SNOMED CT and Antimicrobial Stewardship

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Antimicrobial Stewardship

- Coordinated program directing the appropriate use of antimicrobial drugs (e.g., antibiotics)
- Right drug to “bug”
- As narrowly targeted as possible
  - Save the broad spectrum, “heavy hitter” agents for only those cases when necessary
- Goal is to reduce multidrug antibiotic resistant organisms (MDRO)
Clinical Reality

- Patients present with symptoms of infection
- Identification of organism and antibiotic susceptibility information not immediately available (up to 48 hours)
- Antibiotic therapy must be started based on empiric data
- How is empiric data generated?
Antibiogram

- The antibiogram is a profile of the types of organisms and their antibiotic susceptibility patterns exhibited.
- Required in the US and broadly encouraged by WHO.
- Specific guidelines for calculation.
- Historically, manually calculated.
- Resource intensive.
- Infrequent...not necessarily up to date.
Automation and Standards

- Antibiograms based on laboratory culture data
- In US, electronic laboratory results data exchange is commonplace
- Meaningful Use efforts drove use of standards adoption
- Electronic, machine readable, encoded laboratory data can be used to automate the creation of the antibiogram and increase its utility
Micro Laboratory Data Flow

Data Generation

- Specimen
- Identification
  - Gram Stain
  - Morphology

Data Exchange

- Culture data
  - Susceptibility to antibiotic
  - Minimum inhibitory concentration
  - S/I/R
- HL7 version 2
  - Real-time
  - Incremental results

Data Use and Storage

- Parse Data
- Database
- Preliminary reports
- Final report
**Sample Message Segment**

- **OBX|3|CWE|41852-5^MICROORGANISM/AGENT**
  - **XXX^LN^CULT^Culture Result:^SQLRR|1.2|
  - **60875001^Staphylococcus epidermidis**
    - (organism)^SCT^SEPI^Staphylococcus epidermidis^L^v1^Staphylococcus epidermidis

- **SPM|1|S64958||122880004^Urine specimen obtained by clean catch procedure (specimen)^SCT^UCLN^Urine Clean Catch^L^v1^Urine Clean Catch|||||||date|date

- **OBX|3|SN|267-5^GENTAMICIN ISLT**
  - **MIC^LN^GM^Gentamicin^SQLRR|1.1|<=^1||SS|||F|||date||50545-3^BACTERIAL SUSC PNL ISLT**
  - **MIC^LN^MIC^MIC^SQLRR||date|||
Standards

- **LOINC**: ontology created from LOINC-SNOMED collaboration agreement defining LOINC terms within SNOMED concept model
  - Lab orders and performed tests
- **SNOMED CT**
  - Specimen: sample type, procedure for sampling
  - Organism: enhanced with staining characteristics, morphology and metabolic features
- **RxNorm**: ontology developed by NLM employing SNOMED CT concept model
  - Pharmaceutical products, Substances
Ontology Enhancements

112283007|Escherichia coli (organism)|:
- Associated Staining Feature: Gram negative
- Associated Morphological Feature: Bacillus
- Associated Metabolic Feature: Facultative anaerobic bacterium
LOINC (363787002|Observable entity|)
Ontology Enhancements

44-8 Aztreonam susceptibility of bacterium by MIC (observable entity):
- Property: Susceptibility
- Inheres in: Bacterium
- Relative to: Product containing Aztreonam
- Technique: Minimum inhibitory concentration
Aztreonam 1000 mg Injection (RXNORM:1664981):

- Has precise active ingredient: Aztreonam
- Has presentation strength numerator: 1
- Has presentation strength numerator unit: Gram
- Has presentation strength denominator value: 1
- Has presentation strength denominator unit: Vial
- Has manufactured dose form: Powder for conventional solution for Injection
Nebraska Medicine: Status of Antibiogram Deployment

- 22147 LOINC-on-OWL ontology concepts and groupers
- 756/1269 Enhanced <<41146007|Bacterium| concepts deployed in organism ontology
- 166 RXNORM concepts modelled for medication orders support
- Validated calculated susceptibilities against historical antibiograms published by UNMC for 2016-2019
- Since 2016, accrual of 350000 DRUG-BUG antibiogram facts per year from Sunquest lab reporting via HL7
- Average response time to user query 5 seconds
- Extended antibiogram support outside of hospital to ambulatory clinics and service areas
- “Cascading” antibiograms support detailed statistics for subpopulations of interest such as susceptibility of other antibiotics to ‘resistant’ bug
How Used in Antibiogram

- Specimen aggregation
  - Type of blood specimens
    - Line draw
    - Venipuncture
- Organism
  - Gram Stain (positive/negative)
  - Morphology
  - Metabolism (aerobic, anaerobic...)
  - Genus and species
Antibiogram for E. coli - Inpatient units

<table>
<thead>
<tr>
<th>Organism</th>
<th>Sctid</th>
<th>Antibiotic</th>
<th>Number</th>
<th>%S</th>
<th>Wilson Score</th>
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<td>Cefepime</td>
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</tbody>
</table>
Antibiogram Facts

Microbial Susceptibility fact

- Encounter
- Patient
- Escherichia coli
- 131196009|Susceptible|
- Hospital Unit ID
- Aztreonam
- Specimen datetime
Next steps

- Extending Terminologies to support specificity and CDSS
  - Organism management
  - Integration of susceptibility and NLM binding of RxNorm to SNOMED CT pharmaceuticals

- Integrate patient phenotyping
  - Transplanted patients
  - Cancer patients

- Integrate patient specific data
  - Renal function
  - Hepatic function
  - Comorbidities
  - Allergies

- Regional surveillance
Clinical Use Case:
What are the Aztreonam products in the US pharmacopoeia which can be ordered to treat E. coli isolated from my patient?

- Aztreonam (Azactam) 1000 mg for Injection (RXNORM1664984)
- Aztreonam 1000 MG Injection (RXNORM1664981)
- Aztreonam 2000 MG Injection (RXNORM1664986)
- Aztreonam 75 MG/ML Inhalation Solution (RXNORM901610)
- Aztreonam 75mg powder for nebulizer solution (product)
- Product containing precisely aztreonam 1 gram/1 vial powder for conventional release solution for injection (clinical drug)
- Product containing precisely aztreonam 2 gram/1 vial powder for conventional release solution for injection (clinical drug)
- Product containing precisely aztreonam 500 milligram/1 vial powder for conventional release solution for injection (clinical drug)
### Orderable Medications Ontology Enhancements

**DL query**

**Query (class expression)**

```
'Medicinal product (product)'
and ('Role group (attribute)' some ('Has active ingredient (attribute)' some 'Aztreonam (substance)'))
```

- **Execute**
- **Add to ontology**

**Query results**

Subclasses (9 of 9)

- Aztreonam (Azactam) 1000 mg for Injection (RXNORM1664984)
- Aztreonam 1000 MG Injection (RXNORM1664981)
- Aztreonam 2000 MG Injection (RXNORM1664986)
- Aztreonam 75 MG/ML Inhalation Solution (RXNORM901610)
- Aztreonam 75mg powder for nebulizer solution (product)
- Product containing precisely aztreonam 1 gram/1 vial powder for conventional release solution for injection (clinical drug)
- Product containing precisely aztreonam 2 gram/1 vial powder for conventional release solution for injection (clinical drug)
- Product containing precisely aztreonam 500 milligram/1 vial powder for conventional release solution for injection (clinical drug)
Clinical Use Case:
What are the Aztreonam products in the US pharmacopoeia which can be ordered to treat E coli isolated from my patient?

Clinical Use Case:
US orderable drugs:
- Aztreonam (Azactam) 1000 mg/vial injection
- Aztreonam (generic) 1000 mg/vial injection
- Aztreonam (generic) 2000 mg/vial injection
Conclusions

- Working, validated application
- Addressing key issue in AMS programs
- Example of Standards (broadly) used
- Surveillance tool framework
- Plan for increased incorporation of standards in support of CDSS