

# Antimicrobial Resistance (AR) Option Data Validation using Synthetic Data – Instructions for Vendors

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## Table of Contents

1.	Introduction .....	3
2.	Data Format and Table Descriptions .....	3
2.1.	Physical File Formats .....	3
3.	Lookup (Dim) Tables .....	5
3.1.	Ward Mapping (Dim_WardMapping) .....	5
3.2.	Specimen Type (Dim_SpecType) .....	5
3.3.	Organisms Rollup (Dim_Org_Rollup) .....	5
3.4.	Organisms (Dim_Org) .....	5
3.5.	Antimicrobial Agents (Dim_Abx) .....	5
3.6.	Test Method (Dim_TestMethod) .....	5
3.7.	Test Result (Dim_TestResult) .....	5
3.8.	Lab Observable (Dim_LabObservableCode) .....	5
3.9.	Lab Result (Dim_LabResultCode) .....	5
4.	Data (Fact) tables .....	6
4.1.	ADT Movement (Fact_ADT_Movement) – ADT Format 1 .....	6
4.2.	Transfer In-Out Table (Fact_Transfer_InOut) – ADT Format 2 .....	6
4.3.	Specimen Collection (Fact_SpecimenCollection) .....	6
4.4.	Culture Result (Fact_CultureResult) .....	6
4.5.	Antibiotic Susceptibility (Fact_AntibioticSusceptibility) .....	6
4.6.	Lab Chemistry Results (Fact_LabChemResult) .....	6
4.7.	Final Interpretation (Fact_FinalInterpretation) .....	6
5.	Output Tables .....	7
6.	Applying the AR Option Protocol .....	7



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7. Validation Website.....	7
8. Validation Results.....	7
9. Change Log.....	7
Appendix 1. Validation Rules .....	8

## 1. Introduction

NHSN is publishing a synthetic data set for the validation of the AR Option (hereafter referred to as ARSDS). This package is being released to external organizations for testing as well as familiarizing themselves with the process. Minimal instructions are provided for these organizations to import the data into a database, apply the AR Option protocol, generate the data for submission and to upload it to the validation website. The AR Option protocol defines rules for including or excluding specific isolates from the submission file. The validation website will provide results that explain any isolates that were incorrectly included or excluded from the submission.

## 2. Data Format and Table Descriptions

The ARSDS test data set has the following data structure, shown in the entity relationship diagram (ERD) in figure 1.

### 2.1. Physical File Formats

The data files are provided in two formats – CSV (comma separated values) format that is IETF RFC 4180 compliant and as MySQL import scripts (.sql). The first row contains column headers. Each row is terminated by <LF> including the last row. Null values are indicated by the keyword NULL or by a blank value. Strings are optionally enclosed in double quotes.

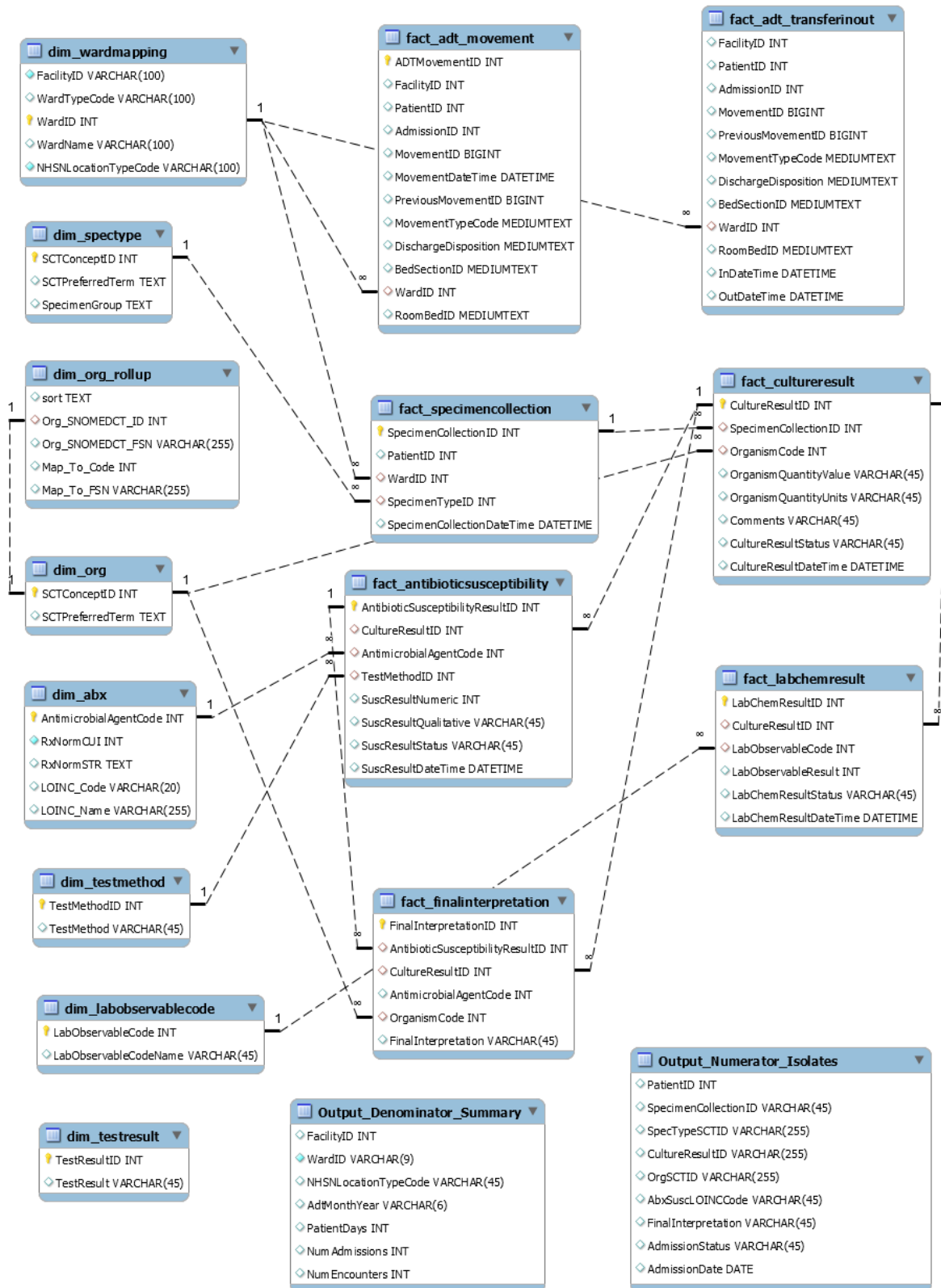


Figure 1. Entity relationship diagram of ARSDS

### 3. Lookup (Dim) Tables

The following lookup tables are provided in the AR SDS release package. Their foreign key relationships are shown in the entity relationship diagram in figure 1. These tables may include ineligible locations, specimens, organisms, or medications as negative test cases, which should not be included while generating the results.

#### 3.1. Ward Mapping (Dim\_WardMapping)

This table provides the mapping between the local units/locations and the NHSN-defined location types. In addition to the units in the hospital, a special 'FACWIDEIN' location type is used in these tables to denote all the inpatient locations in the facility as a single entity.

#### 3.2. Specimen Type (Dim\_SpecType)

This table contains the SNOMED CT concept id and the preferred term of the specimens, along with one of the four specimen groups (Blood, Cerebrospinal Fluid, Urine or Lower Respiratory Specimen).

#### 3.3. Organisms Rollup (Dim\_Org\_Rollup)

This table is a copy of the ARO Organism Rollup table published by NHSN for the year 2022. This table contains the rollup mappings of fine-grained organisms for comparing the organism codes of different isolates while applying the AR protocol. Implementers should first rollup the eligible organisms using this table before applying the isolate selection rules and rules for the removal of same day duplicates using the NHSN Antimicrobial Use and Resistance Module – Antimicrobial Resistance Option protocol.

#### 3.4. Organisms (Dim\_Org)

This table contains the SNOMED CT concept id and the preferred term of the organisms whose SNOMED CT codes are used in the culture results and final interpretation tables.

#### 3.5. Antimicrobial Agents (Dim\_Abx)

This table contains both the LOINC susceptibility result codes and RxNorm ingredient codes along with their text descriptions for antibiotics that are present in the susceptibility results table.

#### 3.6. Test Method (Dim\_TestMethod)

This table contains the various test methods used for antimicrobial susceptibility tests.

#### 3.7. Test Result (Dim\_TestResult)

This table contains a list of qualitative results (S, I, R, etc.) used in the final interpretation table.

#### 3.8. Lab Observable (Dim\_LabObservableCode)

This table contains the local code and the preferred term for the *mecA* gene and the PBP-2a agglutination tests, which are used to test methicillin susceptibility for *Staphylococcus aureus* isolates.

#### 3.9. Lab Result (Dim\_LabResultCode)

This table contains the local code and the preferred terms for the positive and negative results of the lab tests.

## 4. Data (Fact) tables

The following fact tables are included in the ARSDS release package. These tables may include ineligible locations, specimens, organisms, or medications as negative test cases, which should not be included while generating the results. The Admission, Discharge and Transfer data are provided in two formats – a ‘movement’ format and a ‘transfer in-out’ format – the user may use one of these formats at their choice.

### 4.1. ADT Movement (Fact\_ADT\_Movement) – ADT Format 1

The `adtmovement` table contains one patient movement record per row and has keys to link a given ADT row to the previous and next ADT rows. The data rows have a foreign key to the previous movement row to sequentially trace patient movements.

### 4.2. Transfer In-Out Table (Fact\_Transfer\_InOut) – ADT Format 2

The `transferinout` table consists of the admission (or ‘transfer in’) and discharge (or ‘transfer out’) timestamps of a patient into/from a given unit location. The data rows have a foreign key to the previous movement row to sequentially trace patient movements.

### 4.3. Specimen Collection (Fact\_SpecimenCollection)

The `Fact_SpecimenCollection` table contains the various specimen collection records for all the specimens that were sent to the microbiology lab for culture. This table contains the patient identifier, ward location, specimen collection time and the specimen type.

### 4.4. Culture Result (Fact\_CultureResult)

The `Fact_CultureResult` table contains the results of the microbiology cultures. This table has a foreign key to the specimen collection record. Each row in this table describes a unique isolate.

### 4.5. Antibiotic Susceptibility (Fact\_AntibioticSusceptibility)

The `Fact_AntibioticSusceptibility` table contains the results of the antimicrobial susceptibility tests that were performed on selected isolates. This table has a foreign key to the Culture Results table. This table contains the local code of the antimicrobial agent, the susceptibility test method and the qualitative result. The `AntimicrobialAgentCode` in this table provides a foreign key to the column of the same name in `dim_abx.csv`, which in turn provides the LOINC code.

### 4.6. Lab Chemistry Results (Fact\_LabChemResult)

The `Fact_LabChemResult` table contains the chemistry results of *Staphylococcus aureus* isolates tested for the *mecA* gene or the PBP2a protein. A positive result to either of these tests indicates that the isolate is a methicillin resistant *Staphylococcus aureus* (MRSA).

### 4.7. Final Interpretation (Fact\_FinalInterpretation)

The `Fact_FinalInterpretation` table contains the final interpretation of the susceptibility results of an isolate. The final interpretation is based on one or more antimicrobial susceptibility test results or the chemistry results of an isolate.

## 5. Output Tables

An example of these tables is included in the ERD shown in figure 1. The release package contains two Excel files that provide the submission template for the numerator and denominator result files. They contain the column names in the order expected by the validation website.

For numerator results, final interpretation must be reported for eligible isolates. Certain organism codes must be rolled up as described in the protocol. Eligible antimicrobial agents from the appropriate panels for the organism must be reported using their LOINC codes. Eligible antimicrobial agents that were not tested (not included in the data set) must be reported as 'not tested (NT)'. For eligible isolates, admission status and date must be reported according to the description in the 2022 version of the AUR AR Option protocol. AdmissionStatus should be 'Yes' or 'No. AdmissionDate must be in 'YYYY-MM-DD' format.

For denominator results, monthly summary results must be included for Facilitywide Inpatient (FACWIDEIN) and eligible outpatient units included in the data set. WardID for FACWIDEIN must be 'FACWIDEIN'. NumEncounters must be NULL (left blank) for FACWIDEIN. PatientDays and NumAdmissions must be NULL (left blank) for eligible outpatient units. AdtMonthYear must be in 'YYYYMM' format.

## 6. Applying the AR Option Protocol

Implementers should first rollup the eligible organisms using the dim\_org\_rollup table before applying the isolate selection rules and rules for the removal of same day duplicates using the NHSN Antimicrobial Use and Resistance Module – Antimicrobial Resistance Option protocol. The tester should include or exclude the isolates according to the rules defined in the AR Option protocol. This release provides the qualitative results for antimicrobial susceptibility tests but quantitative results are not included.

## 7. Validation Website

The submission file should have the same structure as the susceptibility results table and should only include the isolates that must be included as per the AR Option protocol. The validation website accepts files in Microsoft Excel (.xlsx) format. Numerator validation webpage is at <https://nhsnpilot.ng.techlab.cdc.gov/ARValidation-Numerator/home.html> and denominator validation webpage is at <https://nhsnpilot.ng.techlab.cdc.gov/ARValidation-Denominator/home.html>.

## 8. Validation Results

After a file is submitted, the validation website provides results and explanation when an isolate is incorrectly included or excluded in the submission file. Note that only a partial set of test conditions in the AR Option protocol are included in the validation, and additional test conditions are being added. If testers find that some conditions are not validated correctly, please contact us and we will work with you to ensure that the test condition is validated correctly.

## 9. Change Log

**Production release 1.6. January 22, 2024**

Updated dim\_wardmapping to test transfers to ineligible inpatient locations.

#### **Production release 1.5. April 16, 2023**

Updated Fact\_CultureResult table to resolve an isolate that was tested only for ineligible antimicrobial agents.

#### **Production release 1.4. February 6, 2023**

Updated Fact\_SpecimenCollection table to resolve WardID mismatch with ADT tables.

#### **Production release 1.3. December 2, 2022**

WardID rows of discharge rows updated with the ward from which the patient was discharged. Ward mapping updated for inpatient pediatric rehab unit.

#### **Production release 1.2. October 15, 2022**

A few susceptibility results have been updated.

#### **Production release 1.1. July 15, 2022**

AdmissionStatus and AdmissionDate columns are added in the numerator output requirements and template. Two existing columns are renamed to AbxSuscLOINCCode and FinalInterpretation in the numerator template, and the unused TestMethod column is deleted.

NHSNLocationTypeCode and NumEncounters columns are added in the denominator output requirements and template. Answer keys are updated accordingly on the validation website.

See section 5 for updated validation requirements.

The data set is unchanged.

#### **Production release 1. June 27, 2022**

Initial release.

## **Appendix 1. Validation Rules**

If the uploading results file passed validation, then the validation website will return that the file passed validation successfully. The numerator results may fail validation for a variety of reasons – it contained antibiotic susceptibility results rows that should have been excluded according to the AR Option protocol, it did not contain rows that should have been included according to the protocol or it contained results that have been summarized incorrectly. The denominator validation is much simpler – it may fail validation if it had incorrect results for patient days or number of admissions at the FACWIDEIN level, or number of encounters for eligible outpatient locations included in the data set.

The list of numerator validation rules and their explanation are given below. Note that these rule numbers denote the way in which the validation website interprets and implements validation rules from the protocol. Different implementers may implement the protocol using a varying number of rules. We do not expect the implementers to implement the same number, order or the content of the rules as described below. This section is only provided for informative purposes to illustrate the list of errors



they may see during validation. The implementers should follow the AR Option protocol for their implementation rather than the rules listed below. The validation website will also show descriptions for some rules as listed below.

#### **Rule 1**

Only specimens collected from eligible ward locations must be reported. Please refer to the protocol and IDM v10.1 for 2022.

#### **Rule 2**

Only eligible specimens should be included. Please refer to the protocol and IDM v10.1 for 2022.

#### **Rule 3**

Only eligible organisms should be reported. Please refer to the protocol and IDM v10.1 for 2022.

#### **Rule 4**

Only eligible antimicrobial agents should be reported. Please refer to the protocol and IDM v10.1 for 2022.

#### **Rule 5**

For invasive specimens, there should be at least 14 days between two positive cultures of the same organism.

*Description:* For eligible invasive specimens, there should be 14 days (even across calendar months) with no positive culture result from the laboratory for the patient and specific organism before another invasive source AR event is entered into NHSN for the patient.

#### **Rule 6**

For non-invasive specimens, select only the first isolate in a calendar month for each organism.

*Description:* For eligible non-invasive specimens, all first non-invasive isolates (chronologically) per patient, per month, per organism are reported as an AR event.

#### **Rule 7**

If there are same day duplicates, only one isolate must be reported [Same day duplicates].

*Description:* Multiple isolates of the same organism from the same specimen may be processed and produce conflicting results. Only one isolate should be reported to NHSN, retaining the unique nature of the test results. Rules must be in place to ensure duplicate isolates are not submitted.

#### **Rule 8**

[Same day duplicates]: Eliminate isolates on same day without susceptibility test results as only isolates with complete/final laboratory testing should be reported to NHSN.

#### **Rule 9**

[Same Day Duplicates]: For invasive specimens, CSF should be selected over blood.

**Rule 10**

[Same Day Duplicates]: For non-invasive specimens, lower respiratory should be selected over urine.

**Rule 11**

[Same Day Duplicates]: Do not merge test results across multiple isolates (i.e., don't summarize results across different isolates tested on same day).

**Rule 12**

[Same Day Duplicates]: If the same specific test is performed on the same isolate but they produce conflicting results, report the final interpretation provided by the laboratory.

**Rule 13**

[Same Day Duplicates]: If no final interpretation is provided by the laboratory, then report the most resistant interpretation (i.e., NS > R > I > S-DD > S > NT).

*Description:* For example, if two E-tests are performed for the same drug on the same isolate and one produces "Intermediate" and the other produces "Susceptible", report "Intermediate" as the final interpretation for that specific drug susceptibility.

**Rule 14**

[Same Day Duplicates]: If specific antimicrobial tests are performed on the same isolate and produce conflicting susceptibility interpretations, report the most resistant specific test interpretation as the final interpretation (i.e., NS > R > I > S-DD > S > NT).

*Description:* For example, if drug susceptibility results produced MIC = Resistant and E-Test = Intermediate but not final interpretation was provided, report "Resistant" as the final interpretation for that specific drug susceptibility.

**Rule 15**

Antimicrobial agents that are not included in the panel for the organism and specimen MUST NOT be reported.

*Description:* Please refer to the AntiP tab of the IDM spreadsheet to find the panel for an organism-specimen combination, and then see the 'AR AST 2022' tab of the spreadsheet to find the antimicrobial agent susceptibility tests that are included in that panel. This information is also provided in Appendix F of the NHSN AUR Module protocol.

**Rule 16**

Antimicrobial agents that are included in the panel for the organism and specimen must be reported.

*Description:* All antimicrobial agents included in the panel must be submitted. Please refer to the AntiP tab of the IDM spreadsheet to find the panel for an organism-specimen combination, and then see the 'AR AST 2022' tab of the spreadsheet to find the antimicrobial agent susceptibility tests that are included in that panel. This information is also provided in Appendix F of the NHSN AUR Module protocol.

### **Rule 17**

Antimicrobial agents that are included in a panel but not reported by the lab should be submitted as 'NT' (not tested).

*Description:* All antimicrobial agents included in the panel must be submitted. If an antimicrobial agent included in a panel is not reported by the lab, it should be reported as 'NT' (not tested). Reference: Please refer to the AntiP tab of the IDM spreadsheet to find the panel for an organism-specimen combination, and then see the 'AR AST 2022' tab of the spreadsheet to find the antimicrobial agent susceptibility tests that are included in that panel. This information is also provided in Appendix F of the NHSN AUR Module protocol.

### **Rule 18**

If two isolates from the same day have conflicting susceptibilities to the panel of antimicrobials tested, report the isolate with the most resistant final interpretation (i.e., NS > R > I > S-DD > S > NT).

*Description:* If a final interpretation was not provided by the lab, report the isolate with the higher amount of drug resistance based on the number antimicrobials testing "NS" or "R". If it cannot be determined which isolate is the most resistant, report the isolate that was the first entered into the LIS. For example, *Candida albicans* was isolated from two blood specimens collected from the same patient on the same calendar day and no final interpretation was provided by the lab. The first isolate tested "R" to three of the eight antimicrobials tested and the second isolate tested "R" to four of the eight antimicrobials tested. Report the second isolate to NHSN since it showed the higher amount of resistance.