be expressed using several metrics, likely at quarterly, semi-annual, or annual time frame depending on how rare the isolates occurred. (See [Table 1](#))





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

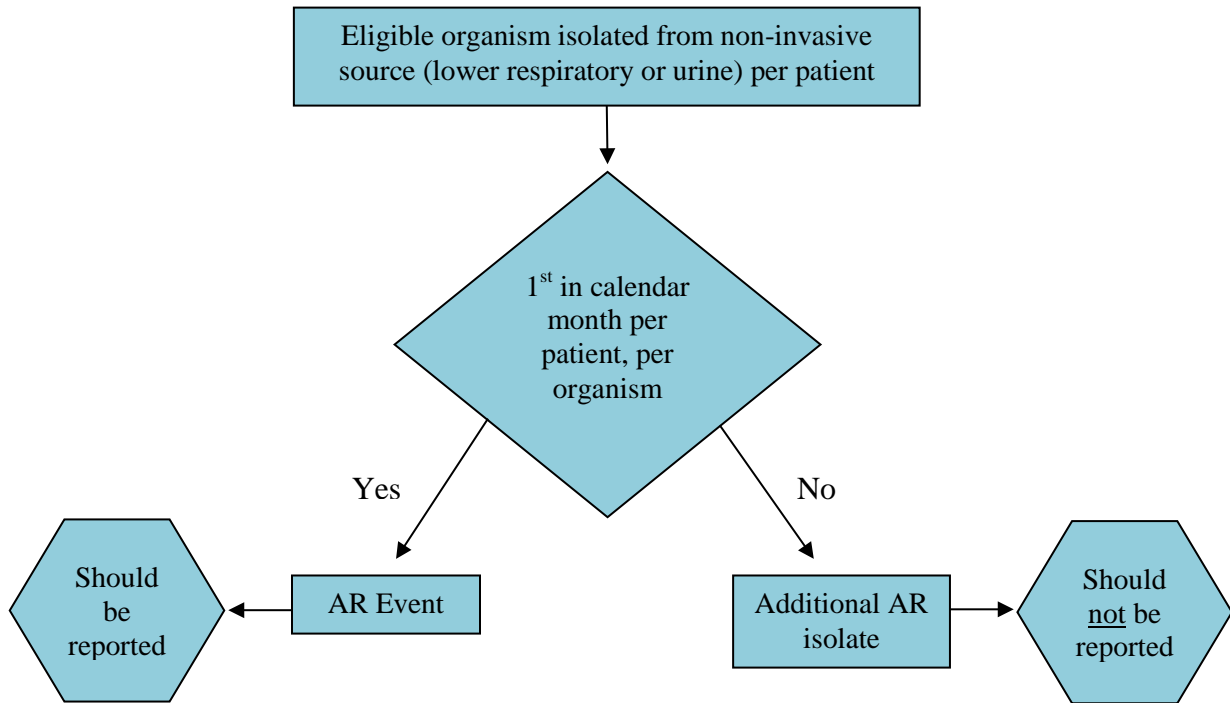
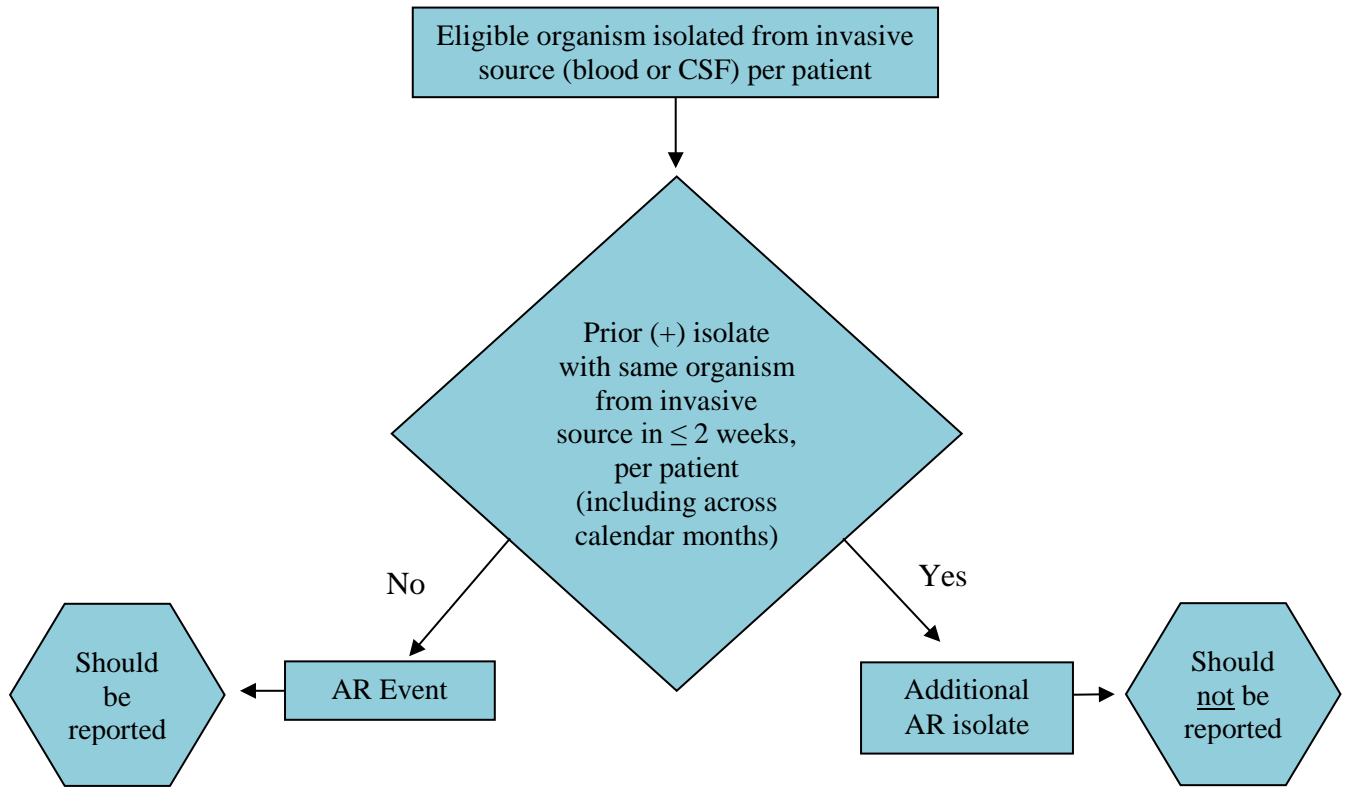




Figure 2. *Test Result Algorithm for Invasive Specimen Reporting*





**Table 1. Current Resistance Metrics**

| Metric   | Definition  |
|--|---|
| <b>Facility-wide-inpatient: standard output for facility and group user.</b> |   |
| % non-susceptible  | (# Resistant + # Intermediate/ # tested)<br>Drug-specific antimicrobial resistance for a facility /Number of isolates tested per facility for specific organism-antimicrobial pairing   |
| BSI % non-susceptible  | (# Resistant BSI + # Intermediate BSI/# tested)<br>Drug-specific antimicrobial resistance among positive blood cultures for a facility/Number of isolates from blood cultures tested per facility for specific organism-antimicrobial pairing |
| Healthcare facility-onset antimicrobial resistance rate                      | Drug-specific antimicrobial resistance (i.e., # non-susceptible) among isolates collected >3 days after admission, for a facility/1000 patient-days   |



## References

1. Schwaber MJ, De-Medina T, and Carmeli Y. Epidemiological interpretation on antibiotic resistance studies – what are we missing? *Nat Rev Microbiol* 2004;2:979-83.
2. National Healthcare Safety Network (NHSN) Patient Safety Component: Clinical Document Architecture. <http://www.cdc.gov/nhsn/CDA/index.html>
3. CLSI. Analysis and Presentation of Cumulative Antimicrobial Susceptibility Test Data; Approved Guideline – Third Edition. CLSI document M39-A3. Wayne, PA: Clinical and Laboratory Standards; 2009.



**Appendix A. List of Organisms for Antimicrobial Resistance<sup>3</sup>**

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

| Organism   | Specimen Type  | Antimicrobial Agents  |
|--|--|---|
| <i>Acinetobacter</i>                               | Blood, Urine, Lower Respiratory, CSF   | Amikacin<br>Ampicillin-sulbactam<br>Cefepime<br>Cefotaxime<br>Ceftazidime<br>Ceftriaxone<br>Ciprofloxacin<br>Doxycycline<br>Gentamicin<br>Imipenem with Cilastatin<br>Levofloxacin<br>Meropenem<br>Minocycline<br>Piperacillin<br>Piperacillin-tazobactam<br>Tetracycline<br>Ticarcillin-clavulanate<br>Tobramycin<br>Trimethoprim-sulfamethoxazole |
|  | Additional Agents for Urine  | None  |
| <i>Candida albicans</i><br><i>Candida glabrata</i> | Blood, Urine, CSF<br>Note: Lower respiratory will not be collected for <i>Candida</i> spp. | Anidulafungin<br>Caspofungin<br>Fluconazole<br>Flucytosine<br>Itraconazole<br>Micafungin<br>Posaconazole<br>Voriconazole  |
|  | Additional Agents for Urine  | None  |



| Organism   | Specimen Type                           | Antimicrobial Agents   |
|--|---|--|
| <i>Citrobacter freundii</i><br><i>Enterobacter</i><br><i>Escherichia coli</i><br><i>Klebsiella oxytoca</i><br><i>Klebsiella pneumoniae</i><br><i>Morganella morganii</i><br><i>Proteus mirabilis</i><br><i>Serratia marcescens</i> | Blood, Urine, Lower<br>Respiratory, CSF | Amikacin<br>Amoxicillin-clavulanic acid<br>Ampicillin<br>Ampicillin-sulbactam<br>Aztreonam<br>Cefazolin<br>Cefepime<br>Cefotaxime<br>Cefoxitin<br>Ceftazidime<br>Ceftriaxone<br>Cefuroxime<br>Chloramphenicol<br>Ciprofloxacin<br>Doripenem<br>Ertapenem<br>Gentamicin<br>Imipenem with Cilastatin<br>Levofloxacin<br>Meropenem<br>Piperacillin<br>Piperacillin-tazobactam<br>Tetracycline<br>Ticarcillin-clavulanic acid<br>Trimethoprim-sulfamethoxazole<br>Tobramycin |
|  | Additional Agents for Urine             | Cephalothin<br>Lomefloxacin<br>Nitrofurantoin<br>Norfloxacin<br>Ofloxacin<br>Sulfisoxazole<br>Trimethoprim   |



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





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



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



- <sup>a</sup> If the LIS does not differentiate between Penicillin G and Penicillin V, list susceptibility results under Penicillin G and indicate that Penicillin V was not tested (N).
- <sup>b</sup> For *Staphylococcus aureus* susceptibility testing, if the LIS tests Nafcillin instead of Oxacillin, report Nafcillin susceptibility results as Oxacillin.
- <sup>c</sup> If the LIS produces meningitis and non-meningitis breakpoint results, rely on the specimen source to determine which susceptibility results to report. If the specimen source is CSF report the meningitis breakpoint susceptibility. If the specimen source is blood, urine, or lower respiratory report the non-meningitis breakpoint susceptibility.



**Appendix 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](mailto: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   |                |



| <b>Specimen Type</b> | <b>Description</b>                             | <b>SNOMED CT Code</b> |
|----------------------|--|-----------------------|
|                      | 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 an inpatient facility including month, day, and year. If the laboratory specimen is reported from an outpatient location enter a null value.                                   |                    | 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 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 and year.  |                    | Required                       |
| Organism                  | Organism identified from specimen collected ( <a href="#">Appendix A</a> ).   | SNOMED             | Required                       |
| Antimicrobial             | Antimicrobial(s) tested for susceptibility ( <a href="#">Appendix A</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 (> < =).  |                    | Conditional                    |
| E-test value              | E-test (Value in micrograms/liter). Use '.' as decimal delimiter, e.g. 0.25   |                    | Conditional                    |
| Interpretation of E-test  | Interpretation result of the E-test susceptibility test performed   |                    | Conditional                    |



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





**Appendix D. Denominator Data Variables**

|                                  | <b>DESCRIPTION OF FIELD</b>  | <b>CODE VALUE LIST</b> | <b>LEVEL OF REQUIREMENT</b> |
|----------------------------------|--|------------------------|-----------------------------|
| <b>Facility Wide Denominator</b> |  |                        |                             |
| 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                    |