Antimicrobial Use and Resistance (AUR) Option

Antimicrobial Use and Resistance (AUR) 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]

The goal of this National Healthcare Safety Network (NHSN) AUR Option is to provide a mechanism for facilities to report and analyze antimicrobial use and/or resistance as part of antimicrobial stewardship efforts at their facility.[6] This module contains two options, one focused on antimicrobial usage and the second on antimicrobial resistance. To participate in either option, the facility must coordinate with their software provider 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 HL7 Clinical Document Architecture (CDA).[7] Manual data entry is not available for the AUR Module.

1. Antimicrobial Use (AU) Option

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 <u>specific</u> 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 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.[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 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[a]: Optional and Minimal Requirements for 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

Inpatient Locations	Minimal Submission Requirements (if applicable for facility)
	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)
Long Term 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 Acute Care Settings Outpatient Emergency Department Pediatric Emergency Department 24-Hour Observation Area	Optional (i.e., no minimal submission requirement)

[a]**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).

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.[8-11] 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 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

Classification: Route of Administration[a]	Definition[b,c]
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.

[a] Other routes of administration are excluded in this module (e.g., antibiotic locks, intraperitoneal, intraventricular, irrigation, topical).
[b] Definitions per SNOMED Reference Terminology
[c] Mapping of standardized terminology for route of administration are provided PHIN VADS

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

	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 antimicrobial agents. The list of select antimicrobial agents will evolve with time as new agents become commercially available. *Topical antimicrobial agents are not included in this module 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 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.[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 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
Inpatient 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:
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.

2. Antimicrobial Resistance Option
Decisions regarding the Antimicrobial Resistance option are still under consideration, and the timeline for launching will be updated in NHSN E-News and on the NHSN AUR website.

References

1. Hidron AI, Edwards JR, Patel J, et al. Antimicrobial-resistant pathogens associated with healthcare-associated infections: annual summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2006-2007. Infect Control Hosp Epidemiol 2008;29:996-1011.

2. Schwartz MN. Use of antimicrobial agents and drug resistance. N Eng J Med 1997;337:491-2.

3. Ansari F, Gray K, Nathwani D, et al. Outcomes of an intervention to improve hospital antibiotic prescribing; interrupted time series with segmented regression analysis. J Antimicrob Chemother 2003;52:842-8.

4. Solomon DH, Van Houten L, Glynn RJ. Academic detailing to improve use of broad-spectrum antibiotics at an academic medical center. Arch Inter Med 2001;161:1897-902.

5. Fraser GL, Stogsdill P, Dickens JD Jr, et al. Antibiotic optimizations: an evaluation of patient safety and economic outcomes. Arch Inter Med 1997;157-1689-94.

6. Dellit TH, Owens RC, McGowan JE, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America Guidelines for Developing an Institutional Program to Enhance Antimicrobial Stewardship. Clin Infect Dis 2007;44:159-77.

7. National Healthcare Safety Network (NHSN) Patient Safety Component: Clinical Document Architecture. www.cdc.gov/nhsn/CDA_eSurveillance.html

8. Schwartz DN, Evans RS, Camins B, et al. Deriving measures of intensive care unit antimicrobial use from computerized pharmacy data: methods, validation, and overcoming barriers. Infect Control Hosp Epidemiol 2011;32:472-80.

9. Polk RE, Fox C, Mahoney A, Letcavage J, MacDougall C. Measurement of adult Antibacterial Drug Use in 130 US Hospitals: Comparison of Defined Daily Dose and Days of Therapy. Clin Infect Dis 2007;44:664-70.

10. Kuster SP, Ledergerber B, Hintermann A, et al. Quantitative antibiotic use in hospitals: comparison of measurements, literature review, and recommendations for standards of reporting. Infection 2008; 6:549-59.

11. Berrington A. Antimicrobial prescribing in hospitals: be careful what you measure. J Antimicrob Chemother 2010:65:163-168.

12. Cohen AL, Calfee D, Fridkin SK, et al. Recommendations for metrics for multidrug-resistant organisms in healthcare settings: SHEA/HICPAC position paper. Infect Control Hosp Epidemiol 2008:29:901-13.

CDC

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 <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 Appendix B) <u>and</u> stratified by route of administration.
Denominator: Days present	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	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[a]	Antimicrobial subclass[a]	Calculations of Antibacterial Days[b]
AMANTADINE	Anti-influenza	M2 ion channel inhibitors		NO
AMIKACIN	Antibacterial	Aminoglycosides		YES
AMOXICILLIN	Antibacterial	Penicillins	Aminopenicillin	YES
AMOXICILLIN/ CLAVULANATE	Antibacterial	Penicillins	B-lactam/ B-lactamase inhibitor combination	YES
AMPHOTERICIN B	Antifungal	Polyenes		NO
AMPHOTERICIN B LIPOSOMAL	Antifungal	Polyenes		NO
AMPICILLIN	Antibacterial	Penicillins	Aminopenicillin	YES
AMPICILLIN/ SULBACTAM	Antibacterial	Penicillins	B-lactam/ B-lactamase inhibitor combination	YES
ANIDULAFUNGIN	Antifungal	Echinocandins		NO
AZITHROMYCIN	Antibacterial	Macrolides		YES
AZTREONAM	Antibacterial	Monobactams		YES
CASPOFUNGIN	Antifungal	Echinocandins		NO
CEFACLOR	Antibacterial	Cephalosporins	Cephalosporin 2nd generation	YES
CEFADROXIL	Antibacterial	Cephalosporins	Cephalosporin 1st generation	YES
CEFAZOLIN	Antibacterial	Cephalosporins	Cephalosporin 1st generation	YES
CEFDINIR	Antibacterial	Cephalosporins	Cephalosporin 3rd generation	YES
CEFDITOREN	Antibacterial	Cephalosporins	Cephalosporin 3rd generation	YES
CEFEPIME	Antibacterial	Cephalosporins	Cephalosporin 4th generation	YES
CEFIXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation	YES
CEFOTAXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation	YES
CEFOTETAN	Antibacterial	Cephalosporins	Cephamycin	YES
CEFOXITIN	Antibacterial	Cephalosporins	Cephamycin	YES
CEFPODOXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation	YES
CEFPROZIL	Antibacterial	Cephalosporins	Cephalosporin 2nd generation	YES
CEFTAROLINE	Antibacterial	Cephalosporins	Cephalosporin 5th generation	YES
CEFTAZIDIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation	YES
CEFTIBUTEN	Antibacterial	Cephalosporins	Cephalosporin 3rd generation	YES

CEFTIZOXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation	YES
CEFTRIAXONE	Antibacterial	Cephalosporins	Cephalosporin 3rd generation	YES
CEFUROXIME	Antibacterial	Cephalosporins	Cephalosporin 2rd generation	YES
CEPHALEXIN	Antibacterial	Cephalosporins	Cephalosporin 1st generation	YES
CHLORAMPHENICOL	Antibacterial	Phenicols		YES
CIPROFLOXACIN	Antibacterial	Fluoroquinolones		YES
CLARITHROMYCIN	Antibacterial	Macrolides		YES
CLINDAMYCIN	Antibacterial	Lincosamides		YES
COLISTIMETHATE	Antibacterial	Polymyxins		YES
DAPTOMYCIN	Antibacterial	Lipopeptides		YES
DICLOXACILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins	YES
DORIPENEM	Antibacterial	Carbapenems		YES
DOXYCYCLINE	Antibacterial	Tetracyclines		YES
ERTAPENEM	Antibacterial	Carbapenems		YES
ERYTHROMYCIN	Antibacterial	Macrolides		NO-IV or IM YES- Digestive
ERYTHROMYCIN/ SULFISOXAZOLE	Antibacterial	Folate pathway inhibitors/ Sulfonamides		YES
FIDAXOMICIN	Antibacterial	Macrocyclic		YES
FLUCONAZOLE	Antifungal	Azoles		NO
FOSFOMYCIN	Antibacterial	Fosfomycins		YES
GEMIFLOXACIN	Antibacterial	Fluoroquinolones		YES
GENTAMICIN	Antibacterial	Aminoglycosides		YES
IMIPENEM/ CILASTATIN	Antibacterial	Carbapenems		YES
ITRACONAZOLE	Antifungal	Azoles		NO
LEVOFLOXACIN	Antibacterial	Fluoroquinolones		YES
LINEZOLID	Antibacterial	Oxazolidinones		YES
MEROPENEM	Antibacterial	Carbapenems		YES
METRONIDAZOLE	Antibacterial	Nitroimidazoles		YES
MICAFUNGIN	Antifungal	Echinocandins		NO
MINOCYCLINE	Antibacterial	Tetracycline		YES
MOXIFLOXACIN	Antibacterial	Fluoroquinolones		YES
NAFCILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins	YES

NITROFURANTOIN	Antibacterial	Nitrofurans		YES
OSELTAMIVIR	Anti-influenza	Neuraminidase inhibitors		NO
OXACILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins	YES
PENICILLIN G	Antibacterial	Penicillins	Penicillin	YES
PENICILLIN V	Antibacterial	Penicillins	Penicillin	YES
PIPERACILLIN	Antibacterial	Penicillins	Ureidopenicillin	YES
PIPERACILLIN/ TAZOBACTAM	Antibacterial	Penicillins	B-lactam/ B-lactamase inhibitor combination	YES
POLYMYXIN B	Antibacterial	Polymyxins		YES
POSACONAZOLE	Antifungal	Azoles		NO
QUINUPRISTIN/ DALFOPRISTIN	Antibacterial	Streptogramins		YES
RIFAMPIN	Antibacterial	Rifampin		NO
RIMANTADINE	Anti-influenza	M2 ion channel inhibitors		NO
SULFAMETHOXAZOLE/ TRIMETHOPRIM	Antibacterial	Folate pathway inhibitors		YES
SULFISOXAZOLE	Antibacterial	Folate pathway inhibitors		YES
TELAVANCIN	Antibacterial	Lipo-glycopeptides		YES
TELITHROMYCIN	Antibacterial	Ketolides		YES
TETRACYCLINE	Antibacterial	Tetracycline		YES
TICARCILLIN/ CLAVULANATE	Antibacterial	Penicillins	B-lactam/ B-lactamase inhibitor combination	YES
TIGECYCLINE	Antibacterial	Glycylcyclines		YES
TINIDAZOLE	Antibacterial	Nitroimidazoles		YES
TOBRAMYCIN	Antibacterial	Aminoglycosides		YES
VANCOMYCIN	Antibacterial	Glycopeptides		YES
VORICONAZOLE	Antifungal	Azoles		NO
ZANAMIVIR	Anti-influenza	Neuraminidase inhibitors		NO

[a] Adapted from CLSI January 2010
[b] In the NHSN data analyses, the calculation of overall antibacterial days are limited to those denoted by YES in this column; thus, antifungals, anti-influenza agents, and select antibacterials (i.e., IV/IM route of administration of erythromycin and rifampin) are excluded.

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.

	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 1Location: 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

	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