# Introduction to SNOMED CT

Expo 2018 Tutorial

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*SNOMED International*

# Overview

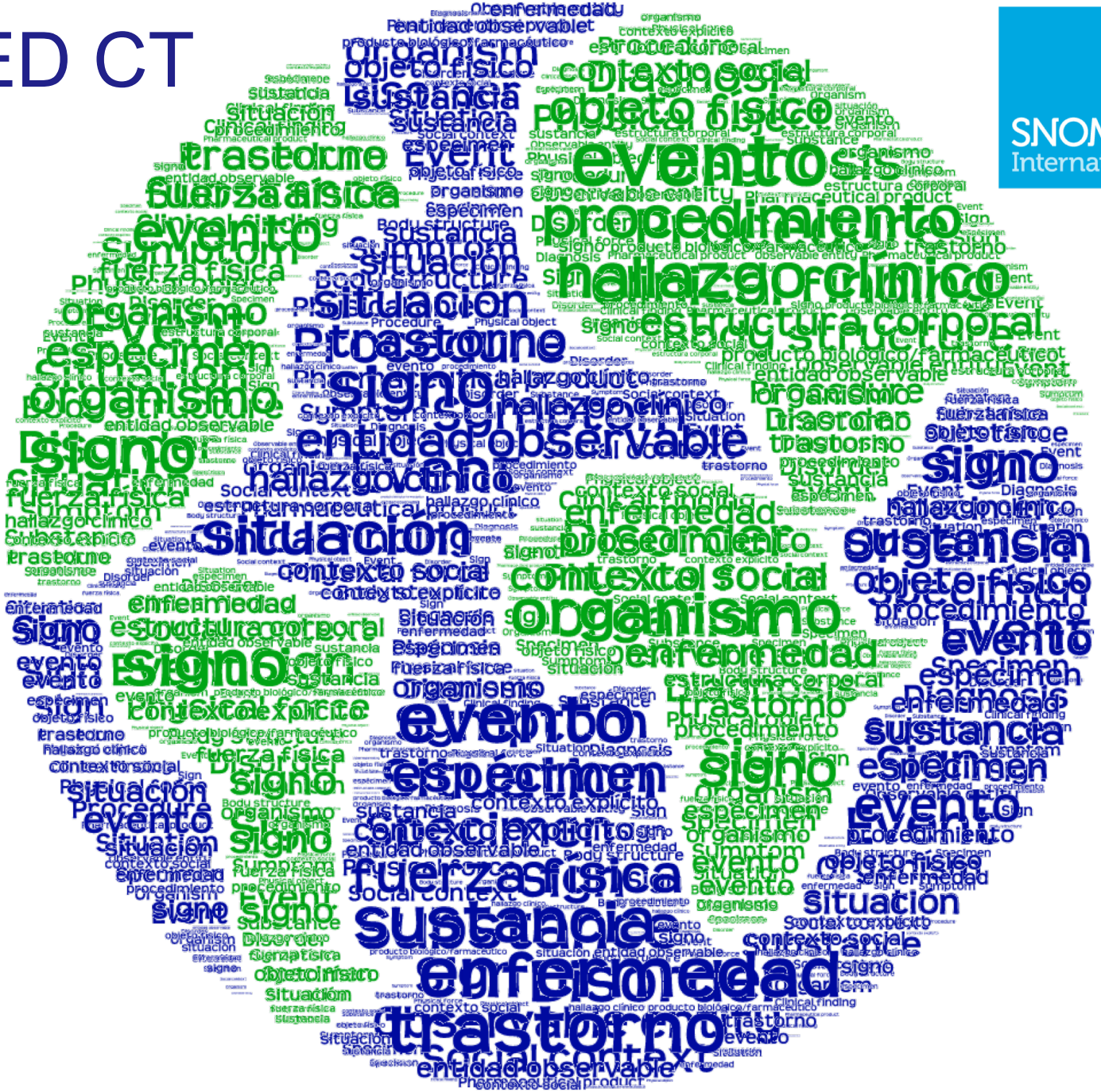
- Part 1
  - Background
  - Benefits
    - Meaningful records
    - Clinical knowledge linkage
- Part 2
  - Features
  - Customizing SNOMED CT
  - Analytics
  - Learn more

# Background

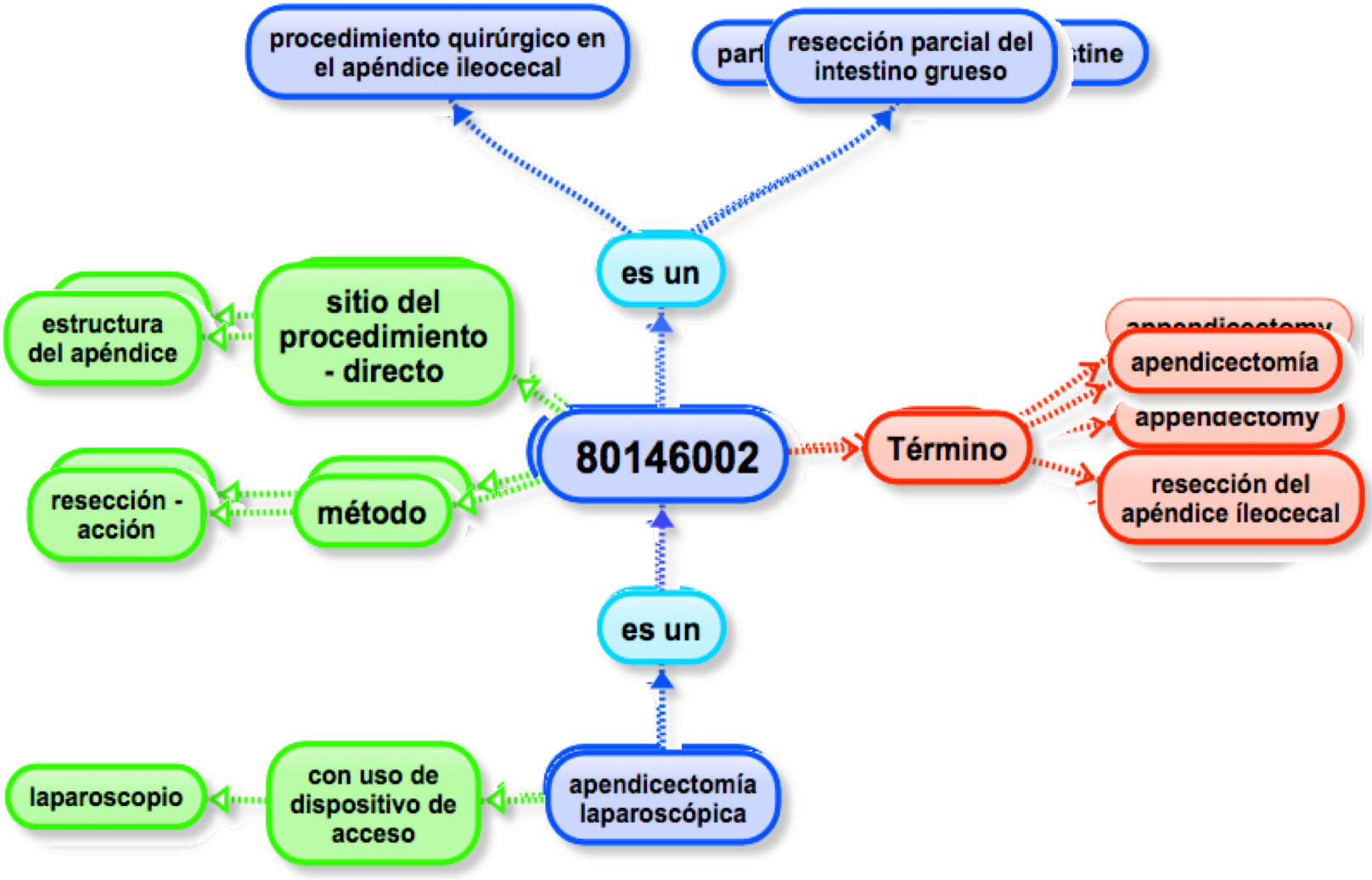
# SNOMED Clinical Terms

- Most comprehensive multilingual clinical terminology
- Supports high quality clinical content in health records
- Increasing number of tools and implementations around the world

# SNOMED CT Scope



# SNOMED CT - Not Just a Code System



# SNOMED International

- An international not-for-profit organisation
  - Owned by Members
  - Governed by General Assembly of its Members
  - Funded by members based on national wealth
- Maintains and delivers SNOMED CT
  - Free use in Member territories
  - Low cost licenses for institutions in other countries

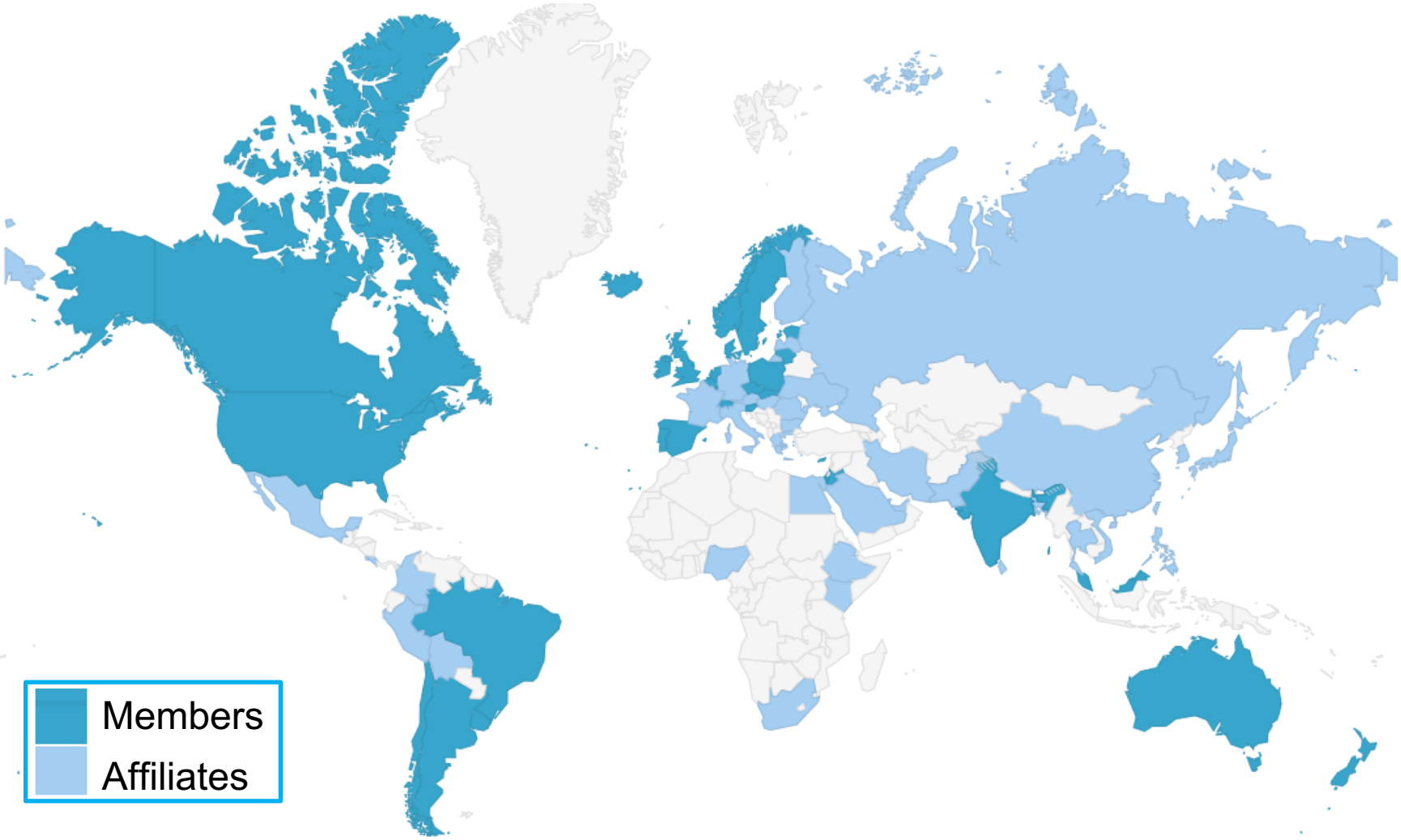
# SNOMED International Membership Benefits

- Free use of SNOMED CT and related products
- Membership of General Assembly
- Ability to create national extension and translation
  - Financial support provided for translation
  - Ability to request additions to international release
- Access to global community of member countries
  - Forums and networks to learn from and share experiences
- Free new member induction
- Free education and courses
- Free open source tooling

# SNOMED International Current Members

| | | | |
|---|---|---|---|
| Argentina | Denmark | Luxembourg | Slovak Republic |
| Australia | Estonia | Malaysia | Slovenia |
| Belgium | Hong Kong | Malta | Spain |
| Brazil | Iceland | The Netherlands | Sweden |
| Brunei | India | New Zealand | Switzerland |
| Canada | Ireland | Norway | United Kingdom |
| Chile | Israel | Poland | USA |
| Cyprus | Jordan | Portugal | Uruguay |
| Czech Republic | Lithuania | Singapore | |

# SNOMED Members and Licensees



# Our Vision

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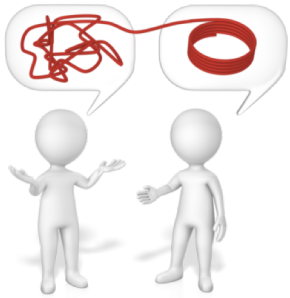
By 2020 clinical terminologies will be used globally, which will result in better health, supported by one language of health.

# Benefits

Making Clinical Information Meaningful

# Electronic Health Records

- Making health records electronic
  - Improves communication
  - Increases availability of relevant information



*… but this is only a partial solution; the real challenge is …*

- Making health records meaningful
  - Identifying significant facts in oceans of data
  - Linking the EHR to authoritative clinical knowledge

- **SNOMED CT represents clinical meaning and contributes to meaningful health records**

# Different Health Record Perspectives

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## Process View of Records

- A chronological log of events and actions carried out as part of care delivery
- Provides information about
  - Who did what, when, where and to whom
- Valuable for
  - Resource management
  - Billing
  - Statistical reporting
  - Audit of processes

## Meaningful View of Records

- A record that can processed to present a meaningful view of the current clinical situation
- Provides information about
  - The immediate problems and risks for a patient
  - Outcomes of different types of clinical treatment
- Valuable for
  - Supporting care decisions
  - Enabling research and trials

**An effective EHR needs to provide both views**

# Meaningful Views of a Game of Chess

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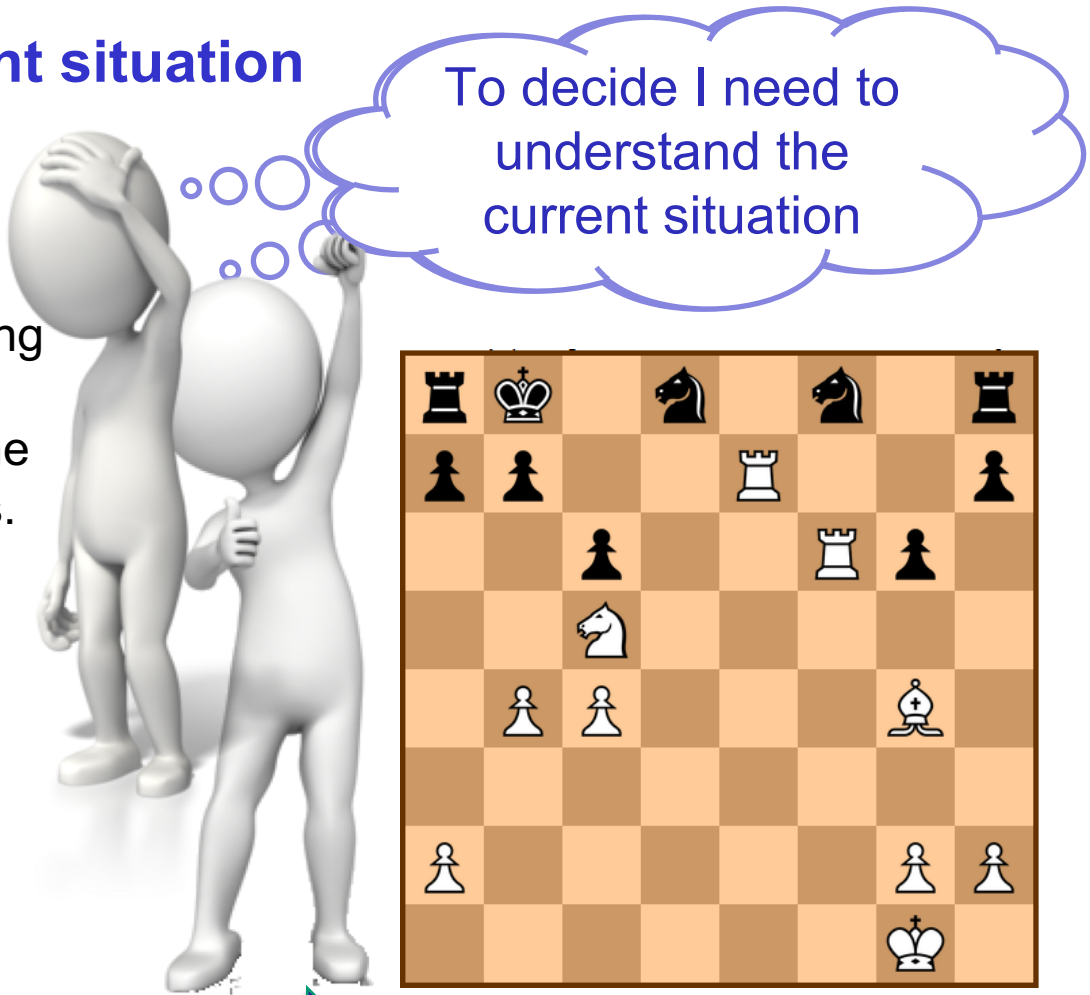
## Meaningful view of current situation




To start with white moved the queen's pawn to forward two spaces. Black responded by moving a knight in front of the kings bishop's pawn. White advanced the queen's bishops pawn two spaces. Black then moved the king's-knight's pawn two spaces.

…

*[47 more moves in same style]*

…

Then black moved his king next to his rook.

What should white do next?

# Meaningful Views of the Current Situation

- Decisions require understanding of the current situation rather than detailed data about every event
  - The significance of past events varies, some are irrelevant others are critically important
- Computing the current situation depends on consistent processable representation of clinical information
- A meaningful record system should be able to make inferences and present a useful view of the current situation as a basis for decision making

## SNOMED CT

- Is designed to support meaning-based processing of clinical information in health records
- The design adopts the peer acclaimed desiderata for clinical vocabularies documented in a paper by Dr James Cimino in 1998

# A Purpose Built Terminology

- The requirements for effective representation of clinical ideas are described in Dr James Cimino's widely referenced, peer acclaimed 1998 paper
- "Desiderata for controlled clinical vocabularies in the twenty-first century"

**SNOMED CT was designed to address these requirements**

1 Content, Content, and Content
2 Concept Orientation
3 Concept Permanence
4 Non-semantic Concept Identifier
5 Polyhierarchy
6 Formal Definitions
7 Reject "Not Elsewhere Classified"
8 Multiple Granularities
9 Multiple Consistent Views
10 Representing Context
11 Evolve Gracefully
12 Recognize Redundancy

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3415631/

# Benefits

Clinical
Knowledge
Linkage

# Knowledge Linkage Progress

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- In recent years there has been rapid growth of knowledge linkage in many domains
  - For example, geographic knowledge linkage now allows us to access information about any point on earth
- Healthcare knowledge linkage remains patchy, system-specific and typically localized
- A standard open way to link health records to relevant clinical knowledge should be possible
  - What is needed to make this happen?

# Geographic Knowledge Linkage

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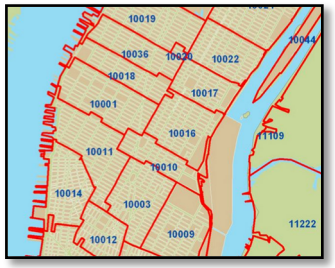
- A ZIP code gives you access to a wealth of knowledge about an area
  - A map, a satellite view, crime statistics, photographs, local restaurants

# Interoperable Geographic Knowledge Linkage

- ZIP codes
  - Groups of locations for one initial use case - postal services
  - Used for other purposes for which no specific areas are defined
- Limitations of ZIP codes
  - Areas vary in size and shape
  - Not precise enough for detailed journey planning
  - Not international




- Latitude and Longitude
  - The common denominator for interoperable geographic knowledge linkage
  - A global, logically defined, consistent set of coordinates for all surface locations on earth
  - Capable of being used to any level of precision
  - Used to define ZIP code areas to allow knowledge to be linked

# Clinical Knowledge Linkage

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- Clinical knowledge linkage needs a common coordinate system
- A way to pinpoint and interrelate health care concepts
  - International, non-commercial with potential for global adoption
  - Broad scope - not focused on a single discipline or specialty
  - Accurate and detailed representation of clinical information
  - Designed to represent meaning rather than terms or categories

Clinical information is complex and requires a coordinate system that captures this complexity

# Clinical Knowledge Linkage

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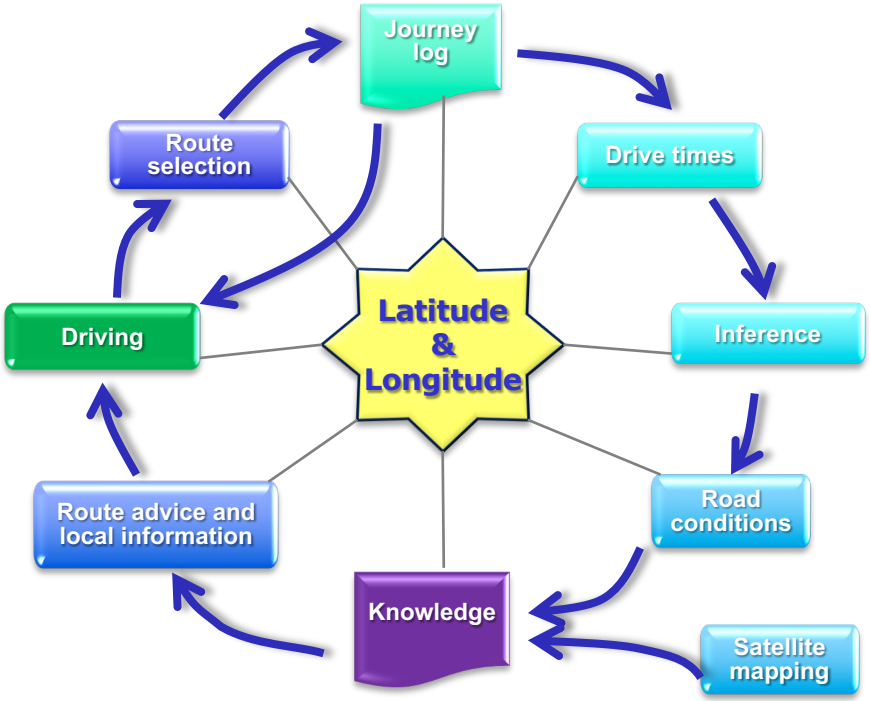
- SNOMED CT meets the requirements for an interoperable coordinate systems for EHR knowledge linkage

- SNOMED CT is designed to represent clinical meanings
  - **International** and owned by a not-for-profit association
  - Covers the broad **scope of healthcare**
  - Represents clinical information at **different levels of detail**
  - A **network of semantic links** between concepts
  - Enables description logic **inferences**

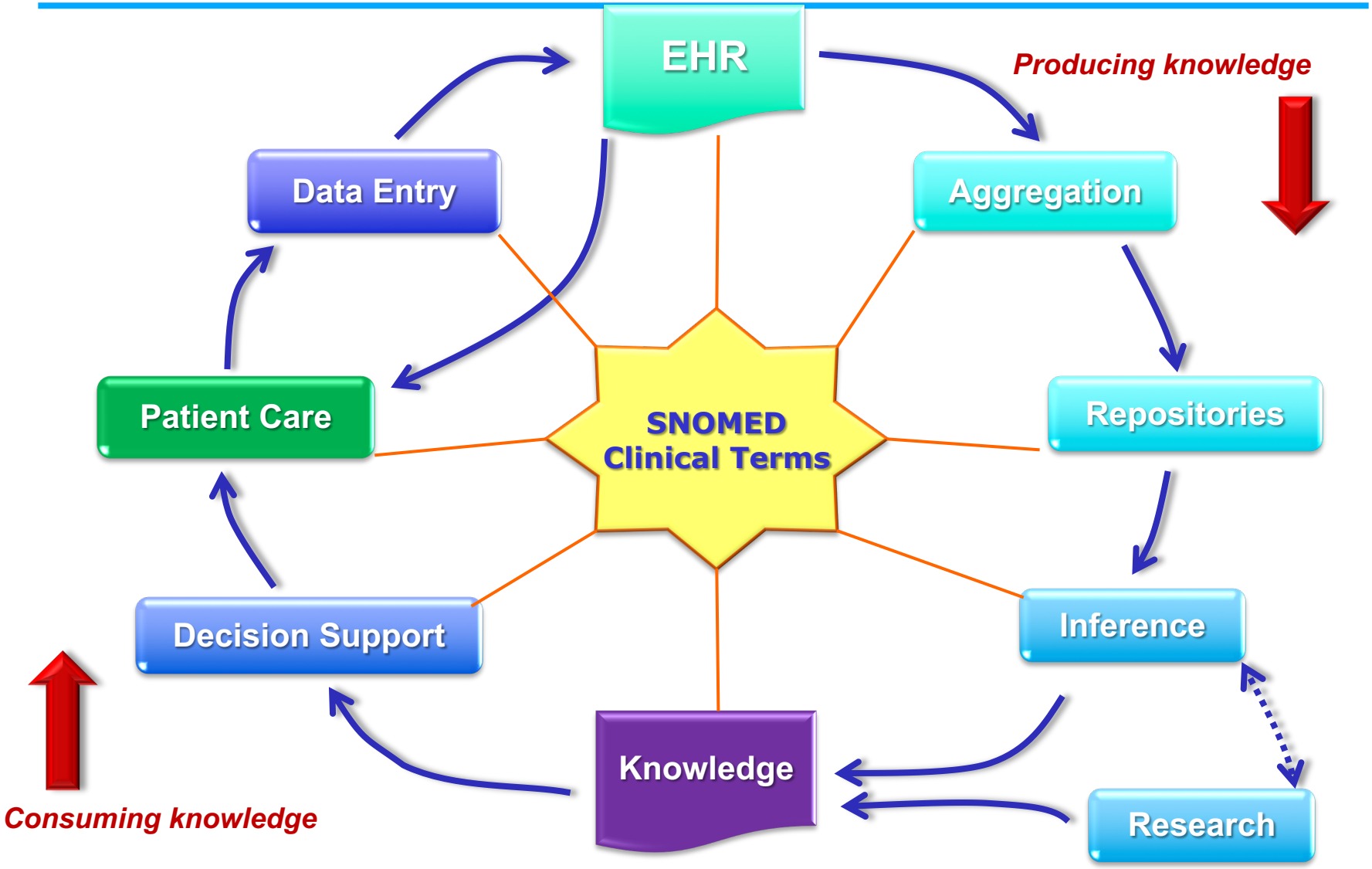
- Note
  - Classifications like ICD-10 are similar to Zip codes in that they specify arbitrary categories for a specific purpose (e.g. for statistical analysis)

# Geographic Knowledge Cycle

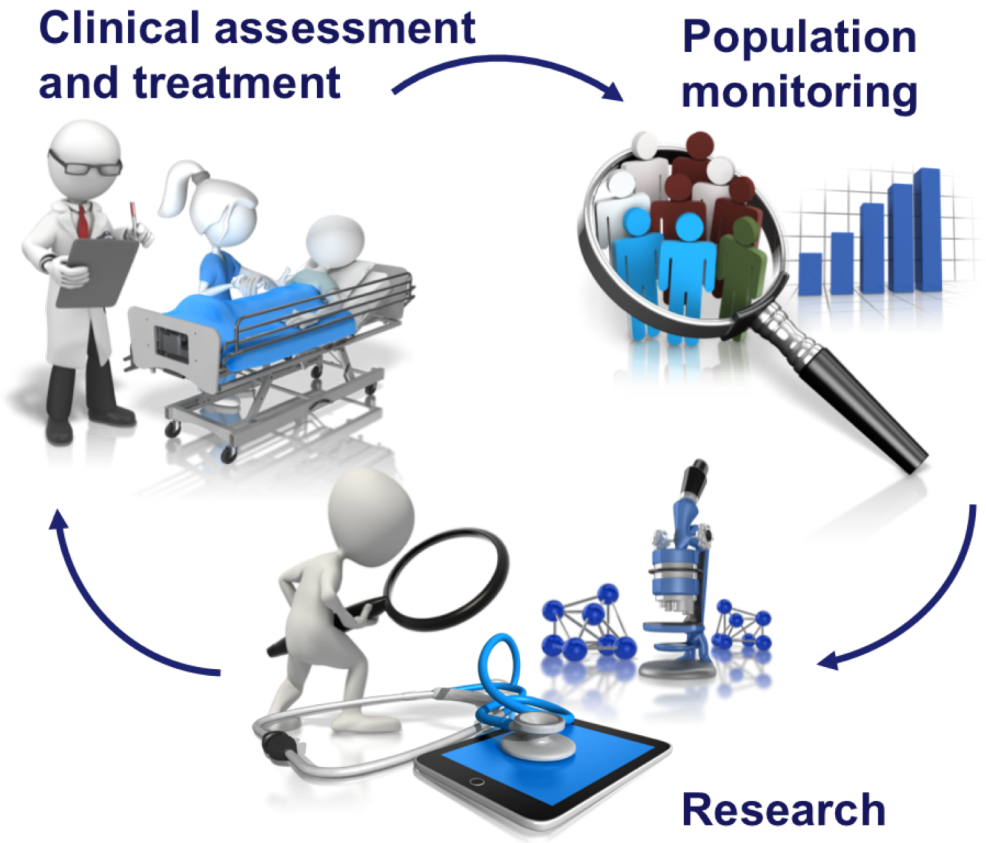
- Knowledge linkage is not a one way street – there is a cycle of knowledge
- Linked knowledge identifies roads, traffic conditions and toll charges to support routing decisions
- The journey itself contributes to linked knowledge about traffic conditions and drive times



# Clinical Knowledge Cycle



# Summary of Benefits

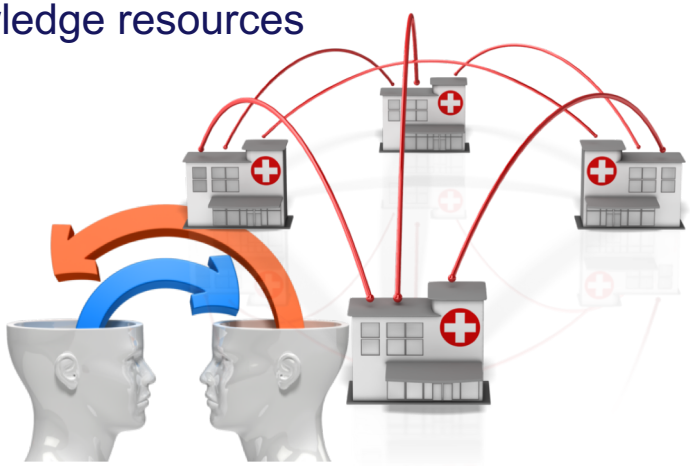


# Benefits of SNOMED CT Implementations

A solid foundation for clinical records

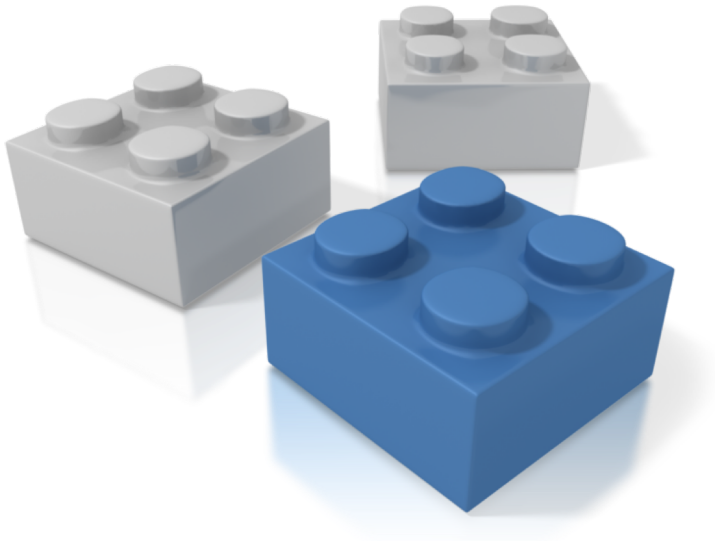
Improved access to guidelines and decision support

Interoperable information and knowledge resources



Improved Clinical and Business Intelligence

# SNOMED CT Features

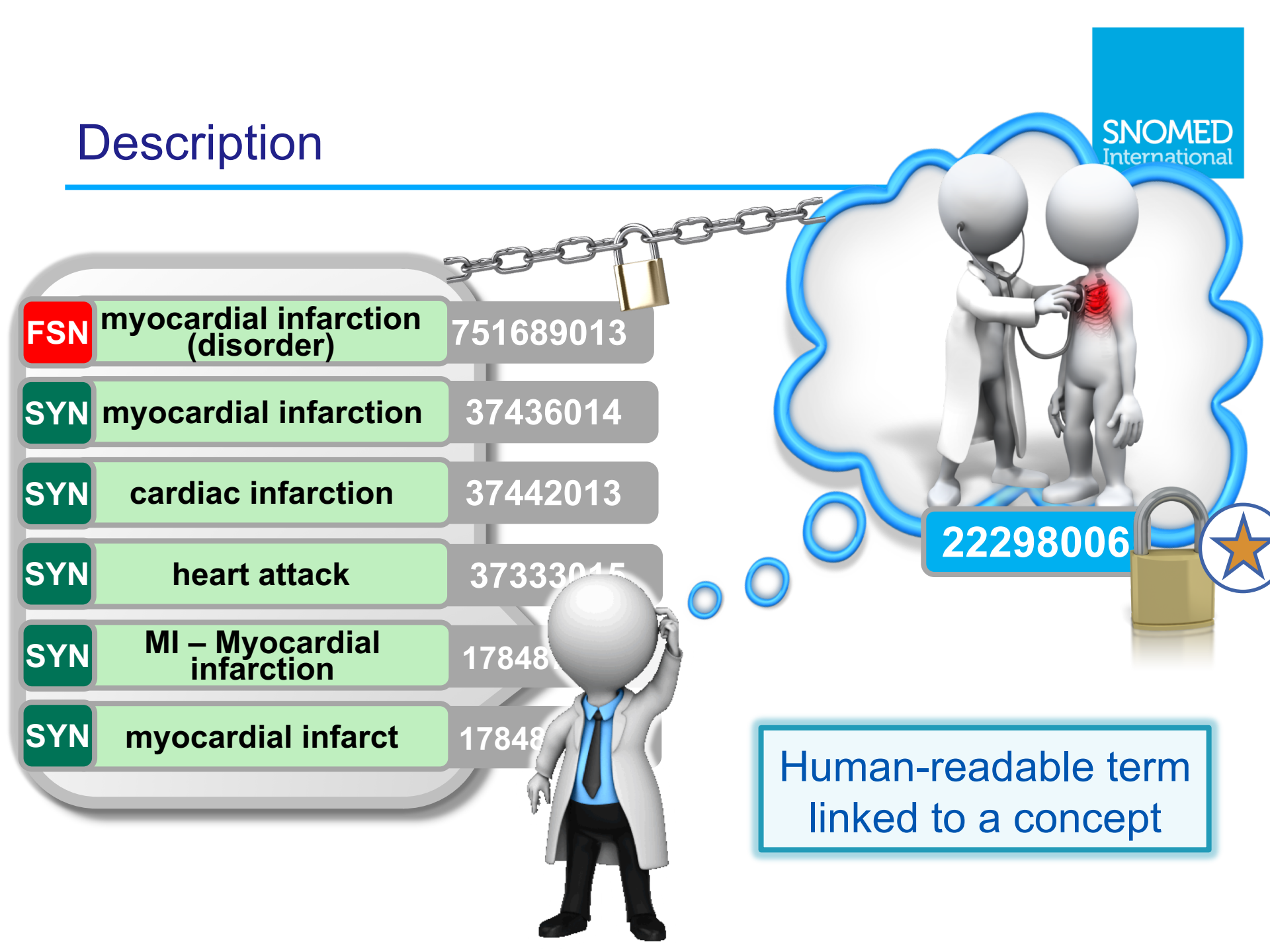


# Concept

A clinical idea with a unique identifier

# Description

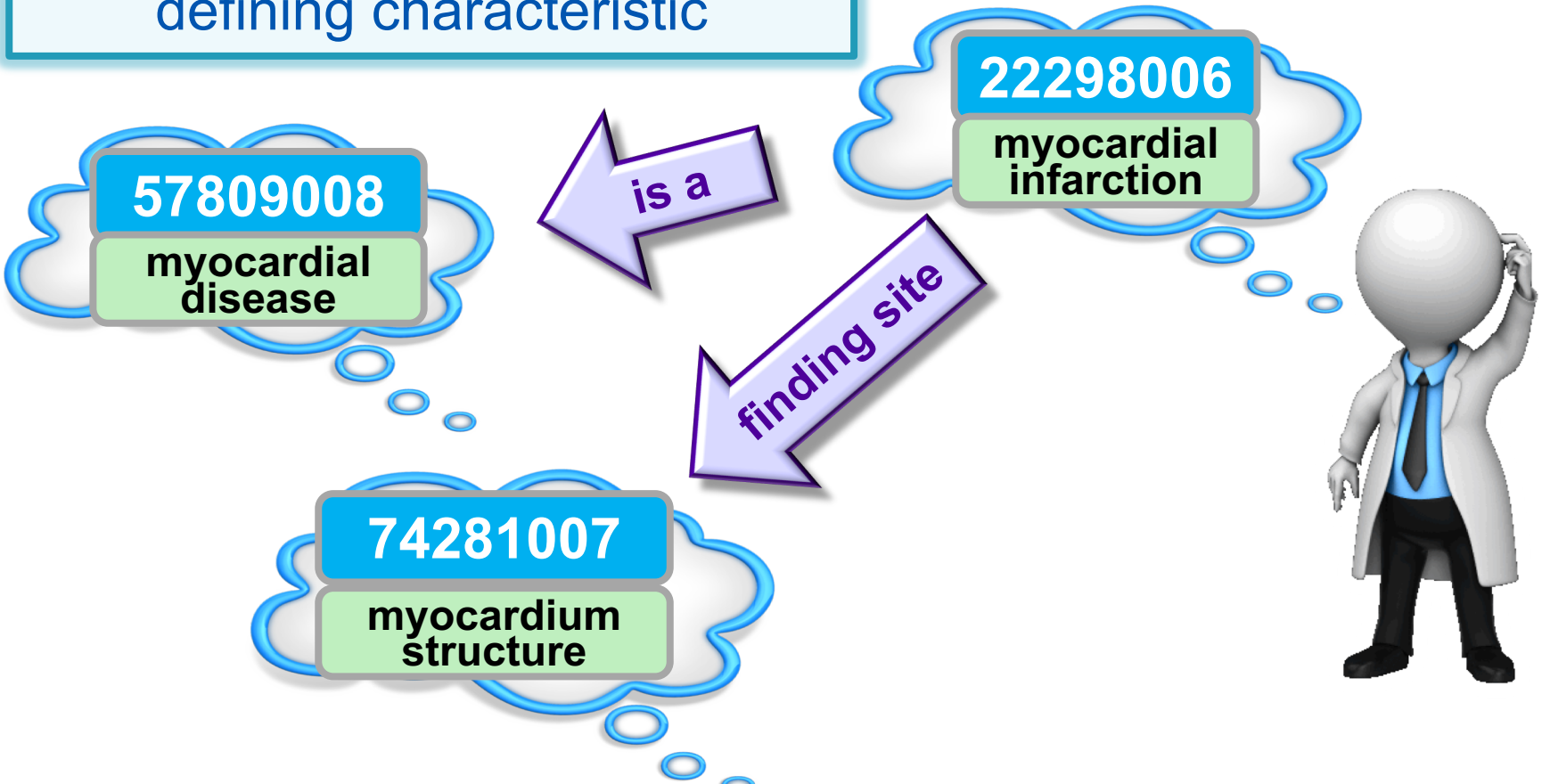
| | | |
|---|---|---|
| FSN | myocardial infarction (disorder) | 751689013 |
| SYN | myocardial infarction | 37436014 |
| SYN | cardiac infarction | 37442013 |
| SYN | heart attack | 37333015 |
| SYN | MI – Myocardial infarction | 17848 |
| SYN | myocardial infarct | 17848 |



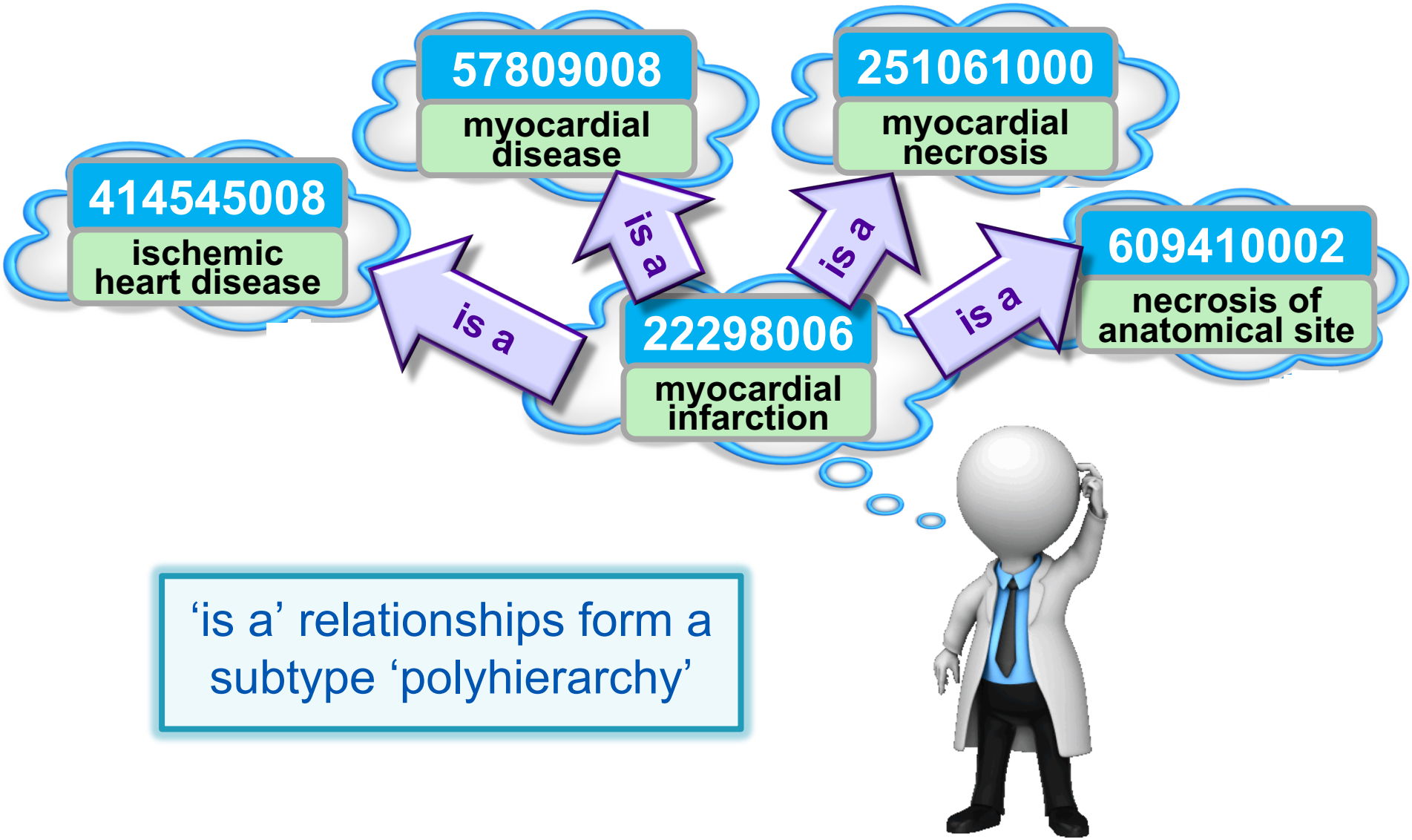

Human-readable term linked to a concept

# Relationship

Association between two concepts to represent a defining characteristic

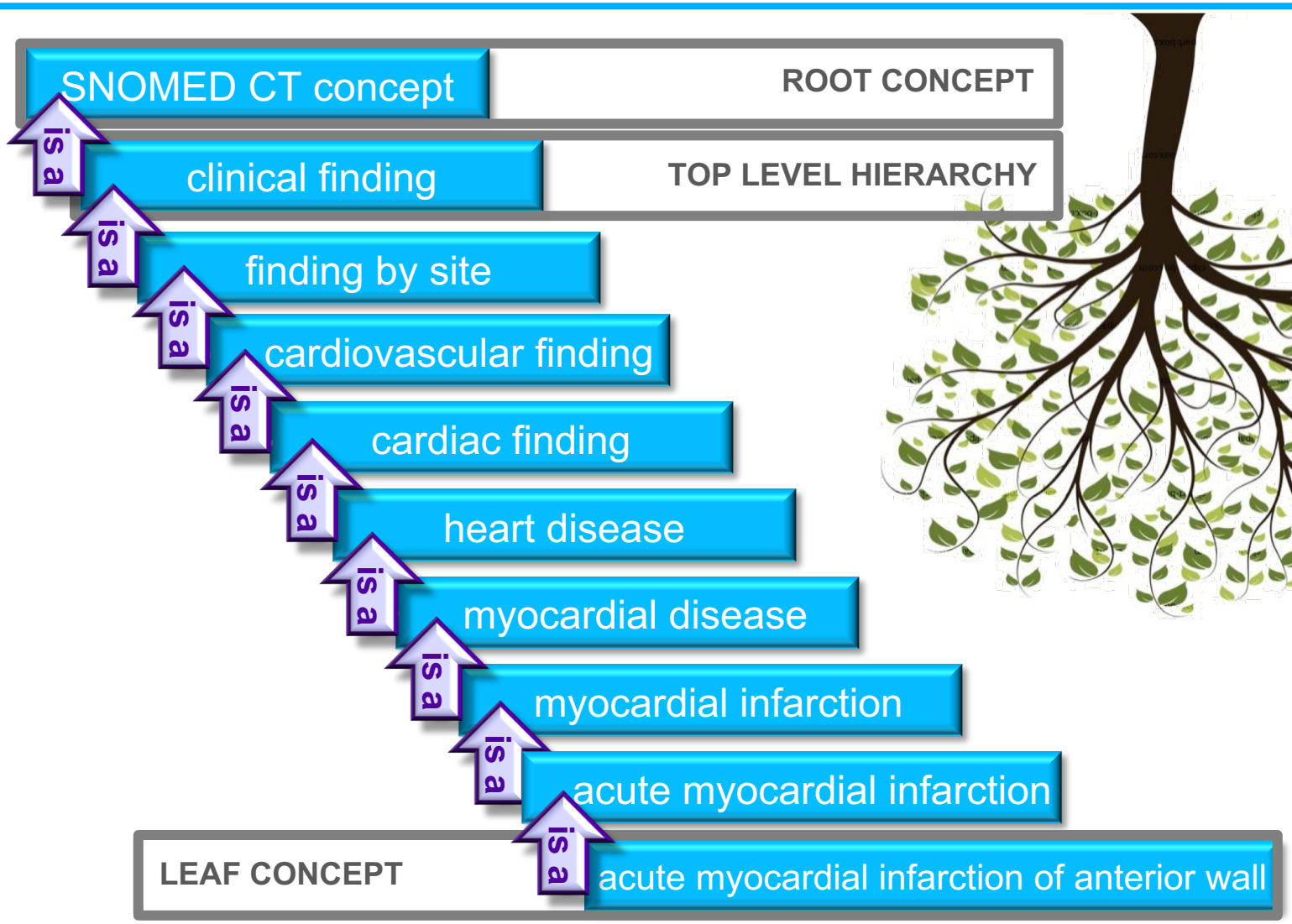


# Relationship

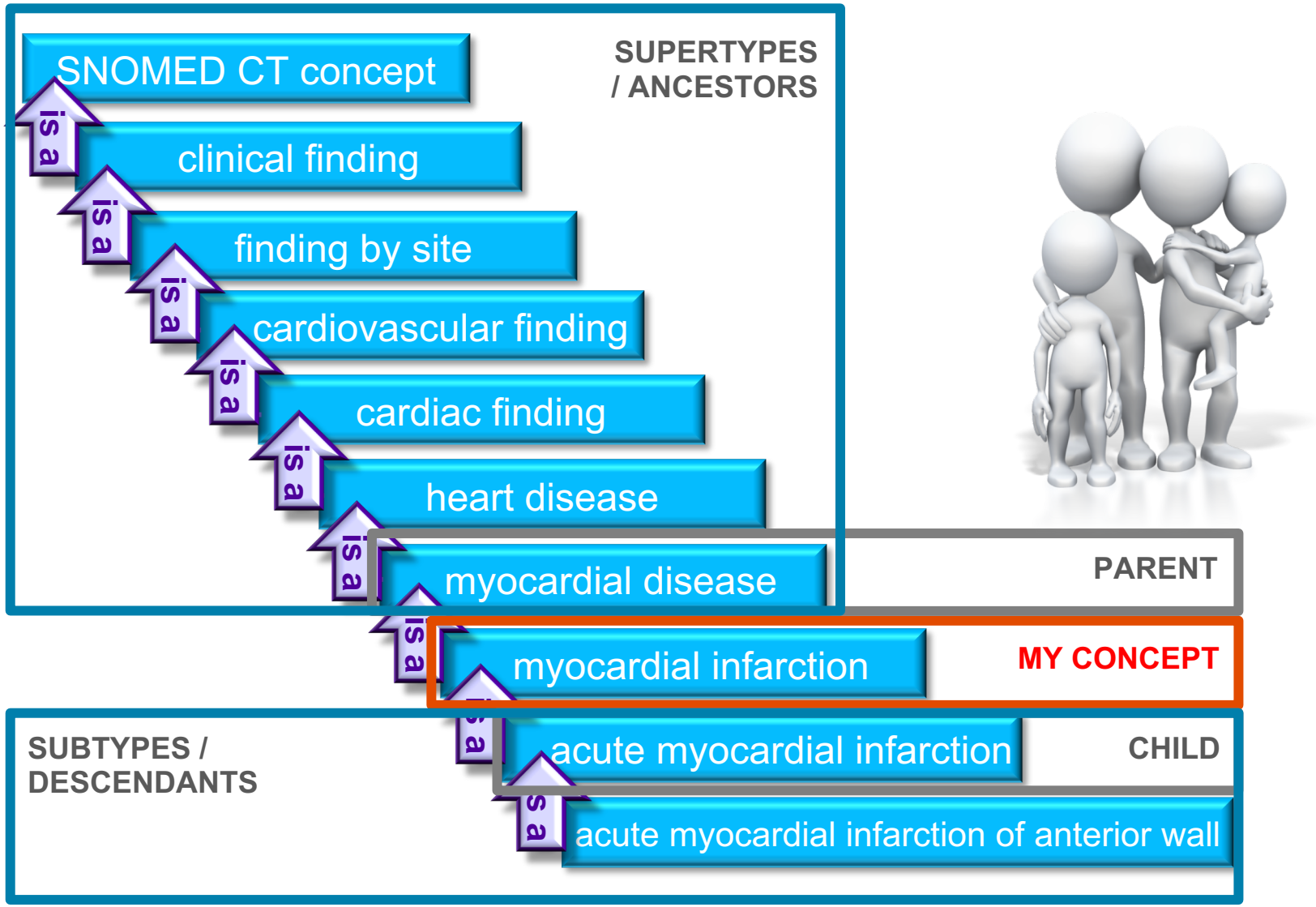



‘is a’ relationships form a subtype ‘polyhierarchy’

# Subtype Relationships



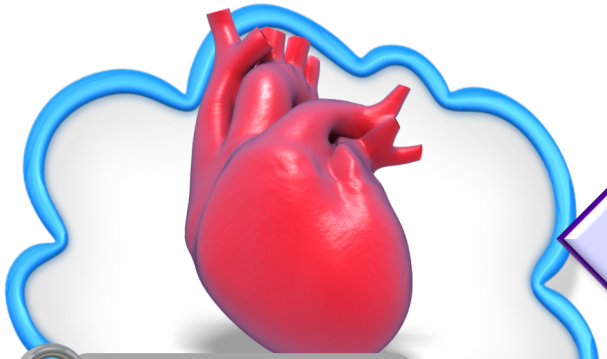
# Subtype Relationships



# SNOMED CT Content Hierarchies

- SNOMED CT Concept
  - Body structure (body structure)
  - Clinical finding (finding)
  - Environment or geographical location
  - Event (event)
  - Observable entity (observable entity)
  - Organism (organism)
  - Pharmaceutical / biologic product (product)
  - Physical force (physical force)
  - Physical object (physical object)
  - Procedure (procedure)
  - Qualifier value (qualifier value)
  - Record artifact (record artifact)
  - Situation with explicit context (situation)
  - SNOMED CT Model Component (metadata)
  - Social context (social concept)
  - Special concept (special concept)
  - Specimen (specimen)
  - Stages and scales (staging scale)
  - Substance (substance)

# Relationship



74281007
myocardium structure
(body structure)

finding site

associated morphology

55641003
Infarct
(morphological abnormality)

22298006
myocardial infarction
(disorder)

414545008
ischemic heart disease

is a

57809008
myocardial disease

is a

251061000
myocardial necrosis

is a

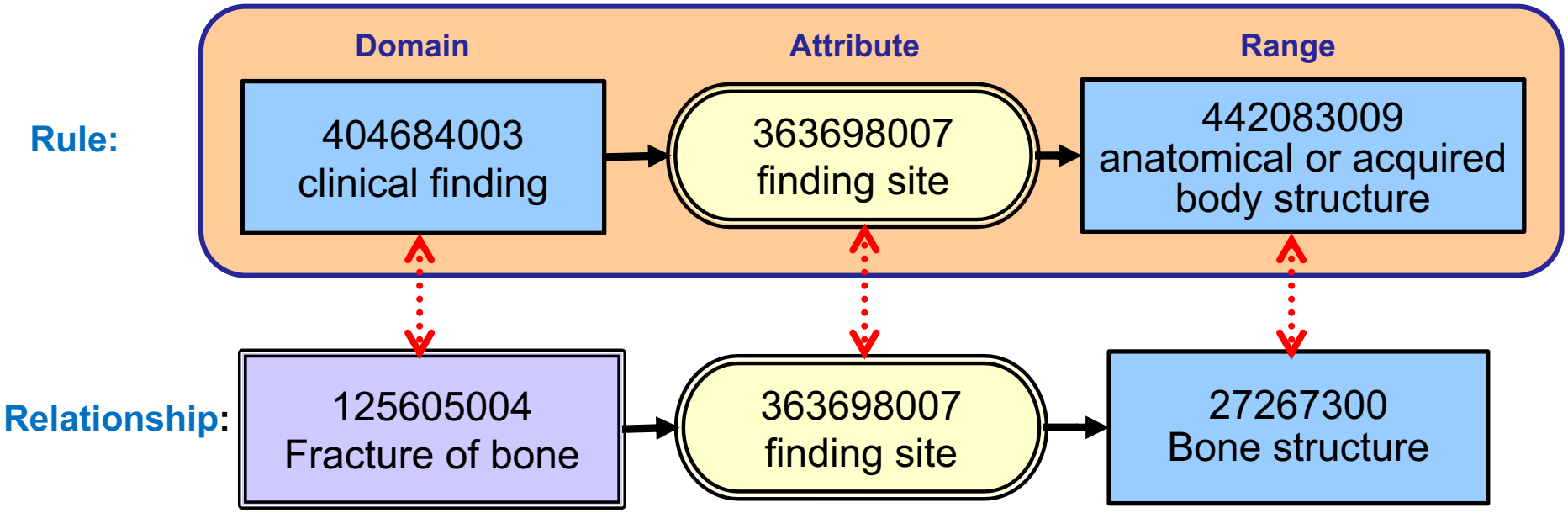
609410
necros
anatomic

is a

Can express the defining characteristics of a concept

# SNOMED CT Concept Model

- Rules for how SNOMED CT concepts are defined
  - Constrains the domain and range of each attribute
  - Defines some additional constraints (e.g. cardinality)
- Machine Readable Concept Model
  - Defines concept model rules is a computer processable way
  - Distributed with the international release of SNOMED CT



# SNOMED CT Languages

1. Compositional Grammar (http://snomed.org/scg)

   To define a SNOMED CT expression

   ```
   182201002 |Hip joint|: 272741003 |Laterality| = 24028007 |Right|
   ```

2. Expression Constraint Language (http://snomed.org/ecl)

   To constrain the set of possible concepts or expressions

   ```
   < 19829001 |Disorder of lung|:
     116676008 |Associated morphology| = << 79654002 |Edema|
   ```

3. Expression Template Language (http://snomed.org/etl)

   To define incomplete expressions with slots that are filled later

   ```
   < 404684003 |Clinical finding|:
     363698007 |Finding site| = [[ +id ]]
   ```

4. Expression Query Language

   To query over SNOMED CT RF2 content

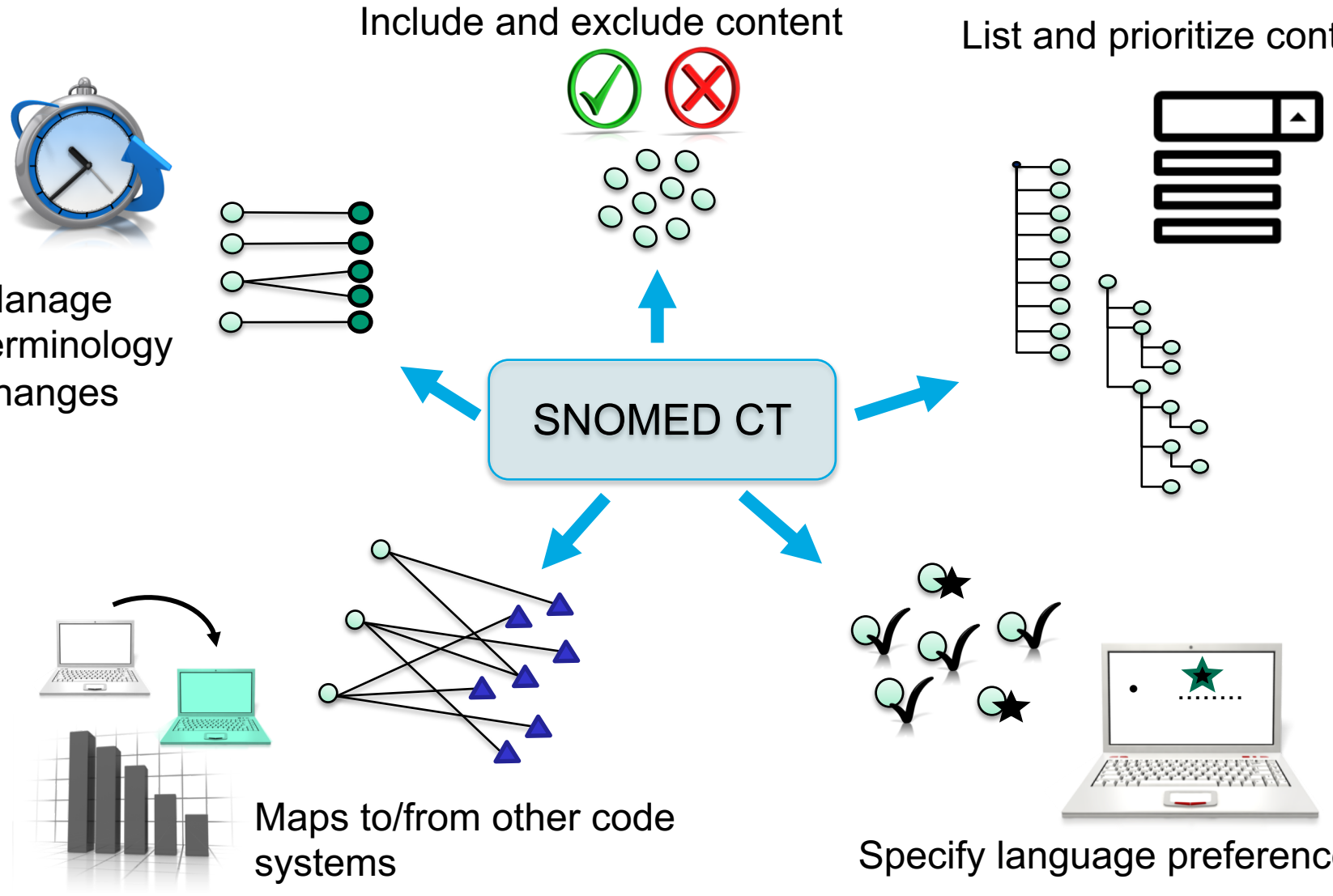
# Customizing SNOMED CT

# Extensions

- Additional content for local use
  - To meet the needs of countries, specialties and realms
  - To meet vendor needs
  - To meet local business needs
- May include local
  - Concepts, relationships, descriptions
  - Subsets, Language, Maps
- Must have one or more authorized namespaces
  - Ensures global uniqueness of identifiers

21782 1000132 10 5

# Reference Sets



# Subset

A collection of components for a particular purpose

**Subset**

| Id | Term |
|---|---|
| 82272006 | Common cold |
| 6142004 | Influenza |
| 55604004 | Avian influenza |

**Reference Set**

| id | effective Time | active | moduleId | refsetId | referenced ComponentId |
|---|---|---|---|---|---|
| 0000d6608041-005b-5108-b608-07891b210365 | 20140731 | 1 | 19999999103 | 49999999102 | 82272006 |
| 00008774f374-5f54-5234-8af1-8aca6e73b5c2 | 20140731 | 1 | 19999999103 | 49999999102 | 6142004 |
| 00006ac9-2f97-5ed4-b37e-84cb158c388d | 20140731 | 1 | 19999999103 | 49999999102 | 55604004 |

# Language Preferences

SNOMED International

22298006

F — 22298006 | Myocardial infarction (disorder) |

S — 37443015 | Heart attack |

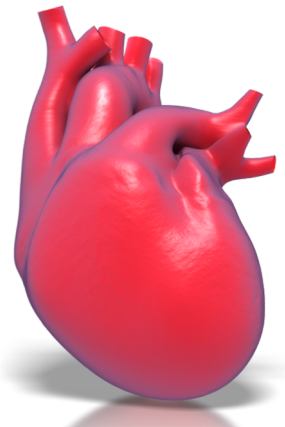
S — 37442013 | Cardiac infarction |

F — 564041000146110 | myocardinfarct (aandoening) |

F — 5861000077119 | infarctus du myocarde (trouble) |

S — 5861000077119 | infarctus du myocarde |

S — 564021000146116 | myocardinfarct |



# Language Preferences - US

22298006

F

22298006 |
Myocardial infarction (disorder) |

S

37443015 |
Heart attack |

S

37442013 |
Cardiac infarction |

F

5861000077119 |
infarctus du myocarde (trouble) |

S

5861000077119 |
infarctus du myocarde

56402100014611 6 |
myocardinfarct|

S

56404100014611 0 |
myocardinfarct
(aandoening) |

F

# Language Preferences – NL

22298006

F 22298006 | Myocardial infarction (disorder) |

S 37443015 | Heart attack |

S 37442013 | Cardiac infarction |

F 5610000771119 | infarctus du myocarde (trouble) |

S 5610000771119 | infarctus du myocarde

564021000146116 | myocardinfarct | S

564041000146110 | myocardinfarct (aandoening) | F

# Language Preferences
# Canadian French

22298006

F 22298006 | Myocardial infarction (disorder) |

S 37443015 | Heart attack |

S 37442013 | Cardiac infarction |

F 564041000146110 | myocardinfarct (aandoening) |

564021000146116 | myocardinfarct | S

F 5861000077119 | infarctus du myocarde (trouble) |

S 5861000077119 | infarctus du myocarde |

# Canadian French Language Reference Set

| FR-CA language reference set | | | |
|---|---|---|---|
| **SNOMED CT description** | | **Acceptability** | |
| 6802110000077116 | infarctus du myocarde (trouble) | 900000000000548007 | Preferred |
| 5861000077119 | infarctus du myocarde | 900000000000548007 | Preferred |

# Canadian French Language Reference Set

| EN-CA language reference set | | | |
|---|---|---|---|
| **SNOMED CT description** | | **Acceptability** | |
| 751689013 | myocardial infarction (disorder) | 900000000000548007 | preferred |
| 37436014 | myocardial infarction | 900000000000548007 | preferred |
| 37442013 | cardiac infarction | 900000000000549004 | acceptable |
| 37443015 | heart attack | 900000000000549004 | acceptable |
| 37441018 | infarction of heart | 900000000000549004 | acceptable |
| 1784872019 | MI - Myocardial infarction | 900000000000549004 | acceptable |
| 1784873012 | myocardial infarct | 900000000000549004 | acceptable |

# SNOMED CT and Other Coding Systems

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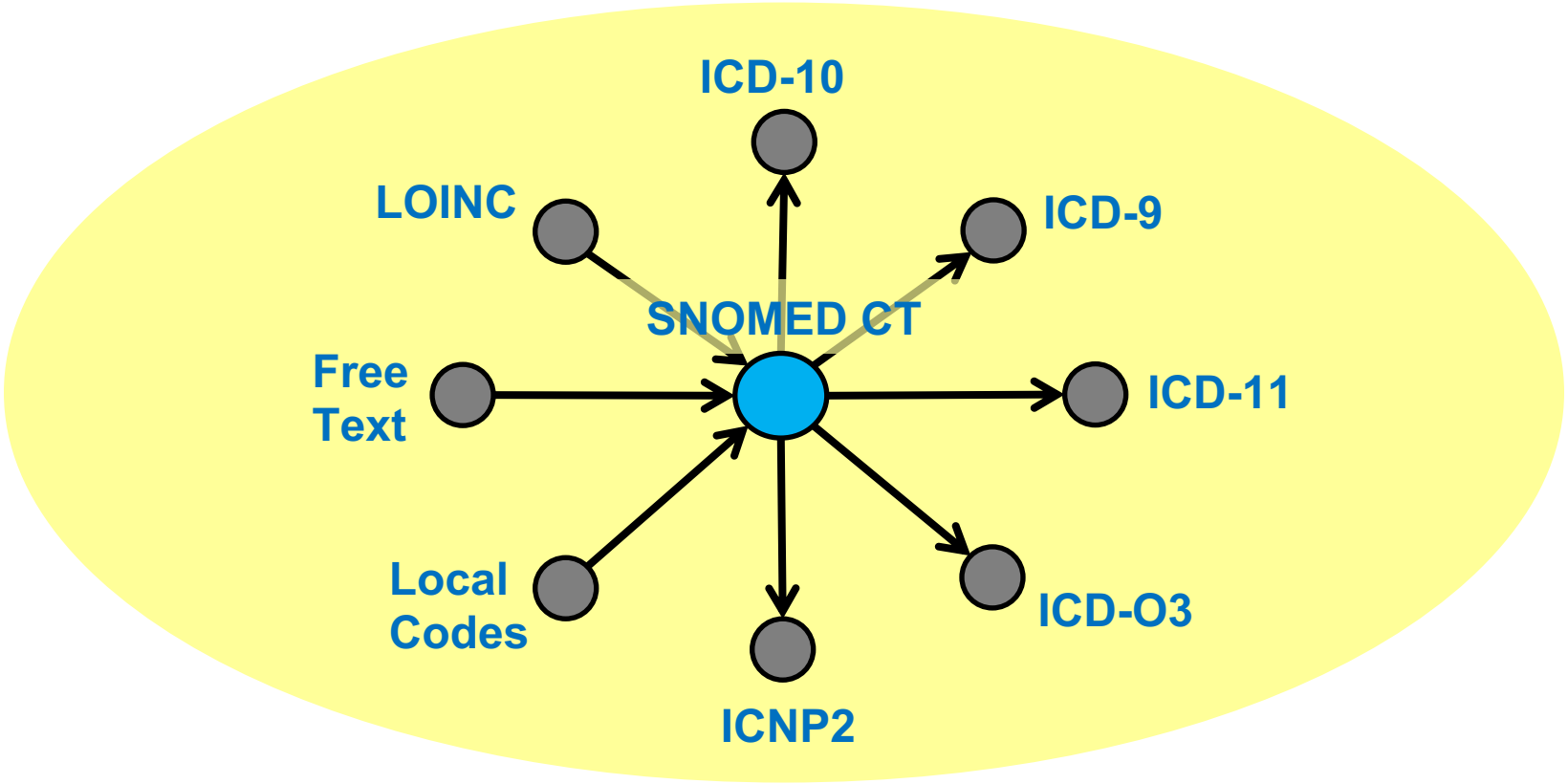
SNOMED CT acts as bridge between other code systems




Enables cross-domain queries and analysis

# Map Example

SNOMED International

## Between SNOMED CT and an external code system

| ICD-O simple map reference set | | | |
|---|---|---|---|
| **SNOMED CT concept** | | **ICD-O code** | |
| 243930007 | entire spine | C41.2 | Vertebral column |
| 372177002 | entire nail plate | C44.9 | Skin, NOS |
| 61685007 | lower limb structure | C76.5 | lower limb, NOS |
| 447643008 | vipoma | 8155/1 | vipoma, NOS |
| 127573000 | neuroendocrine carcinoma, grade 2 | 8249/3 | Neuroendocrine tumor, grade 2 |
| 447644002 | benign stromal tumour | 8935/0 | stromal tumor, benign |

# SNOMED International Collaboration

- WHO
  - Maps to ICD-0, ICD-9 and ICD-10
  - US National Library of Medicine provides map to ICD-10-CM
  - SNOMED International and WHO cooperating on ICD-11
- LOINC
  - Links between SNOMED CT and LOINC minimize duplication and benefit users of both code systems
- HL7
  - Collaboration agreement to encourage use of SNOMED CT in HL7 messages, documents and resources
- GMDN (Global Medical Device Nomenclature)
  - Medical device terminology linked to SNOMED CT
- ICN (International Council of Nursing)
  - Joint work linking SNOMED CT and ICNP

# Analytics with SNOMED CT

# Analytics with SNOMED CT

SNOMED International

**Clinical assessment and treatment**

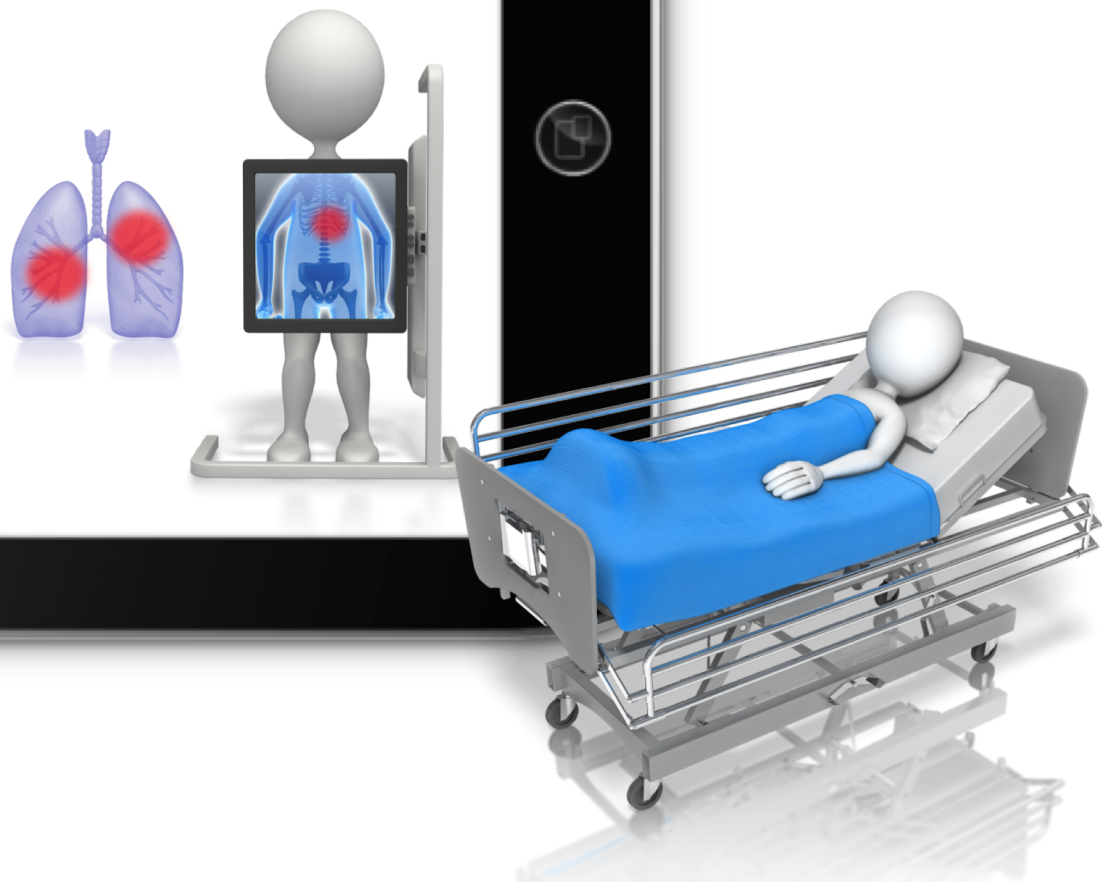
**Population monitoring**

**Research**

***PATIENT: 1961-06-21 Harry Smith***

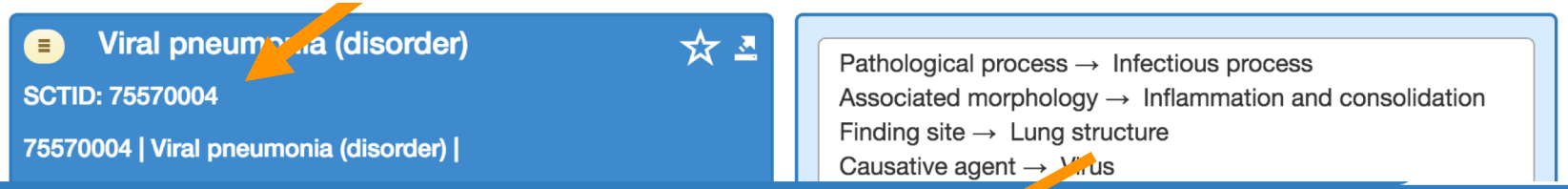
**Diagnosis** (SNOMED CT)

| |
|---|
| 75570004 \| Viral pneumonia (disorder) \| |



# Parents

- Infective pneumonia (disorder)
- Viral lower respiratory infection (disorder)



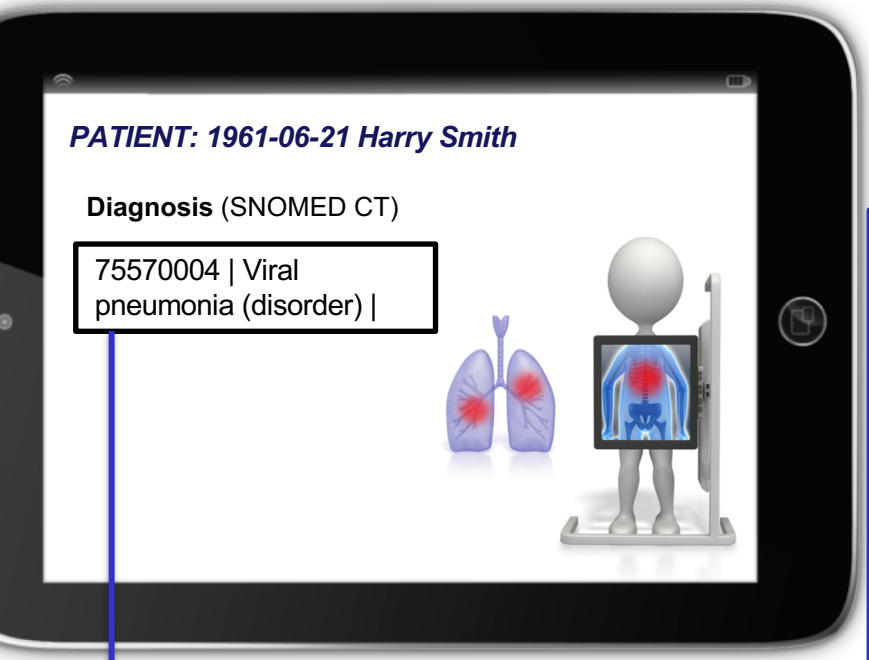

Pathological process → Infectious process

Associated morphology → Inflammation and consolidation

Finding site → Lung structure

Causative agent → Virus

# SNOMED CT Supports Meaningful Health Records




**75570004 | Viral pneumonia (disorder) |**

**Does patient have respiratory disorder?**

**Yes: subtype of respiratory disorder**

**Does patient have an infection?**

**Yes: subtype of infectious disease**

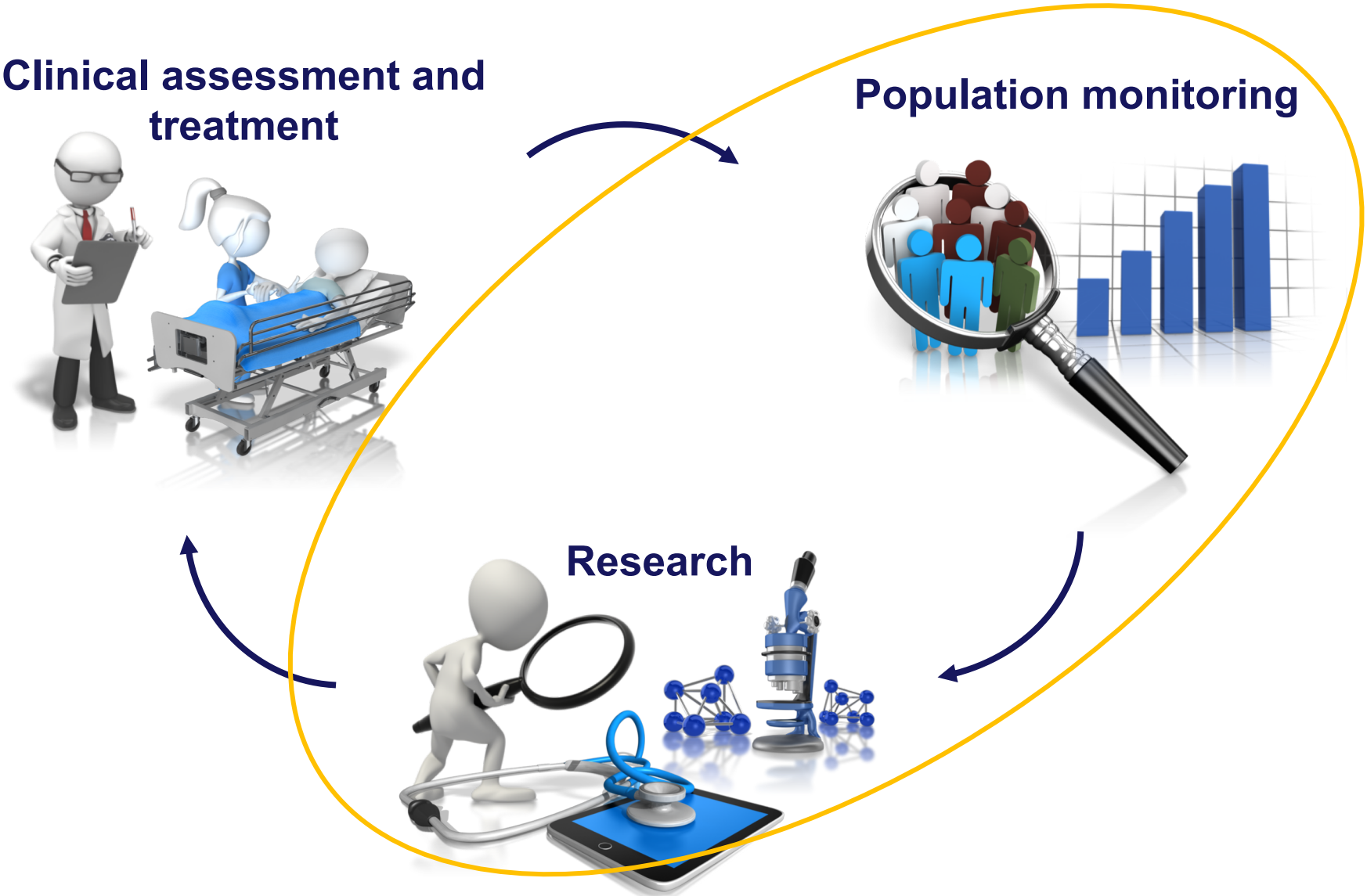
**Does the disorder affect the lung?**

**Yes: finding site is lung structure**

**Is the disorder caused by a virus?**

**Yes: causative agent is virus**

# Analytics with SNOMED CT



Disease

Disorder of respiratory system

Infectious disease

Bacterial infectious disease

Viral disease

Bacterial respiratory infection

Bacterial otitis media

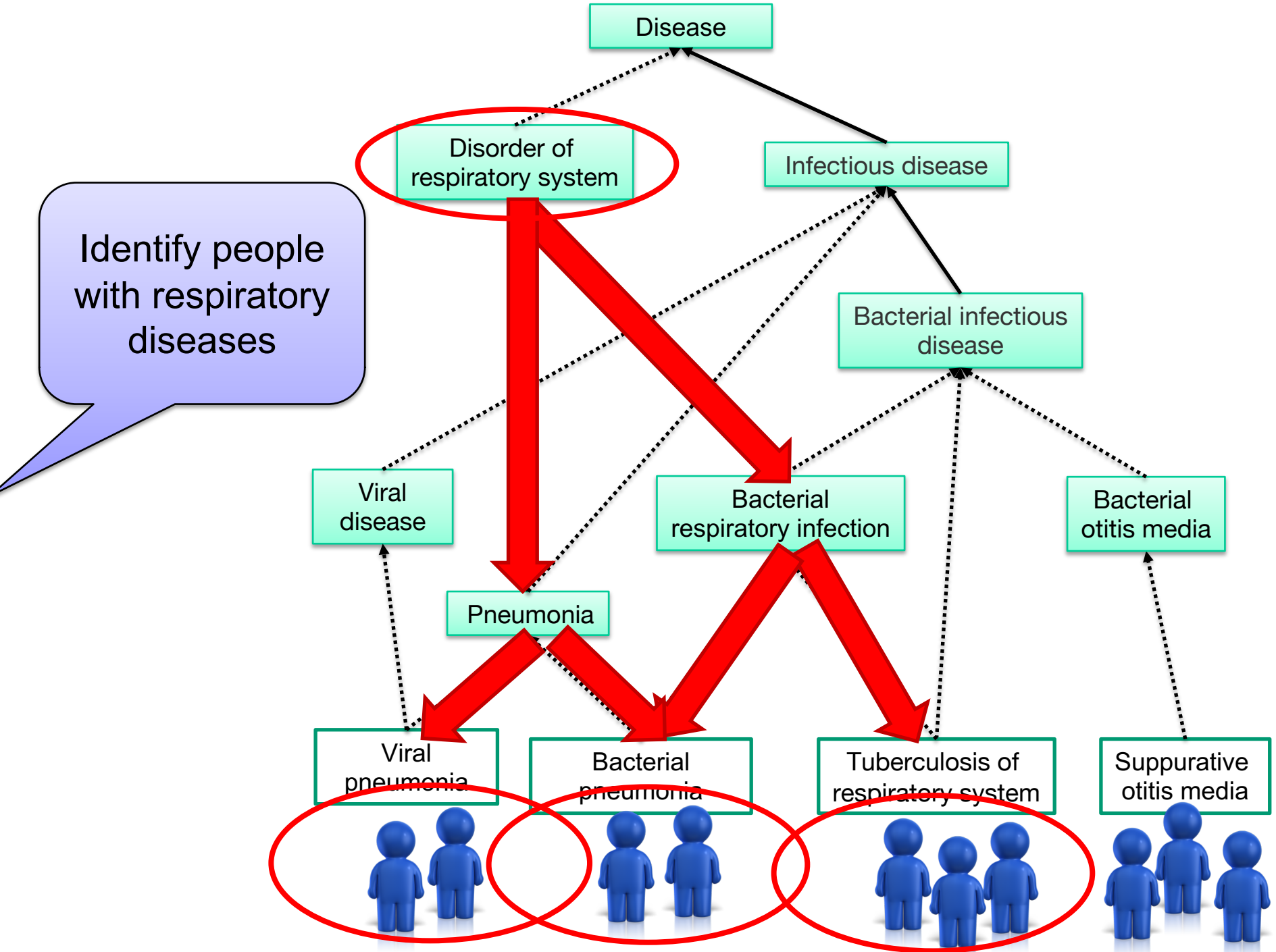
Pneumonia

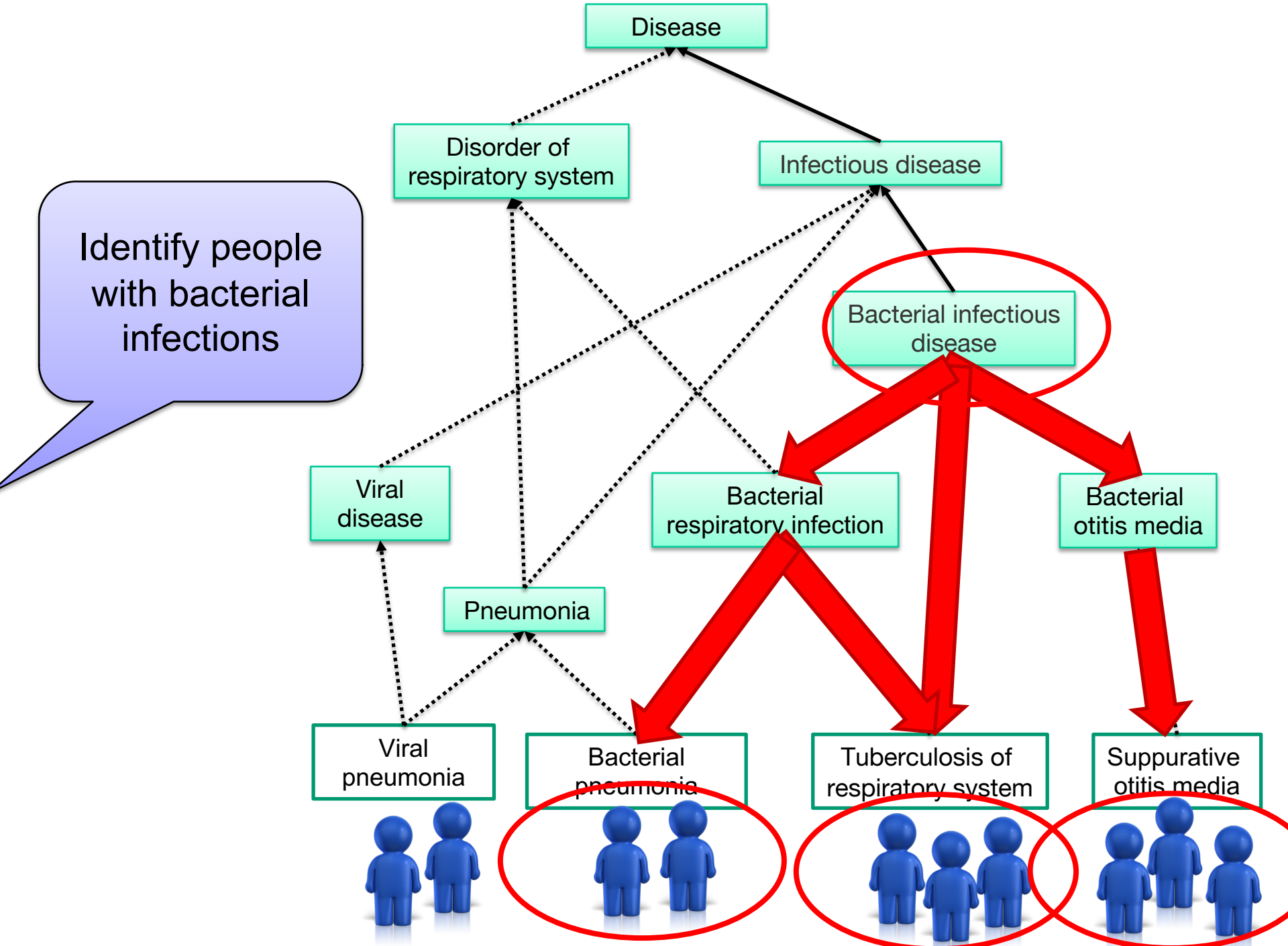
Viral pneumonia

Bacterial pneumonia

Tuberculosis of respiratory system

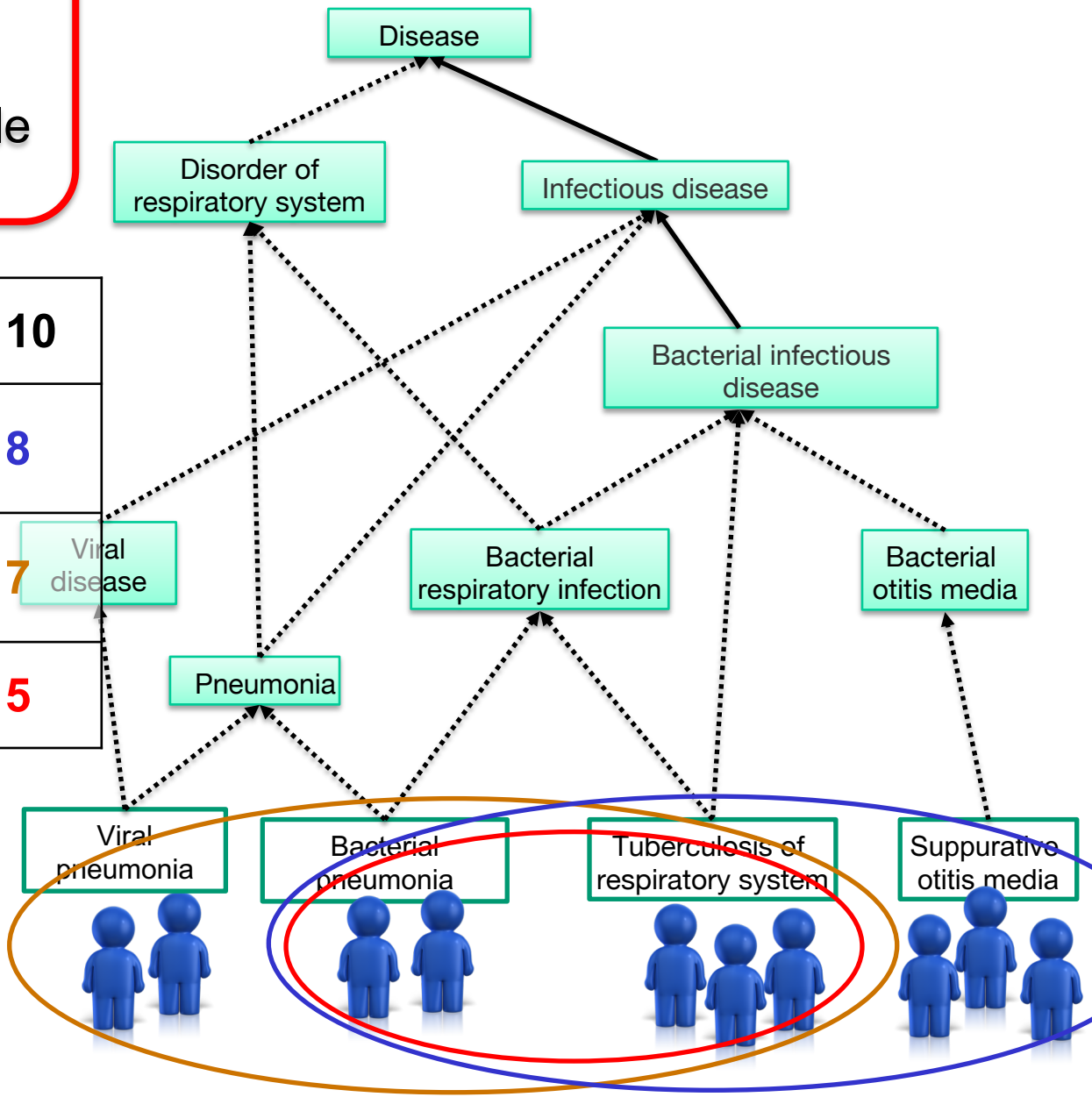
Suppurative otitis media

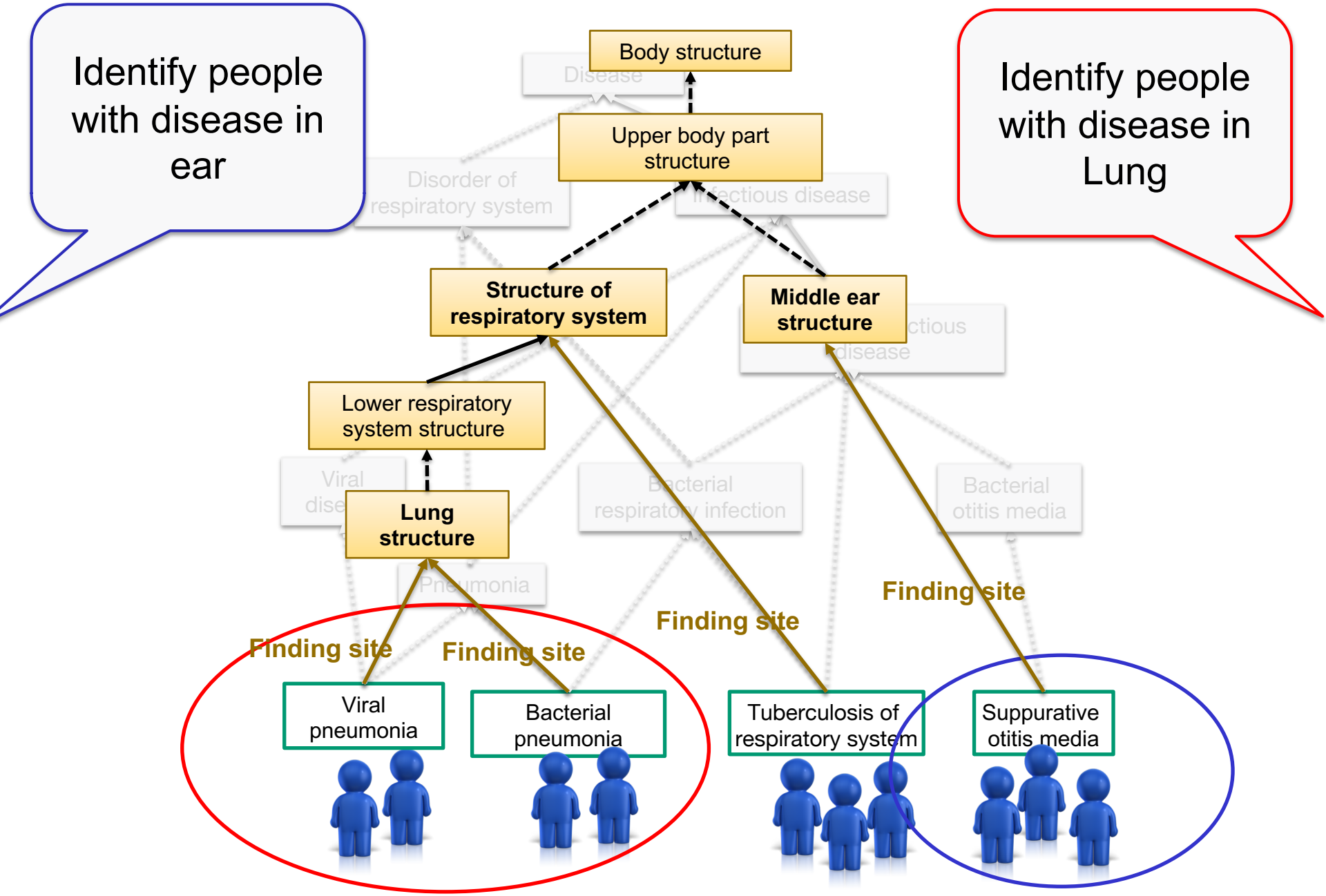

Identify people with respiratory diseases
Disease
Disorder of respiratory system
Infectious disease
Bacterial infectious disease
Viral disease
Bacterial respiratory infection
Bacterial otitis media
Pneumonia
Viral pneumonia
Bacterial pneumonia
Tuberculosis of respiratory system
Suppurative otitis media


Identify people with bacterial infections
Disease
Disorder of respiratory system
Infectious disease
Bacterial infectious disease
Viral disease
Bacterial respiratory infection
Bacterial otitis media
Pneumonia
Viral pneumonia
Bacterial pneumonia
Tuberculosis of respiratory system
Suppurative otitis media

Note: When using SNOMED CT for querying, strategies exist to prevent double counting

| | |
|---|---|
| **Patient count** | **10** |
| **Bacterial infectious diseases** | **8** |
| **Disorder of respiratory system** | **7** |
| **Double counts** | **5** |



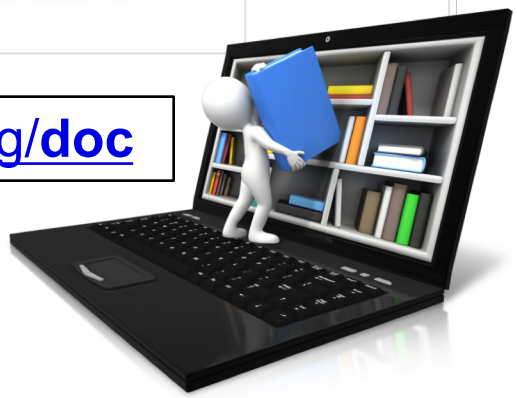

Identify people with disease in ear
Identify people with disease in Lung
Body structure
Upper body part structure
Structure of respiratory system
Middle ear structure
Lower respiratory system structure
Lung structure
Finding site
Finding site
Finding site
Finding site
Viral pneumonia
Bacterial pneumonia
Tuberculosis of respiratory system
Suppurative otitis media

# E-Learning Presentations and Courses

- SNOMED E-Learning:
  - http://snomed.org/courses
- Create an account
  - Enroll on a course or browse our learning materials
- SNOMED E-Learning
  - Formal Courses with Assessments (Enrolment fees apply)
    - Foundation — Free to residents of Member territories
    - Implementation — Discounts for residents of Member territories
    - Authoring Level 1 — Discounts for residents of Member territories
  - Learning Pathways
    - Data Analysts
    - Developers
  - Presentation Library
    - Accessible to anyone with an account

# SNOMED CT Document Library

| Overviews | Guides | Specifications | SNOMED CT Expo | Glossary |
|---|---|---|---|---|
| | | | | |



http://snomed.org/**doc**

- Introductory Guides
  - Starter Guide http://snomed.org/**sg**
  - Vendor Introduction http://snomed.org/**vendorintro**
  - Member (NRC) Guide http://snomed.org/**nrcguide**
- Specifications and Technical Guidance
  - Release file specifications
  - Computable language specifications
  - Terminology and record services
- Practical Guides
  - Search, Data entry, Decision support, Analytics, Reference sets, Extensions

# Learn More About SNOMED CT

# Additional Information

- SNOMED International website
  http://snomed.org
- SNOMED CT Browser
  http://snomed.org/browser
- SNOMED CT Document Library
  http://snomed.org/doc
- SNOMED CT Starter Guide
  http://snomed.org/sg
- SNOMED CT E-Learning server
  http://snomed.org/elearning
- SNOMED CT Tools
  http://snomed.org/tools

# Questions and Discussion

**Contact:** info@snomed.org
**Website:** www.snomed.org