Using NHSN to Analyze Pathogens and Antimicrobial Resistance Data from HAIs

NHSN Methods and Analytics Team

Updated 2021
Outline

- Reports to use when analyzing pathogens & antimicrobial resistance
- Unusual Susceptibility Alerts
- Antibiotic Resistance & Patient Safety Portal

*Note: all screen shots and data used in this presentation are fictitious*
NHSN reports for pathogens & antimicrobial resistance
Results for each drug are entered as either S, I, S-DD, R, or N.
FAQ from NHSN Helpdesk

“I am trying to determine which specific pathogens are common in my facility. How can I review the pathogens I have entered for HAIs? “
Option 1: Add Pathogen Variables to HAI Line List

- Step 1. Modify the line list
  - CLABSI line list used in this example
Add Pathogen Variables to HAI Line List

- Step 2. Navigate to the “Display Variables” tab
- Move pathogen1/2/3 over to the right column
  - “Pathogen” = NHSN code for the organism
  - “PathogenDesc” = Full organism name (description)
# CLABSI Line List Example Output

<table>
<thead>
<tr>
<th>patient</th>
<th>eventDate</th>
<th>location</th>
<th>pathogen1</th>
<th>pathogen2</th>
<th>pathogenDesc1</th>
<th>pathogenDesc2</th>
<th>pathogenDesc3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1234</td>
<td>01/01/2020</td>
<td>MED</td>
<td>EA</td>
<td></td>
<td>Klebsiella aerogenes - EA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1234</td>
<td>01/15/2020</td>
<td>MED</td>
<td>EA</td>
<td></td>
<td>Klebsiella aerogenes - EA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1234</td>
<td>01/30/2020</td>
<td>NONPSYCH</td>
<td>EA</td>
<td></td>
<td>Klebsiella aerogenes - EA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1234</td>
<td>10/01/2020</td>
<td>NEURO</td>
<td>ACINNOSO</td>
<td></td>
<td>Acinetobacter nosocomialis - ACINNOSO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1235</td>
<td>10/15/2020</td>
<td>MED</td>
<td>ACINNOSO</td>
<td></td>
<td>Acinetobacter nosocomialis - ACINNOSO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1235</td>
<td>10/30/2020</td>
<td>ICU</td>
<td>ACINNOSO</td>
<td></td>
<td>Acinetobacter nosocomialis - ACINNOSO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>66666</td>
<td>10/01/2020</td>
<td>ICU</td>
<td>EC</td>
<td>KO</td>
<td>Escherichia coli - EC</td>
<td>Klebsiella oxytoca - KO</td>
<td></td>
</tr>
<tr>
<td>7777</td>
<td>10/01/2020</td>
<td>ICU</td>
<td>EC</td>
<td>EA</td>
<td>Escherichia coli - EC</td>
<td>Klebsiella aerogenes - EA</td>
<td></td>
</tr>
<tr>
<td>88888</td>
<td>10/01/2020</td>
<td>ICU</td>
<td>ACINNOSO</td>
<td>PA</td>
<td>Acinetobacter nosocomialis - ACINNOSO</td>
<td>Pseudomonas aeruginosa - PA</td>
<td></td>
</tr>
<tr>
<td>99999</td>
<td>10/01/2020</td>
<td>ONC ICU</td>
<td>ACINNOSO</td>
<td>ACINPITT</td>
<td>Acinetobacter nosocomialis - ACINNOSO</td>
<td>Acinetobacter pittii - ACINPITT</td>
<td></td>
</tr>
<tr>
<td>EBI</td>
<td>09/20/2020</td>
<td>NONPSYCH</td>
<td>ENTAU</td>
<td></td>
<td>Enterobacter amnigenus - ENTAU</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Option 2: Add Pathogen to a Frequency Table

“What types of pathogens were reported in our facility among CAUTIs?”

- Modify CAUTI frequency table to show pathogenDesc1 as either the Row or Column variable
- Could repeat for pathogenDesc2 and pathogenDesc3
CAUTI Frequency Table Example Output

- Counts of CAUTI pathogens reported during 2020

<table>
<thead>
<tr>
<th>evntDateYr</th>
<th>Acinetobacter pittii - ACINPITT</th>
<th>Klebsiella aerogenes - EA</th>
<th>Escherichia coli - EC</th>
<th>Pseudomonas aeruginosa - PA</th>
<th>Staphylococcus aureus - SA</th>
<th>Staphylococcus - SS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>12.50</td>
<td>12.50</td>
<td>37.50</td>
<td>12.50</td>
<td>12.50</td>
<td>12.50</td>
<td>12.50</td>
</tr>
<tr>
<td></td>
<td>12.50</td>
<td>12.50</td>
<td>37.50</td>
<td>12.50</td>
<td>12.50</td>
<td>12.50</td>
<td>12.50</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>12.50</td>
<td>12.50</td>
<td>37.50</td>
<td>12.50</td>
<td>12.50</td>
<td>12.50</td>
<td>12.50</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>
Are any of these pathogens resistant to key antibiotics?
Antimicrobial Resistance (AR) Output Options

- Analysis reports are available that identify HAIs with antimicrobial resistance patterns (phenotype) of public health importance
- CDC identified 11 AR phenotypes of interest
  - CRE
  - MRSA
  - VRE
  - Multidrug-resistant organisms
  - ...etc.
- Documentation available that identifies and defines each of the 11 phenotypes
  - [http://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/phenotype_definitions.pdf](http://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/phenotype_definitions.pdf)
Three Output Options

- Available in the “HAI Antimicrobial Resistance (DA+PA Modules)” analysis folder
- Line List, Frequency Table, and Rate Table
  - Include all HAIs (CLABSI, CAUTI, SSI, VAE, etc.)
  - All time periods
  - Available for Groups
  - Modify reports to select phenotype or time period of interest
### National Healthcare Safety Network
**Line Listing: Antimicrobial Resistant Organisms**

#### CRE_all_HAI - Carbapenem-resistant Enterobacteriaceae

<table>
<thead>
<tr>
<th>erd1</th>
<th>patID</th>
<th>dob</th>
<th>gender</th>
<th>admitDate</th>
<th>eventID</th>
<th>eventDate</th>
<th>eventType</th>
<th>location</th>
<th>pathogenDesc</th>
<th>phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>LG1</td>
<td>1234</td>
<td>12/12/2007</td>
<td>M</td>
<td>12/15/2019</td>
<td>90658</td>
<td>01/01/2020</td>
<td>BSI</td>
<td>MED</td>
<td>Klebsiella aerogenes - EA</td>
<td>CRE_all_HAI</td>
</tr>
</tbody>
</table>

Criteria used to define each phenotype can be found on the Patient Safety Analysis Resources webpage at: https://www.cdc.gov/nhsn/pdfs/jsa-analysis-resources/phenotype_definitions.pdf

The data in this table include all applicable pathogens entered for an HAI, and are not limited to the first pathogen.

Sorted by erd1,eventDate

Data contained in this report were last generated on December 6, 2020 at 4:08 PM to include data beginning January 2020 through December 2020.

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#### carbNS_PA_HAI - Carbapenem-non-susceptible Pseudomonas aeruginosa

<table>
<thead>
<tr>
<th>erd1</th>
<th>patID</th>
<th>dob</th>
<th>gender</th>
<th>admitDate</th>
<th>eventID</th>
<th>eventDate</th>
<th>eventType</th>
<th>location</th>
<th>pathogenDesc</th>
<th>phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>LG1</td>
<td>1234</td>
<td>12/12/2007</td>
<td>M</td>
<td>09/25/2020</td>
<td>98617</td>
<td>10/01/2020</td>
<td>BSI</td>
<td>ICU</td>
<td>Pseudomonas aeruginosa - PA</td>
<td>carbNS_PA_HAI</td>
</tr>
</tbody>
</table>

Criteria used to define each phenotype can be found on the Patient Safety Analysis Resources webpage at: https://www.cdc.gov/nhsn/pdfs/jsa-analysis-resources/phenotype_definitions.pdf

The data in this table include all applicable pathogens entered for an HAI, and are not limited to the first pathogen.

Sorted by erd1,eventDate

Data contained in this report were last generated on December 6, 2020 at 4:08 PM to include data beginning January 2020 through December 2020.

---

#### MDR_PA_HAI - Multidrug-resistant Pseudomonas aeruginosa

<table>
<thead>
<tr>
<th>erd1</th>
<th>patID</th>
<th>dob</th>
<th>gender</th>
<th>admitDate</th>
<th>eventID</th>
<th>eventDate</th>
<th>eventType</th>
<th>location</th>
<th>pathogenDesc</th>
<th>phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>LG1</td>
<td>1234</td>
<td>12/12/2007</td>
<td>M</td>
<td>09/25/2020</td>
<td>98617</td>
<td>10/01/2020</td>
<td>BSI</td>
<td>ICU</td>
<td>Pseudomonas aeruginosa - PA</td>
<td>MDR_PA_HAI</td>
</tr>
</tbody>
</table>

Criteria used to define each phenotype can be found on the Patient Safety Analysis Resources webpage at: https://www.cdc.gov/nhsn/pdfs/jsa-analysis-resources/phenotype_definitions.pdf

The data in this table include all applicable pathogens entered for an HAI, and are not limited to the first pathogen.

Sorted by erd1,eventDate

Data contained in this report were last generated on December 6, 2020 at 4:08 PM to include data beginning January 2020 through December 2020.

---

By default, separate line lists are generated for each phenotype.
Modify Antimicrobial Resistant Line List

- Use the Modify screen to identify phenotype of interest
  - Example: We are interested in viewing a line list of CRE HAIs

Hint: Each phenotype has a code in NHSN. Refer to resources at the end of the presentation.
CRE Line List

- Includes 3 Enterobacteriaceae species: Klebsiella, E.coli, and Enterobacter

### Line Listing - Antimicrobial Resistant Organisms
**CREall_HAI - Carbapenem-resistant Enterobacteriaceae**

As of: January 6, 2021 at 2:30 PM
Date Range: All ANTIBIOMAN_HAI

<table>
<thead>
<tr>
<th>orgID</th>
<th>patID</th>
<th>dob</th>
<th>gender</th>
<th>admitDate</th>
<th>eventID</th>
<th>eventDate</th>
<th>eventType</th>
<th>location</th>
<th>pathogenDesc</th>
<th>phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>10401</td>
<td>ESC1</td>
<td>10/20/1951</td>
<td>M</td>
<td>12/15/2018</td>
<td>66500</td>
<td>01/01/2019</td>
<td>BSI</td>
<td>ICU</td>
<td>Klebsiella oxytoca - KO</td>
<td>CREall_HAI</td>
</tr>
<tr>
<td>10401</td>
<td>1234</td>
<td>12/12/2007</td>
<td>M</td>
<td>02/01/2019</td>
<td>87661</td>
<td>02/15/2019</td>
<td>BSI</td>
<td>4W</td>
<td>Escherichia coli - EC</td>
<td>CREall_HAI</td>
</tr>
<tr>
<td>10401</td>
<td>1002</td>
<td>01/04/2001</td>
<td>M</td>
<td>01/01/2019</td>
<td>88362</td>
<td>01/05/2019</td>
<td>BSI</td>
<td>ICU</td>
<td>Klebsiella aerogenes - EA</td>
<td>CREall_HAI</td>
</tr>
<tr>
<td>10401</td>
<td>1002</td>
<td>01/04/2001</td>
<td>M</td>
<td>02/01/2019</td>
<td>88363</td>
<td>02/05/2019</td>
<td>BSI</td>
<td>NEURO</td>
<td>Enterobacter aerogenes - ETEN</td>
<td>CREall_HAI</td>
</tr>
<tr>
<td>10401</td>
<td>1234</td>
<td>12/12/2007</td>
<td>M</td>
<td>09/15/2019</td>
<td>89465</td>
<td>10/01/2019</td>
<td>BSI</td>
<td>2N</td>
<td>Klebsiella pneumoniae - KLEO2Z</td>
<td>CREall_HAI</td>
</tr>
<tr>
<td>10401</td>
<td>1234</td>
<td>12/12/2007</td>
<td>M</td>
<td>12/15/2019</td>
<td>90658</td>
<td>01/01/2020</td>
<td>BSI</td>
<td>MED</td>
<td>Klebsiella aerogenes - EA</td>
<td>CREall_HAI</td>
</tr>
</tbody>
</table>

Note: Unless you make specifications on the Modify screen, this report will be inclusive of all HAI types and time periods.
Frequency Table for Antimicrobial Resistant Organisms

- By default: counts of each phenotype by HAI type
- Use the Modify screen to change the row/column variables
Antimicrobial Resistance Percentages (Rate Table)
Antimicrobial Resistance (AR) Percentages

- Calculated for each phenotype, similar to a hospital’s antibiogram report
- Percent of specific pathogens that are resistant to identified drugs (% R)

\[
\frac{\text{# of resistant organisms}}{\text{total # of organisms tested}} \times 100\%
\]

- Example: CRE

\[
\frac{\text{# Enterobacteriaceae resistant to carbapenems}}{\text{# Enterobacteriaceae tested for susceptibility to carbapenems}} \times 100\%
\]
Example: CRE Resistance Percentage

- NumIsolated = 27 Enterobacteriaceae reported to NHSN
- NumTested = 25 Enterobacteriaceae tested for carbapenems
- NumResistant = 12 Enterobacteriaceae resistant to carbapenems (CRE)
- PctResistant = \(\frac{12}{25} \times 100\) = 48% of Enterobacteriaceae tested in the facility were resistant to carbapenems
- 95% confidence interval around percentage to indicate precision (29.2%, 67.2%)
More about AR Percentages

- Percentages are only calculated when at least 20 organisms have been tested (i.e., denominator must be ≥ 20)
  - Rate tables only calculated at the quarter-level or higher
  - “Group by” a wider time variable to include more data

- Detailed footnotes beneath the rate tables
  - Provide definition for the phenotype and important details about the percentage calculation

- National benchmarks for antimicrobial resistance are available
Quick Reference Guides Available

- Phenotype Definitions
- Line List
- Frequency Table
- Rate Table (%R)

Analysis Quick Reference Guides

<table>
<thead>
<tr>
<th>Topic</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Tips</td>
<td></td>
</tr>
<tr>
<td>Troubleshooting Guides</td>
<td>+</td>
</tr>
<tr>
<td>Frequently Requested Output/Reports</td>
<td>+</td>
</tr>
<tr>
<td>Targeted Assessment Prevention (TAP) Strategy Reports</td>
<td>+</td>
</tr>
<tr>
<td>Antimicrobial Use and Resistance Module Reports</td>
<td>+</td>
</tr>
<tr>
<td>Output/Report Option Types</td>
<td>+</td>
</tr>
<tr>
<td>Tips for Customizing Your Output/Reports</td>
<td>+</td>
</tr>
<tr>
<td>Detailed Guides for Specific Analysis Options</td>
<td>+</td>
</tr>
</tbody>
</table>

National AR Report

- Provides information on the most common pathogens reported to NHSN
- National pathogen distributions and resistance data for device-associated HAIs and surgical site infections

https://doi.org/10.1017/ice.2019.296
Other Drug Results

- Individual drug susceptibilities can be found in the Antibiogram Line List (Advanced folder)
- Use this to review each drug result for each pathogen

Advanced > Pathogen-level Data > Line Listing - Antibiogram
Example Antibiogram Line List

- Your hospital pharmacist is interested in the types of resistance patterns seen among HAIs in your facility, and would like to know if any HAI pathogens tested resistant to vancomycin.

- Because you are an expert at NHSN analysis, you volunteered to help!
Goal: Create a line list showing only those pathogens resistant to vancomycin

1. Click “Modify” next to the Antibiogram Line List

2. Use the Filters to set “VANC” = ‘R - Resistant’

Hint: Each drug has an abbreviation in NHSN. Refer to the NHSN data dictionary.
3. By default, the line list will include ALL antibiotics. Remove the antibiotics you don’t need for this report by transferring them to the LEFT column.
## Line List of Vancomycin-Resistant HAIs

### National Healthcare Safety Network
**Line Listing - Antibiogram**

As of: February 1, 2021 at 3:24 PM  
Date Range: All ANTIBIOGRAM

<table>
<thead>
<tr>
<th>orgID</th>
<th>eventID</th>
<th>eventType</th>
<th>eventDate</th>
<th>procCode</th>
<th>pathogenDesc</th>
<th>VANC</th>
</tr>
</thead>
<tbody>
<tr>
<td>10401</td>
<td>101414</td>
<td>BSI</td>
<td>01/19/2020</td>
<td></td>
<td>Staphylococcus aureus - SA</td>
<td>R</td>
</tr>
<tr>
<td>10401</td>
<td>101416</td>
<td>UTI</td>
<td>01/22/2020</td>
<td></td>
<td>Staphylococcus, coagulase negative - CNS</td>
<td>R</td>
</tr>
</tbody>
</table>

**Hint:** Consider sorting the line list by eventType or by pathogenDesc.

**More information on how to modify a line list:** [https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/linelist_qrg.pdf](https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/linelist_qrg.pdf)
Unusual Susceptibility Alerts
Alert for an Unusual Susceptibility Profile

- Highlights reporting of an epidemiologically important pathogen
  - Prompt infection control interventions
  - Assist with data cleaning

- User will be notified when unusual susceptibility profiles are entered into NHSN for in-plan events

- Will be notified immediately after saving the event
**Unusual Susceptibility Profiles**

<table>
<thead>
<tr>
<th>SUSCEPTIBILITY</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbapenem resistant Enterobacteriaceae</td>
<td></td>
</tr>
<tr>
<td>Carbapenem intermediate or resistant <em>Acinetobacter baumannii</em>, <em>Pseudomonas aeruginosa</em></td>
<td></td>
</tr>
<tr>
<td>Highly Drug Resistant <em>Enterobacteriaceae</em>, <em>Pseudomonas aeruginosa</em>, <em>Acinetobacter baumannii</em></td>
<td></td>
</tr>
<tr>
<td>Colistin/Polymyxin B-resistant <em>Acinetobacter baumannii</em>, <em>Pseudomonas aeruginosa</em></td>
<td></td>
</tr>
<tr>
<td>Daptomycin-susceptible-dose dependent, resistant, or non-susceptible, and Linezolid-resistant <em>Enterococcus</em> spp.</td>
<td></td>
</tr>
<tr>
<td>Vancomycin-resistant <em>Staphylococcus aureus (SA)</em></td>
<td></td>
</tr>
<tr>
<td>Daptomycin-non-susceptible and Linezolid-resistant and Vancomycin-intermediate <em>Staphylococcus aureus</em></td>
<td></td>
</tr>
<tr>
<td>Vancomycin-resistant <em>Staphylococcus</em>, coagulase negative (VRSE)</td>
<td></td>
</tr>
</tbody>
</table>

*All defined drug classes have at least one drug within the class reported as either Intermediate (I) or Resistant (R)*
Unusual Susceptibility Profile Alert

- Upon saving an event, a pop-up window will appear
- Click details to view more information about this specific alert
- The user can confirm accurate data entry and susceptibility reporting by clicking confirm, or amend data entry by clicking cancel
- Click OK to acknowledge the alert and save the record without immediately confirming the result
If you click “OK”....

- You are tentatively saving the event – but confirmation of data entry is still needed!
- You will receive an Alert on your home screen
- To clear the alert, you must
  - Confirm the resistance profile
  - Or, modify the susceptibilities on the event form with corrected data
Analysis of Unusual Susceptibility Profiles

- Analysis options are available that track all unusual susceptibility alerts in a facility that have been confirmed or are pending confirmation.
Analysis of Unusual Susceptibility Profiles, Continued

- Examples of line list and frequency table
- Available for facilities and Groups
- Applies to 2014 data and forward
More Guidance on Unusual Susceptibility Alerts

- Information on unusual phenotypes
- How to run analysis reports for these data
- Steps to take if you receive an alert

Antibiotic Resistance & Patient Safety Portal

Explore and Visualize Data on Antibiotic Resistance and Healthcare-Associated Infections
Background: Antibiotic Resistance & Patient Safety Portal (AR&PSP)

- An interactive web-portal open to the public that allows exploration of national, regional, and state antimicrobial resistance data
- Agency goal to increase public availability of AR data
  - Improve access of AR data to wide audiences with multiple uses
- National Action Plan to Combat Antimicrobial Resistant Bacteria (CARB)

https://arpsp.cdc.gov/
Data Included

- Pathogen and drug susceptibility information are taken from CLABSIs, CAUTIs, and SSIs reported to NHSN
  - Does not capture all resistance in the community or within a hospital
- National, state, and regional resistance data
- Can view %R for different years, age groups, facility types, and HAI types in your state
AR&PSP Example: Geographic Location of MRSA

- This map shows the variation in % methicillin resistance among *Staphylococcus aureus* associated with CLABSIs in 2018
PSP Example: Changes over time in MRSA

- This graph displays percent resistance (%R) for MRSA CLABSIs, from 2011 to 2018
Resources

- NHSN Data Dictionary (antibiotic codes):
  https://www.cdc.gov/nhsn/xls/analysis/nhsn-data-dictionary.xlsx

- Reference Guide for AR Line List:
  http://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/linelist_qrg.pdf

- Reference Guide for AR Frequency Table:
  http://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/freqtable_qrg.pdf

- Reference Guide for AR Rate Table:
  https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/ratetable_qrg_cre.pdf

- Codes and Definitions for NHSN Phenotypes:
  http://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/phenotype_definitions.pdf

- CDC’s 2019 AR Threat Report:

- National Action Plan to Combat Antibiotic-Resistant Bacteria (CARB):

- CDC’s Vital Signs on HAIs and Antimicrobial Resistance: https://www.cdc.gov/vitalsigns/containing-unusual-resistance/index.html
Send questions to:

NHSN@cdc.gov

For more information, contact CDC
1-800-CDC-INFO (232-4636)

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.