Antimicrobial Resistance (AR)
Agenda

• **Introduction**
  • Overview of the Antimicrobial Resistance Module
  • AR Data Requirements
  • NHSN Metrics and Benchmarks
  • CDA and the NHSN HAI IG
  • Our Support
  • Resources
Speaker

KP Sethi

- Director of Information Analysis and Technology
- Lead Analyst
- Quality and public health reporting expert
Project Background

• Project Goal
  Provide technical assistance to the CDPH HAI Program and California hospitals implementing National Healthcare Safety Network (NHSN) Antimicrobial Use and Resistance Reporting

• Background
  – CDPH distributed two surveys in 2015 to identify California hospitals with sufficient informatics capabilities to monitor AU and AR data with NHSN
  – Progress requires assistance in implementing AUR reporting
Organizations Involved

CDPH contracts with Health IT experts for NHSN reporting support

NHSN Program at CDC

CDPH, LA County and Health IT Experts

<you>

Receive support to implement and benefit from AR reporting

CDC funds CDPH to provide AR Reporting support
Agenda

• Introduction

• **Overview of the Antimicrobial Resistance Module**

• AR Data Requirements NHSN Metrics and Benchmarks

• CDA and the NHSN HAI IG

• Our Support

• Resources
NHSN Goals

- Identify infection prevention problems by facility, state, or quality improvement project
- Comply with state and federal public reporting mandates
- Benchmark the progress of infection prevention efforts
- Track blood safety errors and important healthcare process measures
CDC NHSN Structure

NHSN

- Patient Safety
  - Device Associated
  - Procedure Associated
  - Healthcare Personnel Safety
- Biovigilance
- Long-term Care
- Dialysis
  - Antimicrobial Use and Resistance
    - Antimicrobial Resistance Option
    - Antimicrobial Use Option
## Antimicrobial Use and Resistance Reporting

<table>
<thead>
<tr>
<th>Antimicrobial Use Option</th>
<th>Antimicrobial Resistance Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracks usage of antimicrobials across inpatient locations</td>
<td>Tracks the resistance of antimicrobials across inpatient locations</td>
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</tbody>
</table>

AUR Module allows choice of AU, AR, or both
Data Submission

NHSN Data Submission

Manual Data Entry
All Modules other than AUR allow manual data entry.

Electronic Data Submission
All modules can submit electronic data, which is a requirement for the AUR module.
Electronic Data Submission

Electronic Submission requires the HL7 Clinical Document Architecture (CDA) format.

Hospitals submit data via the NHSN Portal.

Submitted data are analyzed and benchmarked.
NHSN CDA Submission Format

• HL7 Clinical Document Architecture (CDA)
  – Standard for electronic clinical documents
  – Used in Meaningful Use
  – Generic format for all NHSN HAI Modules
  – Specific document types per reporting option
## AR Option

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Benefits</th>
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<tr>
<td>• Evaluate AR data with a standardized approach</td>
<td>• Improve awareness of AR problems</td>
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<tr>
<td>• Facilitate regional and national AR assessment</td>
<td>• Aid decision making and prioritize transmission prevention efforts</td>
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<td>• Provide benchmarking to aid regional and national tracking</td>
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</tbody>
</table>
Meaningful Use and AUR Reporting

- (f)(6) Transmission to Public Health Agencies – Antimicrobial Use and Resistance Reporting
- Create antimicrobial use and resistance reporting information for electronic transmission in accordance with the standard in § 170.205(r)(1).

Agenda

- Introduction
- Overview of the Antimicrobial Resistance Module
- **AR Data Requirements**
  - NHSN Metrics and Benchmarks
  - CDA and the NHSN HAI IG
- Our Support
- Resources
Minimum Requirements to Report AR

- Facilities enrolled in NHSN are:
  - General acute care hospitals
  - Critical access hospitals
  - Oncology hospitals
  - Long term acute care hospitals
  - Inpatient rehabilitation facilities

- NHSN does not support data submission for the AR Option from long term care facilities (i.e., skilled nursing facilities, nursing homes) or outpatient dialysis facilities.

- Collect the numerator and denominator data electronically.
- Upload data into NHSN with CDA specifications.
AR Data Elements

• Facilities report 2 types of data each month:
  – Numerator (Multiple files)
  – Denominator (Single file)

• Numerator: Patient-level susceptibility results for specific organisms

• Denominator: Patient days and admissions (facility-wide only)
System Requirements

• Denominator: Patient Days and Admissions
  – Admission Discharge Transfer System
  – Tracking patient flow by location, and time

• Numerator: Patient-level Isolate Report
  – Lab Information System
  – Isolate Susceptibility report including organism, source, time and location where collected, and antimicrobial susceptibility test results.
NHSN AR Denominator

- Typically calculated using ADT data
- Counts are collected at the Facility Level
- NHSN AUR Module guide suggests reporting from all patient care locations is technically easier than from selected locations.
Denominator Data Elements

Facility-Level Data

- Unique NHSN Facility ID
- Location
- Month
- Year

Patient Days

Admission Count
Denominator Data

• Each month, across all inpatient units:
  – Patient Days:
    • Number of patients present in the facility at a specific time on each day
    • Usually, midnight census (AKA butts in bed)
  – Admissions:
    Number of patients admitted to an inpatient location in the facility
• Calculated from A/D/T Data
• No denominator data for outpatient locations
## Calculating Patient Days

<table>
<thead>
<tr>
<th>Patient Movement</th>
<th>Patient Days (Census Count)</th>
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<tbody>
<tr>
<td><strong>Patient A</strong></td>
<td></td>
</tr>
<tr>
<td>Medical Ward: 00:01-24:00</td>
<td>Medical Ward = 1</td>
</tr>
<tr>
<td><strong>Patient B</strong></td>
<td></td>
</tr>
<tr>
<td>Medical ICU: 00:01-24:00</td>
<td>Medical ICU = 1</td>
</tr>
<tr>
<td><strong>Patient C</strong></td>
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</tr>
<tr>
<td>Medical ICU: 00:01-08:30</td>
<td>Medical ICU = 0</td>
</tr>
<tr>
<td>Medical Ward: 08:31-24:00</td>
<td>Medical Ward = 1</td>
</tr>
<tr>
<td><strong>Patient D</strong></td>
<td></td>
</tr>
<tr>
<td>Medical ICU: 00:01-10:00</td>
<td>Medical ICU = 0</td>
</tr>
<tr>
<td>Step Down: 10:01-15:00</td>
<td>Step Down = 0</td>
</tr>
<tr>
<td>Medical Ward: 15:01-24:00</td>
<td>Medical Ward = 1</td>
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<tr>
<td><strong>Totals:</strong></td>
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<tr>
<td></td>
<td>Medical Ward = 3</td>
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<tr>
<td></td>
<td>Medical ICU = 1</td>
</tr>
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<td></td>
<td>Step Down = 0</td>
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</table>
NHSN AR Numerator

• Patient-level susceptibility results for specific organisms
  – Patient data:
    • DOB, gender, date admitted to facility, location
  – Specimen data:
    • Collection date, Source
  – Susceptibility data:
    • Organism
    • Antimicrobial susceptibility data
      – For each antimicrobial required for the isolate organism/specimen type
    • Final lab interpretation

• Hospitals use LIS to gather this data.
Numerator Data Elements

Facility Identifier

Unique NHSN Facility ID (i.e., Object Identifier [OID] in the CDA)

Patient Data

- Patient identifier
- Date of birth
- Gender
- Date admitted to facility (use the encounter date if the event occurred in outpatient location)

Specimen Data

- Specimen collection date
- Specimen source
- Location code (mapped to CDC location codes)
- Isolate identifier (unique isolate ID in the electronic laboratory report)
- Organism
Numerator Data Elements

Antimicrobial Susceptibility Data

- Antimicrobial
- PBP2a-agglutination (only if Staphylococcus aureus)
- PCR mec-gene (only if Staphylococcus aureus)
- E-test sign
- E-test value and unit of measure
- Interpretation of E-test
- MIC sign
- MIC value and unit of measure
- Interpretation of MIC test
- Disk diffusion (KB) test sign
- Disk diffusion (KB) test value and unit of measure
- Interpretation of disk diffusion (KB) test
- Final interpretation result
AR vs AU Reporting

– Denominator:
  • AU: Days Present count
  • AR: Patient Days count

– Numerator:
  • AU: Days of Therapy for 90 antimicrobials, for each location
  • AR: Isolate Reports for Organisms in any inpatient location

– Location Data:
  • AU: All collected, and reported by location
  • AR: Facility-wide for inpatient locations
AR vs AU Reporting

– Different Source Systems:
  • AU requires data from ADT and eMAR systems
  • AR requires data from LIS and ADT systems

– Data Sensitivity:
  • AU is summary data, with no PHI
  • AR reports contain patient level data

– CDA Reports:
  • AU reporting requires 1 file per location
  • Each files contain numerator and denominator
  • AR reporting requires 1 file per isolate
  • Denominator is a separate file, for entire facility
Location Mapping in AR

• Hospitals reporting HAI have Inpatient Locations mapped in NHSN.

• AUR uses same location mapping to identify locations.

• Hospitals do not report Antimicrobial Resistance by location.

• Isolate reports derive from all inpatient locations or select outpatient locations.
Numerator Reporting

Deduplication Steps

Collect isolates for patient for the last month

Select Eligible Organisms with results

Select first isolate in reporting month

Filter based on when isolate was last reported

Duplicate Isolate Scenarios

Select Priority Source

Group by Source

Invasive

Non-invasive
Eligible Organisms

• Full List: Appendix A, NHSN AUR Guide
• Antimicrobials required for resistance testing

<table>
<thead>
<tr>
<th>Organism</th>
<th>Specimen Type</th>
<th>Antimicrobial Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acinetobacter</em></td>
<td>Blood, Urine, Lower Respiratory, CSF</td>
<td>Amikacin, Ampicillin-sulbactam, Cefepime, Cefotaxime, Ceftazidime, Ceftriaxone, Ciprofloxacin, Doxycycline, Gentamicin, Imipenem with Cilastatin, Levofloxacin, Meropenem, Minocycline, Piperacillin, Piperacillin-tazobactam, Tetracycline, Ticarcillin-clavulanate, Tobramycin, Trimethoprim-sulfamethoxazole</td>
</tr>
<tr>
<td><em>Acinetobacter</em> (All <em>Acinetobacter</em> species noted in the IDM/Pathogen Codes tab listed in the ARO Pathogen column)</td>
<td>Additional Agents for Urine</td>
<td>None</td>
</tr>
</tbody>
</table>

*Note: Additional agents for urine may include: Aminoglycosides, Carbapenems, Fluoroquinolones, Macrolides, Tetracyclines, and β-Lactams.*
Eligible Isolates

• Report all required data each month for each eligible isolate-based report
• Inpatient or specific outpatient locations (i.e., ED, pediatric ED, and 24-hour observation)
• Regardless of antimicrobial resistance
  – Even if susceptible to all required antimicrobials
Lab Reporting Guidelines

• Interpretation of test results (i.e., E-test, MIC test, Disk diffusion [KB] test):
  – S = Susceptible
  – S-DD = Susceptible-Dose Dependent
  – I = Intermediate
  – R = Resistant
  – NS = Non-Susceptible
  – N = Not Tested

• Specific to Gentamicin and Streptomycin results for Enterococcus testing:
  – S = Susceptible/Synergistic
  – R = Resistant/Not Synergistic

• Facilities should only report final or corrected susceptibility testing.
Electronic Calculation Requirement

- Facilities should not employ manual data collection to report AR.
- Facilities that cannot electronically obtain the results of the individual laboratory tests should:
  - Use ‘Unknown’ or ‘Not Tested’
  - Provide the final interpretation result
Specimen Types

• Two distinct sources are reported:
  – Invasive Specimen: Blood or cerebrospinal fluid
  – Non-Invasive Specimen: Lower respiratory or urine

• Different sources, different “AR Events”
Reporting Rules for Specimen Sources

• Invasive Sources
  Each eligible organism isolated from an invasive source (i.e., blood or CSF) per patient, per 14-day period, across calendar months

• Non-Invasive Sources
  First eligible organism isolated from an eligible non-invasive culture source (i.e., lower respiratory or urine), per patient, per month
Edge Case: Report Non-Required Drugs

• Isolate is eligible for reporting even if:
  – All of the *NHSN required* antimicrobials were not tested
  – At least one non-required drug is eligible

• Example:
  – Oritavancin is not a required antimicrobial for the *Staphlococcus aureus* isolate
  – None of the 23 required antimicrobials were tested
  – Isolate is still considered eligible for reporting
Reporting for Non-Required Drugs

• For such an isolate, the facility will:
  – Report the specimen.
  – Report “Not Tested” for all required drugs.
  – Exclude the susceptibility information for Oritavancin because it not in the drug panel for that organism.
Numerator Reporting: Invasive Steps

Collect isolates for patient for the last month

Select isolates with susceptibility results

Invasive vs. Non-invasive

Invasive
- Filter based on when isolate was last reported
- Select first isolate in reporting month

Non-invasive

Select isolates with susceptibility results

Deduplication Steps
- Select Priority Source
- Duplicate Isolate Scenarios
Invasive Specimen Reporting

• The 14-day Rule for Invasive Specimens:
  – Record an AR Event after 14 days with no positive culture result from the laboratory if the patient and specific organism pass.

• Record an AR Event for:
  – Each eligible organism isolated from an invasive source (i.e., blood or CSF)
  – Per patient
  – Per 14-day period
  – Across Calendar Months
14 Day Rule

• Additional Guidance for the 14 day Rule:
  – Count starts on the day of specimen collection
  – Only applies to those specimens from an inpatient location or select outpatient location (i.e., ED, pediatric ED, or 24-hour observation area)
  – Exclude cultures from other healthcare facilities

• At a maximum, there will be no more than three invasive isolates per specific organism per patient per month.
Algorithm for Invasive Specimen

Eligible organism isolated from invasive source (blood or CSF) per patient

Prior (+) isolate with same organism from invasive source in ≤ 14 days, per patient (Including across calendar months)

1. Yes
   - Additional AR isolate
   - Should not be reported

2. No
   - AR Event
   - Should be reported
### Walkthrough: 14 Day Rule

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>Antimicrobial Agent</th>
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<td>E-test</td>
<td>Greater than 5.0 μg/ml</td>
<td>Ceftazidime</td>
<td>E-test</td>
<td>Less than 0.1 μg/ml Susceptible</td>
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<td>Resistant</td>
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<td>2018-02-24</td>
<td>CSF</td>
<td>Chloramphenicol</td>
<td>E-test</td>
<td>Susceptible</td>
<td>Levofloxacin</td>
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<td>2018-03-16</td>
<td>Blood</td>
<td>Minocycline</td>
<td>E-test</td>
<td>Less than 0.1 μg/ml</td>
<td>Ceftazidime</td>
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Apply 14 day rule when sources are invasive.
## Walkthrough: 14 Day Rule

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*Do not report to NHSN*

*It has been less than 14 days since the last positive culture (Feb/20)*
### Walkthrough: 14 Day Rule

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**Report to NHSN**

It has been more than 14 days since the last positive culture (Feb/24)
## Walkthrough: 14 Day Rule
### Data Reported

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Numerator Reporting: Non Invasive Steps

Collect isolates for patient for the last month

Select isolates with susceptibility results

Invasive vs. Non-invasive

Invasive

Filter based on when isolate was last reported

Non-invasive

Select first isolate in reporting month

Select Priority Source

Duplicate Isolate Scenarios

Deduplication Steps
Non-Invasive Specimen Reporting

• Record an AR Event for:
  – First eligible organism isolated from an eligible non-invasive culture
  – Each patient
  – Each month

• NHSN only allows one AR event for lower respiratory or urine specimens per month per patient, per organism.
Non Invasive Specimen Algorithm

Eligible organism isolated from non-invasive source (lower respiratory or urine) per patient

1st in calendar month per patient, per organism

Yes

AR Event

Should be reported

No

Additional AR isolate

Should not be reported
Numerator Data Deduplication

Patient has multiple isolates collected on the same day with same organism and same source

Select isolates with susceptibility results

Invasive vs. Non-invasive

Invasive

Apply 14 day Rule

Non-invasive

Select first isolate in reporting month

Deduplication Steps

Select Priority Source

Duplicate Isolate Scenarios
Duplicate Isolates

• Duplicate Isolates
  – Defined as same species or same genus from same patient on same day
  – Isolates must have the same source type (i.e., invasive or non-invasive)

• Handling multiple isolates of the same organism
  – Isolates may produce conflicting results
  – Facilities should only report one isolate to NHSN
  – NHSN has rules for removing duplicates
Duplicate Isolate Removal Rules

• General rules:
  – Do not merge test results across multiple isolates
  – Don’t summarize results across different isolates tested on same day
  – Eliminate isolates on same day without susceptibility test results
  – For Invasive Specimens:
    • CSF isolates > blood isolates
  – For Non-Invasive Specimens:
    • lower respiratory isolates > urine isolates
Duplicate Isolate Scenarios: Conflicting Results

1. Same isolate tested using the same test, with conflicting results
2. Same isolate tested using different tests, with conflicting results
3. Two isolates collected on the same day return conflicting results from a panel of antimicrobial tests
Duplicate Isolate Removal Rules

• Same isolate, same specific test, conflicting results:
  – If available, report the final interpretation
  – Without a final interpretation, report the most resistant interpretation (i.e., NS > R > I > S-DD > S > NT)

• Example:
  – Interpretation of E-test 1 = Intermediate
  – Interpretation of E-test 2 = Susceptible
  – Report E-test 1/ Intermediate as final interpretation
Duplicate Isolate Removal Rules

• Same isolate, different specific tests, conflicting results:
  – If available, report the final interpretation
  – If no final interpretation is provided, report the most resistant interpretation (i.e., NS > R > I > S-DD > S > NT).

• Example:
  – Interpretation of MIC test = Resistant
  – Interpretation of E-Test = Intermediate
  – No final interpretation was provided
  – Report “Resistant” as the final interpretation
Duplicate Isolate Removal Rules

• Different isolates, specific tests, conflicting results:
  – If available, report isolate with the most resistant final interpretation.
  – If no final interpretation, report the isolate with the higher amount of drug resistance based on the number of antimicrobials testing "NS" or "R".
  – If all else fails, report first isolate entered into LIS

• Example: *Candida albicans*, isolated from two blood specimens, same patient, same calendar day, no final interpretation
  – First isolate tested “R” to 3 of 8 antimicrobials
  – Second isolate tested “R” to 4 of 8 antimicrobials
  – The facility reports the second isolate to NHSN because it showed greater resistance
## Walkthrough: Deduplication

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**Scenario:**

*Two isolates from same day, conflicting results to panel of antimicrobials*
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Collected on the same day
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### Report most resistant result

60
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Numerator Reporting: Chart

Isolate(s) collected for Patients for last month

Isolate has susceptibility result?
  Yes
  Are all isolates Invasive or non-invasive?
    Invasive
      Isolates pass 14-day rule?
        Yes
        Select CSF over blood isolate
        No
        Report the isolate
      No
      Multiple isolates remain?
        Yes
        Determine Duplicate Isolate Scenario
        No
        Eliminate isolate(s)
    Non-invasive
      Is the first isolate in the reporting month?
        Yes
        Select lower respiratory over urine isolates
        No
        Multiple isolates remain?
          Yes
          Determine Duplicate Isolate Scenario
          No
          Eliminate isolate(s)
AR Monthly Data Submission

• Locations and Timeline:
  – Submit data from all NHSN-defined inpatient locations
    Beginning January 1, 2017, facilities can submit AR specimens from three outpatient locations: ED, pediatric ED, and 24-hour observation area
  – Upload within 30 days of completion

• Submit:
  – One CDA file per organism (AR Event)
  – One CDA file for denominator
  – Example:
    • 50 separate CDA files for 50 separate AR Events
    • One CDA for facility-wide denominators
    • All CDA files are uploaded in one Zip file
    • Max: 1000 CDAs or file size of 2 MB per zip file
Agenda

• Introduction
• Overview of the Antimicrobial Resistance Module
• AR Data Requirements
• **NHSN Metrics and Benchmarks**
• CDA and the NHSN HAI IG
• Our Support
• Resources
Benchmarks for AR Reporting

• AR Option Metrics:
  – Metrics at the monthly, quarterly, semi-annual, or annual period depend on the frequency the isolates occur.
  – Facility-wide antibiogram
  – Stratified by specimen source, time period, specific antimicrobial, and organism
Facility Wide Antibiogram

For each organism-antimicrobial pairing*

Percentage of Non-susceptible =

Total # of organisms resistant or intermediate for a pathogen

Divided By

Total # of organisms tested for that pathogen

*exceptions based on organism species
Benchmarks for AR Reporting

• AR Option Line List:
  – Show all AR Events for a given time period
  – Most customizable report
  – Displays:
    • AR Event
    • Patient ID
    • Date of birth
    • Gender
    • NHSN assigned Event ID
    • Specimen type
    • Organism identified.
  – Customizations show specific months, locations, organisms, and test results.
  – Helpful when validating the data after upload.
• NHSN can export all AR Option data in various formats (CSV etc...)

Agenda

• Introduction
• Overview of the Antimicrobial Resistance Module
• AR Data Requirements
• NHSN Metrics and Benchmarks
  • CDA and the NHSN HAI IG
• Our Support
• Resources
CDA R2

• Clinical Document Architecture (CDA)
• Common model defining the structure and semantics of clinical documents
• Developed by Health Level Seven
• XML syntax
• First released in 2005
CDA Body and Header

• Header
  – Facility OID
  – Authoring vendor
  – Patient Information

• Body
  – Report Data:
    • Specimen Type
    • Date Specimen Collected
    • In-Facility location of patient
    • Pathogen Isolate
    • Specific Tests
    • Results
Object Identifier (OID)

- A unique identifier that represents an object:
  - A tree of nodes and edges (i.e., branches and leaves, sometimes called OID arcs)
  - A positive integer is assigned to each edge in the tree.

- OIDS in CDA:
  - Add global uniqueness to identifiers in clinical documents.
  - Identify the Facility submitting data to NHSN
  - Identify the vocabulary terminology systems in a document.
# HL7 V3 Data Types: R1 in CDA

<table>
<thead>
<tr>
<th>BASIC DATA TYPES</th>
<th>CODED VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANY</td>
<td>CS</td>
</tr>
<tr>
<td></td>
<td>CE</td>
</tr>
<tr>
<td></td>
<td>CD</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>BL</td>
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<tr>
<td>ED</td>
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<tr>
<td>ST</td>
<td></td>
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<table>
<thead>
<tr>
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<th>ADDRESSES</th>
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<td>PN</td>
<td>ADXP</td>
</tr>
<tr>
<td>ON</td>
<td>AD</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
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<table>
<thead>
<tr>
<th>COLLECTIONS</th>
<th>IDENTIFIERS</th>
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</thead>
<tbody>
<tr>
<td>SET</td>
<td>II</td>
</tr>
<tr>
<td>LIST</td>
<td></td>
</tr>
<tr>
<td>IVL</td>
<td></td>
</tr>
<tr>
<td>QUANTITIES</td>
<td>TIME</td>
</tr>
<tr>
<td>INT</td>
<td>TS</td>
</tr>
<tr>
<td>PQ</td>
<td>PIVL</td>
</tr>
<tr>
<td>REAL</td>
<td>IVL</td>
</tr>
<tr>
<td>RTO</td>
<td>GTS</td>
</tr>
</tbody>
</table>

- **Organism Codes**
- **Antimicrobial Agents**
- **Drug Susceptibility Tests**
- **OIDs**
- **Patient Days**
Value Sets and Code Systems

- **Code** – a sequence of characters assigned meaning by some formal system
  - Expression, Symbol

- **Code System** – formal definitions that define the meaning of a set of concepts, with codes
  - Terminology, Ontology, Enumeration, Classification...
  - SNOMED, LOINC, RxNorm
  - Drive meaning/analysis off code systems

- **Value Set** – a group of code/codeSystem pairs
  - Doesn’t define its own codes
  - Picks codes from multiple code systems
  - AR examples:
    - Isolate Codes
    - Specific Tests performed
Example of Code System Vs. Value Sets

- Ice Cream flavors code system
  - Chocolate
  - Vanilla
  - Strawberry
  - Mango
  - Pear
  - Rocky Road
  - Cookie Dough
  - Cake
  - Caramel
  - Coffee
  - Blueberry
  - Raspberry

- “Berry Flavors” Value Set
  - Strawberry
  - Blueberry
  - Raspberry
Code Systems

• **SNOMED-CT**: Systematized Nomenclature Of Medicine Clinical Terms
  – Specimen Type (codes for invasive/non-invasive)
  – Pathogen Identified

• **LOINC**: Logical Observation Identifiers Names and Codes
  – Document and section codes
  – Antibiotic susceptibility tests

• **RxNorm**: RxNorm provides normalized names for clinical drugs
  – Antimicrobial ingredients
Tools

• Tools find codes from the three hierarchies:
  – SNOMED Browser
  – LOINC on-line (LOINC.org)
  – RxNorm’s RxNav

• Finding value sets:
    • General Source of truth for most (all) Value Sets
  – HAI Specific Values Sets Excel Spreadsheet
    https://gforge.hl7.org/gf/project/strucdoc/scmsvn/?action=browse&path=/*checkout*/trunk/HAI/HAI-R1-Normative_XML_Support_Files/hai_voc.xls&revision=182
SNOMED Browser
<table>
<thead>
<tr>
<th>LOINC</th>
<th>LongName</th>
<th>Component</th>
<th>Property</th>
<th>Timing</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>82271-8</td>
<td>Activity metabolic rate/Standard resting metabolic rate [Relative Energy/Time] adjusted for age+sex+race+BMI 1 minute mean Estimated</td>
<td>Activity metabolic rate/Standard resting metabolic rate adjusted for age+sex+race+BMI</td>
<td>RelEngRat</td>
<td>1M</td>
<td>^Patient</td>
</tr>
<tr>
<td>74728-7</td>
<td>Vital signs, weight, height, head circumference, oximetry, BMI, and BSA panel - HL7.CCDAr1.1</td>
<td>Vital signs, weight, height, head circumference, oximetry, BMI, &amp; BSA panel</td>
<td>-</td>
<td>Pt</td>
<td>^Patient</td>
</tr>
<tr>
<td>85353-1</td>
<td>Vital signs, weight, height, head circumference, oxygen saturation and BMI panel</td>
<td>Vital signs, weight, height, head circumference, oxygen saturation &amp; BMI panel</td>
<td>-</td>
<td>Pt</td>
<td>^Patient</td>
</tr>
<tr>
<td>59574-4</td>
<td>Body mass index (BMI) [Percentile]</td>
<td>Body mass index</td>
<td>Prctl</td>
<td>Pt</td>
<td>^Patient</td>
</tr>
<tr>
<td>59575-1</td>
<td>Body mass index (BMI) [Percentile] Per age</td>
<td>Body mass index</td>
<td>Prctl</td>
<td>Pt</td>
<td>^Patient</td>
</tr>
<tr>
<td>59576-9</td>
<td>Body mass index (BMI) [Percentile] Per age and gender</td>
<td>Body mass index</td>
<td>Prctl</td>
<td>Pt</td>
<td>^Patient</td>
</tr>
<tr>
<td>39156-5</td>
<td>Body mass index (BMI) [Ratio]</td>
<td>Body mass index</td>
<td>Ratio</td>
<td>Pt</td>
<td>^Patient</td>
</tr>
<tr>
<td>88087-2</td>
<td>Estimated BMI greater than 40</td>
<td>Estimated body mass index greater than 40</td>
<td>Find</td>
<td>Pt</td>
<td>^Patient</td>
</tr>
</tbody>
</table>

Search generated 8 hits in 0.009 secs.
### Value Set Authority Center

The Value Set Authority Center (VSAC) is a repository for value sets, which are sets of codes used to represent concepts in health care. VSAC is maintained by the U.S. National Library of Medicine (NLM) and is part of the National Institutes of Health (NIH).

The VSAC website provides a search function for users to find specific value sets. Users can search by program, release, stewards, or code systems. The search results are displayed in a table format, showing the name of the value set, the code system used, the type, the steward, the OID (Object Identifier), and the code count.

#### Search Results

<table>
<thead>
<tr>
<th>Name</th>
<th>Code System</th>
<th>Type</th>
<th>Steward</th>
<th>OID</th>
<th>Code Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Inactive) Encounter Reason</td>
<td>SNOMEDCT</td>
<td>Extensional</td>
<td>PharmacyHIT</td>
<td>2.16.840.1.113762.1.4.1096.153</td>
<td>1</td>
</tr>
<tr>
<td>(Inactive) Interventions Related to Medication Management, Medication Action Plan</td>
<td>SNOMEDCT</td>
<td>Extensional</td>
<td>PharmacyHIT</td>
<td>2.16.840.1.113762.1.4.1096.82</td>
<td>1</td>
</tr>
<tr>
<td>AAN - Encounter CPT Codes</td>
<td>CPT</td>
<td>Extensional</td>
<td>AAN</td>
<td>2.16.840.1.113883.3.2288</td>
<td>20</td>
</tr>
<tr>
<td>AAN - Encounter Codes Grouping</td>
<td>CPT</td>
<td>Grouping</td>
<td>AAN</td>
<td>2.16.840.1.113883.3.2286</td>
<td>27</td>
</tr>
<tr>
<td>AAN - Encounter SNOMED-CT Codes</td>
<td>SNOMEDCT</td>
<td>Extensional</td>
<td>AAN</td>
<td>2.16.840.1.113883.3.2287</td>
<td>7</td>
</tr>
<tr>
<td>AAN - Epilepsy DX Codes - ICD9</td>
<td>ICD9CM</td>
<td>Extensional</td>
<td>AAN</td>
<td>2.16.840.1.113883.3.2272</td>
<td>14</td>
</tr>
<tr>
<td>AAN - ALS ICD10</td>
<td>ICD10CM</td>
<td>Extensional</td>
<td>AAN</td>
<td>2.16.840.1.113762.1.4.1034.65</td>
<td>1</td>
</tr>
</tbody>
</table>
### Healthcare Associated Infection (HAI) Reports, Normative Release 1, vocabulary

Each tab in this Workbook contains an HAI value set or list of single-value bindings; the index below provides links to each tab. Three large

The top row of each worksheet indicates value set name, OID, and binding. A list of code system OIDs and names is at the bottom of this

Each worksheet contains the codes and standard displayNames for the value set (arranged by code). Additional columns may also give

**Special character strings are used in some instances to permit proper coding for the Schematron:**

<table>
<thead>
<tr>
<th>Character string</th>
<th>Represents</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>% (Registered)</td>
</tr>
<tr>
<td>&lt;8482;</td>
<td>™ (Trademark)</td>
</tr>
<tr>
<td>&gt;</td>
<td>&gt;</td>
</tr>
<tr>
<td>&gt;=</td>
<td>&gt;=</td>
</tr>
<tr>
<td>&lt;</td>
<td>&lt;</td>
</tr>
<tr>
<td>&lt;=</td>
<td>&lt;=</td>
</tr>
</tbody>
</table>

**Large Value Sets Not Included in this Spreadsheet**

<table>
<thead>
<tr>
<th>External Link</th>
<th>Value Set Name</th>
<th>Value Set OID</th>
<th>Value Set Binding</th>
<th>codeSystemName</th>
<th>codeSystemOID</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://phinvads.cdc.gov">http://phinvads.cdc.gov</a></td>
<td>NHSNBloodProductISBTCode</td>
<td>2.16.840.1.114222.4.11.3334</td>
<td>DYNAMIC</td>
<td>ISBT-128</td>
<td>2.16.840.1.113883.6.18</td>
</tr>
</tbody>
</table>

**Index of Tabs / Value Sets -- Single-Value Bindings (SVBs) are listed at the end**

<table>
<thead>
<tr>
<th>Tab Name</th>
<th>Value Set Name</th>
<th>Value Set OID</th>
<th>Value Set Binding</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration Location Type</td>
<td>NHSSAdministrationLocationTypeCode</td>
<td>2.16.840.1.114222.4.11.3188</td>
<td>STATIC</td>
<td></td>
</tr>
<tr>
<td>Antibiotic Susc Test</td>
<td>NHSSAntibioticSuscTest</td>
<td>2.16.840.1.114222.4.11.7161</td>
<td>STATIC</td>
<td></td>
</tr>
<tr>
<td>Antimicrobial Agent AURP</td>
<td>NHSSAntimicrobialAgentAURPCode</td>
<td>2.16.840.1.114222.4.11.3360</td>
<td>DYNAMIC</td>
<td></td>
</tr>
</tbody>
</table>
Null Flavor

Expresses details about a lack of value

<table>
<thead>
<tr>
<th>VALUE</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>NI</td>
<td>No Information (default NULL)</td>
</tr>
<tr>
<td>OTH</td>
<td>It is not in the domain for the variable.</td>
</tr>
<tr>
<td>NINF</td>
<td>Negative infinite</td>
</tr>
<tr>
<td>PINF</td>
<td>Positive infinite</td>
</tr>
<tr>
<td>UNK</td>
<td>Unknown</td>
</tr>
<tr>
<td>ASKU</td>
<td>It was asked, but it is unknown</td>
</tr>
<tr>
<td>NASK</td>
<td>It was not asked</td>
</tr>
<tr>
<td>NAV</td>
<td>Temporarily not available. Can be known later.</td>
</tr>
<tr>
<td>TRC</td>
<td>Content is greater than zero but cannot be quantified.</td>
</tr>
<tr>
<td>MSK</td>
<td>The information exists but cannot be revealed based on business rules (policy, privacy, etc.)</td>
</tr>
<tr>
<td>NA</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
CDA Templates and HAI Reports
Templates: The Lego Analogy

CDA

Templates

1 2 3
4 5 6
HAI Reports

The HL7 Implementation Guide for Healthcare Associated Infection Reports is a collection of documents for NHSN reporting

- Population Summary Reports
  - ARO Reporting
  - AUP Summary Report
  - ICU Summary Report
  - ...

- Single Person Reports
  - HAI AUR Antimicrobial Resistance Option
  - HAI Bloodstream Infection Report
  - ...

ANSI/HL7 CDAR2IG HAIRPT, RI-2013
8/9/2013


August 2013

Sponsored by:
Structured Documents Working Group
National Healthcare Safety Network

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Evolution of the HAI IG

• HAI Reporting has moved through several releases – most notably:
  • Early Releases (2008 – 2013)
    • R1 -> R9
    • Incremental changes, draft standard
  • First Normative Release (2013)
    • AU/AUR Reporting is introduced
  • Second Normative Release (2015)
Troubleshooting Scenario
Using the HAI IG
Materials

The NHSN HAI Implementation Guide

Source of truth for HAI value sets
Troubleshooting Scenario

• The CDA zip file that was obtained from the vendor system contained some CDA files that were rejected by NHSN on import.
• Received an error output PDF file.
In an infection-type report, a criterion is reported as a code. The value of @xsi:type SHALL be CD and the value of @code SHALL be selected from Value set 2.16.840.1.114222.4.11.3195 NHSNCriterionOfDiagnosisCode DYNAMIC (CONF:4786).
Output Walkthrough

- CONF: 4786

5. SHALL contain exactly one [1..1] statusCode (CONF:11338).
   a. This statusCode SHALL contain exactly one [1..1] @code="completed"
      Completed (CodeSystem: ActStatus 2.16.840.1.113883.5.14 STATIC)
      (CONF:2062).

6. SHALL contain exactly one [1..1] value (CONF:2063).
   a. In an infection-type report, a criterion is reported as a code. The value of
      @xsi:type SHALL be CD and the value of @code SHALL be selected from Value
      Set 2.16.840.1.114222.4.11.3195 NHSNCriterionOfDiagnosisCode DYNAMIC
      (CONF:4786).
      i. To record a criterion of diagnosis as a code, the value of @xsi:type
         SHALL be CD and the value of @code SHALL be selected from Value Set
         2.16.840.1.114222.4.11.3195 NHSNCriterionOfDiagnosisCode DYNAMIC
         (CONF:10909).
      ii. To record a criterion not included in the
         NHSNCriterionOfDiagnosisCode value set, the value of @xsi:type
         SHALL be ST and a text value SHALL be present (CONF:10910).
Output Walkthrough

a. In an infection-type report, a criterion is reported as a code. The value of `@xsi:type` SHALL be CD and the value of `@code` SHALL be selected from Value Set 2.16.840.1.114222.4.11.3195 NHSNCriterionOfDiagnosisCode DYNAMIC (CONF:4786).

• The value in the report must be selected from the NHSNCriterionOfDiagnosisCode value set
### Locate in HAI_VOC.xlsx

<table>
<thead>
<tr>
<th>Tab Name</th>
<th>Value Set Name</th>
<th>Value Set OID</th>
<th>Value Set Binding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration Location Type</td>
<td>NHSNAdministrationLocationTypeCode</td>
<td>2.16.840.1.114222.4.11.3188</td>
<td>STATIC</td>
</tr>
<tr>
<td>Antibiotic Susceptibility Test</td>
<td>NHSNAntibioticSuscTest</td>
<td>2.16.840.1.114222.4.11.7161</td>
<td>STATIC</td>
</tr>
<tr>
<td>Antimicrobial Agent AURP</td>
<td>NHSNAntimicrobialAgentAURPCode</td>
<td>2.16.840.1.114222.4.11.3360</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>ASA Class</td>
<td>NHSNASAClassCode</td>
<td>2.16.840.1.113883.13.10</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>BSI Evidence Type</td>
<td>NHSNBSIEvidenceTypeCode</td>
<td>2.16.840.1.113883.13.7</td>
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<tr>
<td>Catheter Type</td>
<td>NHSNCatheterTypeCode</td>
<td>2.16.840.1.114222.4.11.3185</td>
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</tr>
<tr>
<td>Certainty</td>
<td>NHSNCertaintyCode</td>
<td>2.16.840.1.114222.4.11.3387</td>
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<tr>
<td>Closure Technique</td>
<td>NHSNClosureTechniqueCode</td>
<td>2.16.840.1.114222.4.11.6051</td>
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<tr>
<td>Criterion of Diagnosis</td>
<td>NHSNCriteriaOfDiagnosisCode</td>
<td>2.16.840.1.114222.4.11.3195</td>
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<tr>
<td>Eligibility</td>
<td>NHSNEligibilityCode</td>
<td>2.16.840.1.114222.4.11.3248</td>
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<tr>
<td>Encounter Type</td>
<td>NHSNEncounterTypeCode</td>
<td>2.16.840.1.113883.13.1</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>Ethnicity Group</td>
<td>CDC Ethnicity Group</td>
<td>2.16.840.1.114222.4.11.837</td>
<td>STATIC</td>
</tr>
<tr>
<td>Healthcare Service Location</td>
<td>NHSNHealthCareServiceLocationCode</td>
<td>2.16.840.1.113883.13.19</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>Hip Replacement</td>
<td>NHSNHipReplacementCode</td>
<td>2.16.840.1.113883.13.3</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>Imputability</td>
<td>NHSNImputabilityCode</td>
<td>2.16.840.1.114222.4.11.3388</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>Infection Condition</td>
<td>NHSNInfectionConditionCode</td>
<td>2.16.840.1.114222.4.11.3196</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>Infection Risk Factors</td>
<td>NHSNInfectionRiskFactorsCode</td>
<td>2.16.840.1.113883.13.6</td>
<td>STATIC</td>
</tr>
<tr>
<td>Infection Type</td>
<td>NHSNInfectionTypeCode</td>
<td>2.16.840.1.113883.13.20</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>Insertion Site</td>
<td>NHSNInsertionSiteCode</td>
<td>2.16.840.1.114222.4.11.3180</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>Knee Replacement</td>
<td>NHSNKneeReplacementCode</td>
<td>2.16.840.1.113883.13.4</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>Organism AST</td>
<td>NHSNOrganismASTCode</td>
<td>2.16.840.1.114222.4.11.3283</td>
<td>DYNAMIC</td>
</tr>
<tr>
<td>Outcome Type</td>
<td>NSHNOutcomeTypeCode</td>
<td>2.16.840.1.114222.4.11.3386</td>
<td>DYNAMIC</td>
</tr>
</tbody>
</table>
Validation
Implementation Guide

Is it CDA?
Tested by Schema

Is it a Car?
(4 wheels, seats, headlights, steering)

Is it HAI?
Tested by Schematron

Is it a Ford Mustang?
(powerful engine, muscular body, big wheels)
Validation: Sample Implementation

- **Online CDA Validator**
  - Implements a basic multi-stage validation pipeline
  - Freely available
  - Validation for most SDWG-developed IGs

  - [http://www.lantanagroup.com/validator](http://www.lantanagroup.com/validator)
Validation vs. Verification

Validation:
Ensure the report format and structure is correct.

Verification:
Ensure the information found within the report is accurate.
Rendering
NHSN Transformation and Stylesheet

• Developed by NHSN
• Creates CDA Narrative from machine readable entries
  – Recreates the forms they are representing
## Example

**Antimicrobial Resistance Option (ARO) report**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Ned Nuclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission Date</td>
<td>January 15, 2009</td>
</tr>
<tr>
<td>Date of birth</td>
<td>November 25, 1954</td>
</tr>
<tr>
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<td>Race</td>
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<td>Encounter Date</td>
<td>From January 15, 2009</td>
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### Findings

#### Microbiology Studies: Pathogen Isolate

<table>
<thead>
<tr>
<th>Specimen type</th>
<th>Date Specimen Collected</th>
<th>In-facility location of patient when specimen was drawn</th>
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<tbody>
<tr>
<td>Blood specimen</td>
<td>January 21, 2009</td>
<td>9W Medical/Surgical critical care unit</td>
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#### Staph Aureus Specific Test

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
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<tbody>
<tr>
<td>Oxacillin Resistant Staphylococcus sp isolate [Presence] in Isolate by Latex agglutination</td>
<td>Negative</td>
</tr>
<tr>
<td>Bacterial methicillin resistance (mecA) gene [Presence] by Probe and target amplification method</td>
<td>Positive</td>
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</tbody>
</table>
Agenda

• Introduction
• Overview of the Antimicrobial Resistance Module
• AR Data Requirements
• NHSN Metrics and Benchmarks
• CDA and the NHSN HAI IG
  • Our Support
• Resources
Our Support

• Implementation Support
• Verification of reporting outputs
• Customized resources and trainings
• Learning collaborative
Agenda

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The AR toolkit provides implementers with the specific identifiers, locations, vocabulary, constraints, etc. required in the CDA.

AR Option Overview for Vendors.docx
- A Review of AR Option.

Information Data Module(IDM) for Vendors
- Includes business rules, coding information and codes used during development of the CDA.

57.123_AUR Micro Electronic Upload Tables
- View of the AR Option form to offer a visual of data elements required for submission.

ARO organism mapping.xlsx
- Lists the valid AR Option pathogens.
- Refer to AntiP tab in the IDM for details.

AR_CDA_Vendor Samples
Contains Antimicrobial Resistance (AR) xml samples of various AR-numerator CDAs.
Important Links


- Direct link to AUR Module protocol: https://www.cdc.gov/nhsn/pdfs/pscmanual/11pscaurcurrent.pdf


Questions