

# Hands-on use of SNOMED CT and other International Standards for Clinical and Translational Research

Scott Campbell, MBA, PhD

Connection and Innovation with SNOMED – Workshop 1.2

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University of Nebraska  
Medical Center



Nebraska  
Medicine

# Disclosures

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# Workshop Objectives

- Increase understanding of how SNOMED CT can be used in research
- Brief discussion of SNOMED CT concept model
- Review specific use cases, informatics and terminology standards considerations
  - Hierarchical use (Public health)
  - Defining relationships and hierarchical uses (Biobank use case)
  - Multiple terminologies
- Interactive discussion and system exploration



# The Question and the Tooling

- **Knowing the question (mostly obvious)**
- **Knowing your tools**
  - How data captured
    - Understand the workflow (context)
  - Database architecture
  - How data represented
    - Discrete
    - Encoding
    - Local coding systems
    - Standard coding systems

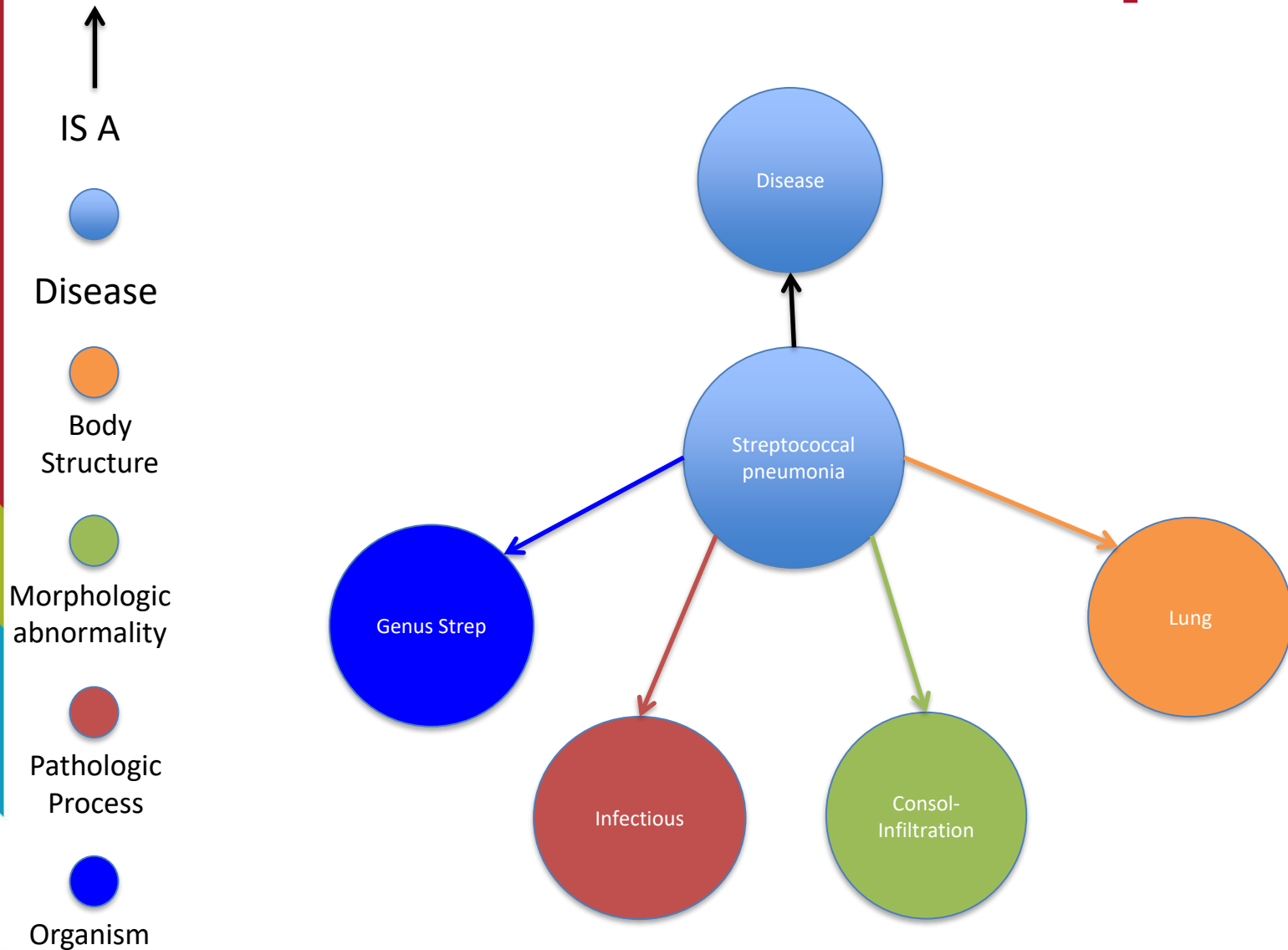


# Common Standards

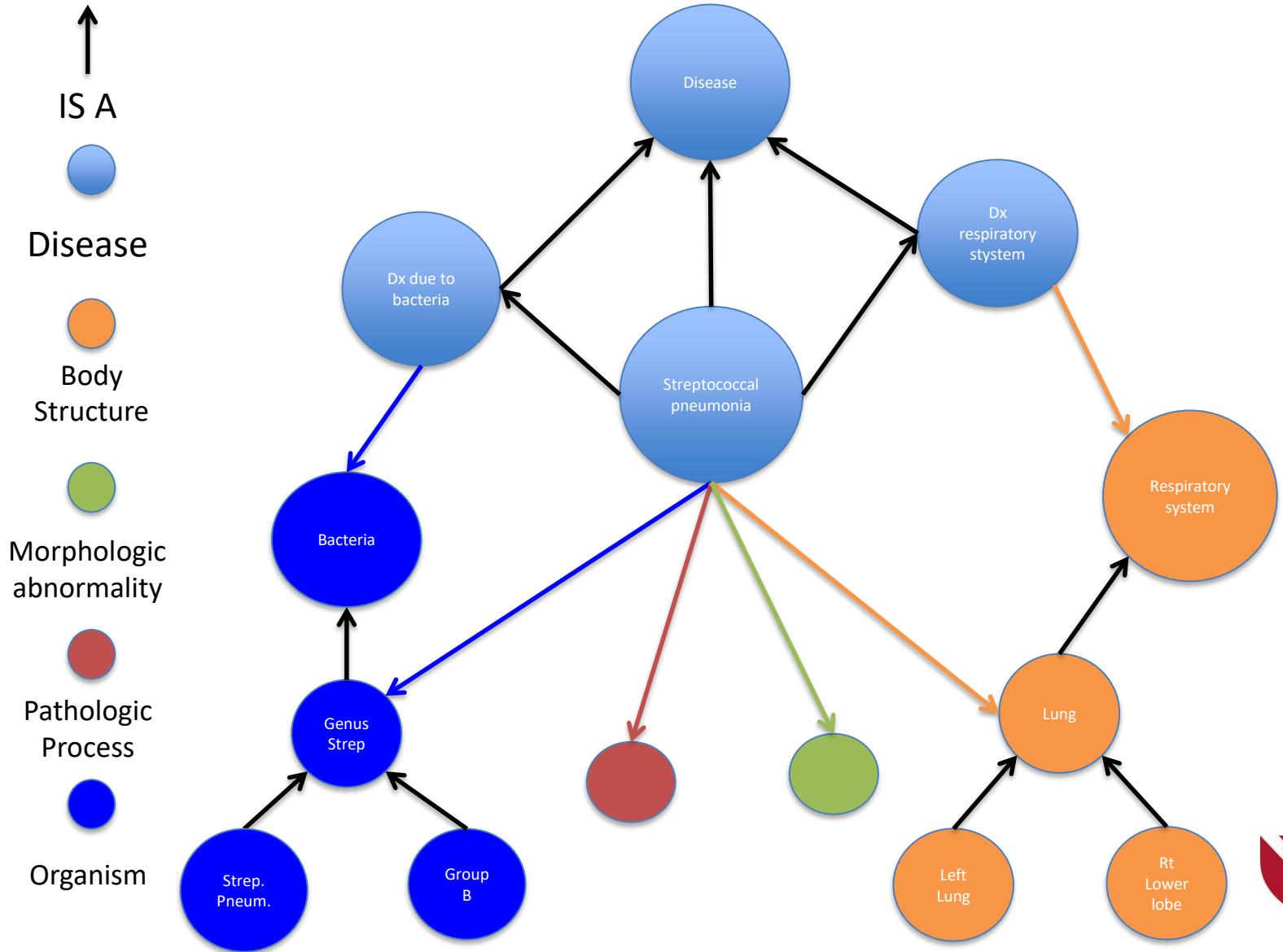
- **ICD-X**
  - Taxonomic
- **Laboratory standards**
  - Various models
  - Focus on SNOMED CT representations
- **Medications**
  - RxNorm (US)
  - SNOMED CT harmonization (Australia/US NLM)
- **SNOMED CT**
  - Polyhierarchical
  - Stated definition (declared meaning)
  - Logical axioms applied
  - Logical inferences/inferred meanings



# SNOMED CT Example



# Inferred Relationships



# SNOMED CT Navigation

- **Subsumption**
  - ISA paths
- **Defining relationships**
  - Following the defining paths across concepts
- **Subsumption and defining relationships**
  - Use of ISA paths
  - Use of defining paths
  - Combining defining with ISA paths





# Basic Subsumption - ISA examples

- Use basic grouping (inferred) feature of SNOMED CT
- Logic groupings at various levels of aggregation or granularity
- Can be managed well in SQL data structures
  - Transitive closure table (precalculated)
  - Lists all concepts and **all** child concepts

Parent concept	Child concept
709044004   Chronic kidney disease (disorder)	104931000119100   Chronic kidney disease due to hypertension (disorder)
709044004   Chronic kidney disease (disorder)	284961000119106   Chronic kidney disease due to benign hypertension (disorder)
709044004   Chronic kidney disease (disorder)	722150000   Chronic kidney disease due to systemic infection (disorder)
709044004   Chronic kidney disease (disorder)	And so on...



# Chronic Kidney Disease

## Parents

- ▶ ☰ Chronic disease of genitourinary system (disorder)
- ▶ ☰ Renal impairment (disorder)

☰ **Chronic kidney disease (disorder)** ☆ ↗

SCTID: 709044004

709044004 | Chronic kidney disease (disorder) |

- en Chronic renal impairment
- en Chronic renal disease
- en CKD - chronic kidney disease
- en Chronic kidney disease (disorder)
- en Chronic kidney disease

Clinical course → Chronic

Has interpretation → Impaired  
Interprets → Measurement of renal function

Finding site → Kidney structure

## Children (15)

- ▶ ☰ Chronic kidney disease due to hypertension (disorder)
- ☰ Chronic kidney disease due to systemic infection (disorder)
- ☰ Chronic kidney disease due to traumatic loss of kidney (disorder)
- ▶ ☰ Chronic kidney disease due to type 1 diabetes mellitus (disorder)
- ▶ ☰ Chronic kidney disease due to type 2 diabetes mellitus (disorder)
- ☰ Chronic kidney disease following donor nephrectomy (disorder)
- ☰ Chronic kidney disease following excision of renal neoplasm (disorder)
- ☰ Chronic kidney disease mineral and bone disorder (disorder)
- ▶ ☰ Chronic kidney disease stage 1 (disorder)
- ▶ ☰ Chronic kidney disease stage 2 (disorder)
- ▶ ☰ Chronic kidney disease stage 3 (disorder)
- ▶ ☰ Chronic kidney disease stage 4 (disorder)
- ▶ ☰ Chronic kidney disease stage 5 (disorder)
- ▶ ☰ Chronic renal failure syndrome (disorder)
- ☰ Chronic renal insufficiency (disorder)



# Clinical Data Warehouse Example

Query & Analysis Tool      Project: Production      User: Scott Campbell      Find Patients | Analysis Tools | Message Log | Help | Change Passw...

ate Terms      Find

- Chronic digestive system disorder (disorder) [ 15,775 facts; 13,611 patients ] - 13611
- Chronic disease of breast (disorder) [ 12 facts; 12 patients ] - 12
- Chronic disease of cardiovascular system (disorder) [ 19,381 facts; 13,599 patients ] - 13599
- Chronic disease of ear (disorder) [ 3,830 facts; 3,399 patients ] - 3399
- Chronic disease of genitourinary system (disorder) [ 47,697 facts; 28,795 patients ] - 28795
  - Problem List Diagnosis
    - Chronic cystitis (disorder) [ 1,412 facts; 1,131 patients ] - 1131
    - Chronic glomerulonephritis (disorder) [ 892 facts; 644 patients ] - 644
    - Chronic gonorrhoea of genitourinary tract (disorder) [ <10 facts ] - 1
    - Chronic interstitial nephritis (disorder) [ 38 facts; 37 patients ] - 37
    - Chronic kidney disease (disorder) [ 41,065 facts; 24,430 patients ] - 24430
      - Problem List Diagnosis
        - Acute-on-chronic renal impairment (disorder) [ 1,425 facts; 1,278 patients ] - 1278
        - Chronic kidney disease due to hypertension (disorder) [ 75 facts; 65 patients ] - 65
        - Chronic kidney disease due to type 1 diabetes mellitus (disorder) [ 34 facts; 32 patients ] - 32
        - Chronic kidney disease due to type 2 diabetes mellitus (disorder) [ 286 facts; 243 patients ] - 243
        - Chronic kidney disease following donor nephrectomy (disorder) [ <10 facts ] - 1
        - Chronic kidney disease mineral and bone disorder (disorder) [ 19 facts; 18 patients ] - 18
        - Chronic kidney disease stage 1 (disorder) [ 728 facts; 667 patients ] - 667
        - Chronic kidney disease stage 2 (disorder) [ 1,650 facts; 1,391 patients ] - 1391
        - Chronic kidney disease stage 3 (disorder) [ 10,755 facts; 8,361 patients ] - 8361
        - Chronic kidney disease stage 4 (disorder) [ 3,264 facts; 2,521 patients ] - 2521
        - Chronic kidney disease stage 5 (disorder) [ 1,220 facts; 970 patients ] - 970
        - Chronic renal failure syndrome (disorder) [ 4,140 facts; 3,531 patients ] - 3531
        - Chronic renal insufficiency (disorder) [ 2,987 facts; 2,621 patients ] - 2621
        - Hypertensive heart and chronic kidney disease (disorder) [ 15 facts; 12 patients ] - 12
      - Chronic nephritic syndrome (disorder) [ <10 facts ] - 1
      - Chronic pelvic inflammatory disease (disorder) [ <10 facts ] - 9
      - Chronic prostatitis (disorder) [ 384 facts; 341 patients ] - 341
      - Chronic rejection of renal transplant (disorder) [ 29 facts; 28 patients ] - 28
      - Chronic salpingo-oophoritis (disorder) [ <10 facts ] - 2
      - Chronic urate nephropathy (disorder) [ <10 facts ] - 1
      - Chronic urinary tract infection (disorder) [ 3,487 facts; 3,034 patients ] - 3034
      - Chronic uterine inflammatory disease (disorder) [ <10 facts ] - 2

Query Tool

Query Name: Chronic kidney @15:12:22

Query Timing: Treat all groups independently

Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
Treat Independently ▾			Treat Independently ▾			Treat Independently ▾		
Chronic kidney disease (disorder) [ 41,065 facts; 24,430 patients ] - 24430								

one or more of these      AND      drop a term on here

Run Query      Clear      1 Group      New Group

Show Query Status      Graph Results      Query Report

Number of patients

**26618**

For Query Chronic kidney @15:12:22"



# Antimicrobial Stewardship

- Use of antibiogram for empirical antimicrobial use
  - Statistical profile of microorganism resistance to antimicrobial agents
- Requires knowledge of microbiology laboratory results
  - Organism identification
  - Organism susceptibilities to antimicrobials
- Can employ logical groupings (subsumption)
  - Organism hierarchy
  - Specimen hierarchy



# UNMC Antibiogram Demonstration

Antibiogram MY ANTIBIOGRAMS

STANDARD ANTIBIOGRAM SPECIMEN SOURCE TRENDS CASCADE

Organism  
All Organisms

Generate in accordance with WHO guidance only.

Filter by Location/Group  
All Inpatient

Specimen Source(s)  
All Specimens (SNOMED CT Concept)

Date From 02/09/2019 Date To 02/09/2020

Minimum Number of Cultures 30

GENERATE DOWNLOAD



# Defining relationship example

- Use defining attribute and values of a definitions
- Finds all concepts with a particular defining set of attributes and values
- Not readily accommodated with SQL data structures
  - Transitive closure calculations at runtime
  - Risk of recursion (intractable in some environments)
  - Requires complete representation of SNOMED CT in database
  - Not common in, and of, itself
- Example: Find all patients with diagnosis containing defining attribute/value definition of:

|Pathologic process| = |Infectious process|



# Combined example

- Use both ISA (subsumption) and defining aspects of concepts
- Can be very powerful
- Difficult in SQL environment
- Graph (NoSQL) environments very useful in this regard
- Example: Find all medications where

|Finding site| = <<|Lung structure (body structure)|

AND

|Causative agent| = <<|Gram-negative bacterium (organism)|



## Parents

- ▶ Lower respiratory tract structure (body structure)
- ▶ Pulmonary structure including vessels and lymphoid tissue (body structure)
- ▶ Structure of organ in respiratory system (body structure)
- ▶ Structure of pulmopleural compartment (body structure)
- ▶ Structure of thoracic viscus (body structure)

### Lung structure (body structure)



SCTID: 39607008

39607008 | Lung structure (body structure) |

en Lung

en Lung structure (body structure)

en Lung structure

## Children (6)

- ▶ Entire lung (body structure)
- ▶ Left lung structure (body structure)
- ▶ Lung part (body structure)
- ▶ Pneumocyte (cell)
- ▶ Right lung structure (body structure)

erium (organism)

### Gram-negative bacterium (organism)



No attributes

SCTID: 81325006

81325006 | Gram-negative bacterium (organism) |

en Gram-negative bacterium (organism)

en Gram-negative bacterium

No

16)

obic-microaerophilic, motile curved gram-negative bacteria (organism)

aerobic gram-negative, straight, curved, and helical rods (organism)

cultatively anaerobic gram-negative rod (organism)

family Chlamydiaceae (organism)

acid-fast Gram Negative Rods (organism)

Gram-negative bacillus (organism)

Gram-negative coccobacillus (organism)

Gram-negative coccus (organism)

Chlamydiales (organism)

non-motile curved gram-negative bacteria (organism)

non-photosynthetic, non-fruiting gliding bacteria (organism)

order Mycoplasmatales (organism)

phylum Proteobacteria (organism)

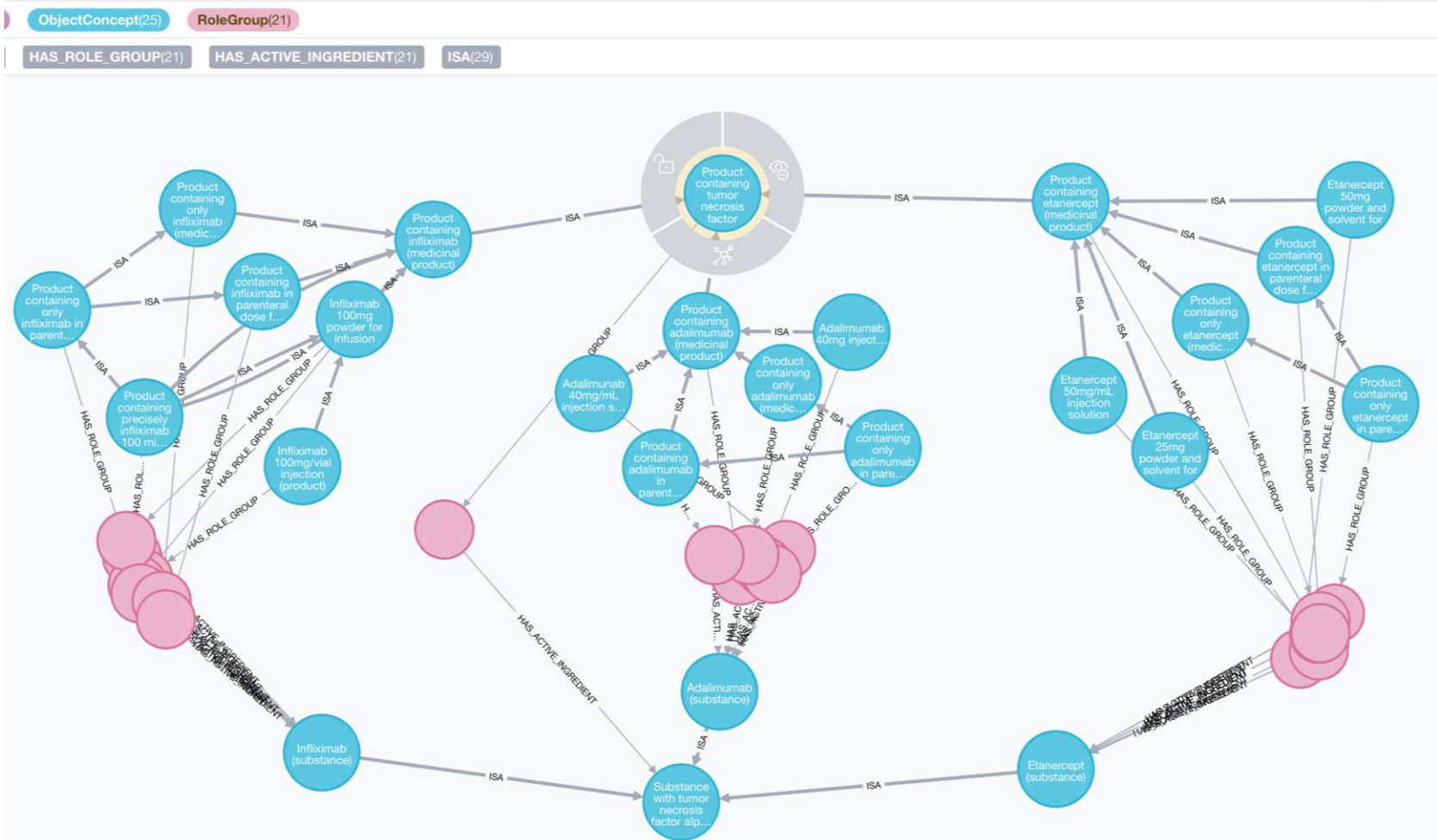
pathogenic bacteria (organism)

class Myxobacteria: Fruiting Gliding Bacteria (organism)

Streptococcus pneumoniae (organism)



# Tumor Necrosis Factor inhibitor drugs



# UNMC Biobank Example

- Use of synoptic cancer data
  - Question/answer pairs
  - Questions contain context of cancer
  - Primary tumor location
  - Histologic feature solicited
  - Answer is some Histology (Morphologic abnormality)
- Find all adenocarcinomas with mucinous features of the gastrointestinal tract
  - Must find all synoptic questions associated with histologic type
  - Must find only those synoptic questions pertaining to body structures of gastrointestinal tract



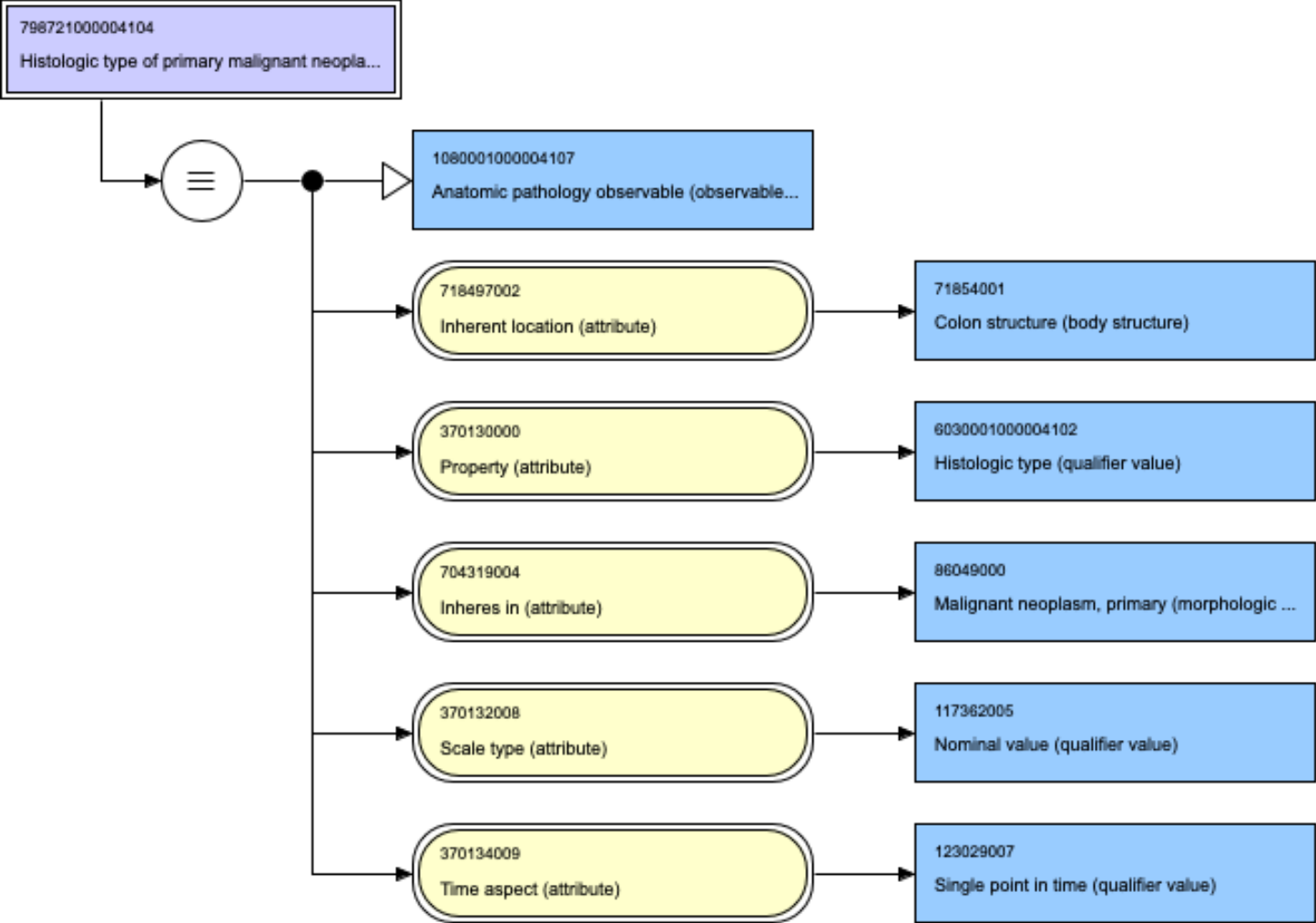
# Sample Synoptic Question

## Histologic Type (select all that apply) (Note B)

- Adenocarcinoma
- Mucinous adenocarcinoma
- Signet-ring cell carcinoma
- Medullary carcinoma
- Micropapillary carcinoma
- Serrated adenocarcinoma
- Large cell neuroendocrine carcinoma
- Small cell neuroendocrine carcinoma
- Neuroendocrine carcinoma (poorly differentiated)#
- Squamous cell carcinoma



# SNOMED CT - Histologic type



# Nebraska Cancer Analytic Resource



## NECARES

Inventory Reports Orders Checkout Admin Logout

### Reports

REPORT: GI_ADENOCARCINOMA				CYPHER			
890001000004107	Histologic type of excised colon neoplasm (observable entity)	1710001000004108	abnormality)	Adenocarcinoma, with mucinous features (morphologic abnormality)	F	65	309488006 Y
890001000004107	Histologic type of excised colon neoplasm (observable entity)	1710001000004108	Adenocarcinoma, with mucinous features (morphologic abnormality)	Adenocarcinoma, with mucinous features (morphologic abnormality)	M	73	309488006 Y
890001000004107	Histologic type of excised colon neoplasm (observable entity)	1710001000004108	Adenocarcinoma, with mucinous features (morphologic abnormality)	Adenocarcinoma, with mucinous features (morphologic abnormality)	M	73	309488006 N
890001000004107	Histologic type of excised colon neoplasm (observable entity)	1710001000004108	Adenocarcinoma, with mucinous features (morphologic abnormality)	Adenocarcinoma, with mucinous features (morphologic abnormality)	U		309488006 N
890001000004107	Histologic type of excised colon neoplasm (observable entity)	1710001000004108	Adenocarcinoma, with mucinous features (morphologic abnormality)	Adenocarcinoma, with mucinous features (morphologic abnormality)	F	82	309488006 Y
890001000004107	Histologic type of excised colon neoplasm (observable entity)	1710001000004108	Adenocarcinoma, with mucinous features (morphologic abnormality)	Adenocarcinoma, with mucinous features (morphologic abnormality)	F	82	309488006 N
890001000004107	Histologic type of excised colon neoplasm (observable entity)	1710001000004108	Adenocarcinoma, with mucinous features (morphologic abnormality)	Adenocarcinoma, with mucinous features (morphologic abnormality)	M		Y
890001000004107	Histologic type of excised colon neoplasm (observable entity)	1710001000004108	Adenocarcinoma, with mucinous features (morphologic abnormality)	Adenocarcinoma, with mucinous features (morphologic abnormality)	M	75	Y
911753511000004104	Histologic type of malignant neoplasm of pancreas (observable entity)	1710001000004108	Adenocarcinoma, with mucinous features (morphologic abnormality)	Adenocarcinoma, with mucinous features (morphologic abnormality)	U		122665008 Y



# Use of multiple terminologies

- No single terminology is exclusive
- Situations require combining multiple terminologies
- Essentially – phenotyping a clinical scenario
- Example:
  - Find all patients diagnosed with colorectal cancer between 2013-2016
  - Diagnosis at Stage IV or progressed to metastatic disease by 2016



# Metastatic Colon Cancer

**Query Tool**

Query Name: Carcinoembryoni@15:52:44

Query Timing: Non-Temporal Query: Treat Independently

Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
Treat Independently ▼			Treat Independently ▼			Treat Independently ▼		
<p> Carcinoembryonic Ag [ 41,973 facts; 9,876 patients ] &gt; 25 ug/L [01/01/2013 to 12/31/2016]</p> <p> Malignant tumor of colon (disorder) [ 6,849 facts; 4,776 patients ] - 4776 [01/01/2013 to 12/31/2016]</p> <p> C18: Malignant neoplasm of colon [ 67,818 facts; 2,515 patients ] - 2515 [01/01/2013 to 12/31/2016]</p> <p> C19: Malignant neoplasm of rectosigmoid junction [ 2,021 facts; 227 patients ] - 227 [01/01/2013 to 12/31/2016]</p> <p> C20: Malignant neoplasm of rectum [ 22,611 facts; 830 patients ] - 830 [01/01/2013 to 12/31/2016]</p> <p> C21: Malignant neoplasm of anus and anal canal [ 4,748 facts; 164 patients ] - 164 [01/01/2013 to 12/31/2016]</p>								

**one or more of these**      **AND**      **drop a term on here**


**Run Query**   **Clear**      1 Group      **New Group**

**Show Query Status**   **Graph Results**   **Query Report**

Number of patients

# 2686

For Query Carcinoembryoni@15:52:44"



# Accuracy of patient identification

	True Positive	False Negative
NAACCR Stage IV	45	n/a
SNOMED CT	50	25
ICD-10-CM	27	38
CEA level > 25	49	26

False negative indicates no concept data available that supported metastasis.

Collectively, 100% identification

NAACCR Stage IV indicated inclusion. False negatives n/a

15 patients (20%) had no NAACCR stage record. SNOMED CT, ICD\* or CEA > 25 only method to identify metastasis





# Questions



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