Data Analytics and Clinical Decision Support with SNOMED CT

Expo 2017 Tutorial

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SNOMED International

Overview

- Data analytics
  - Introduction
  - Preparing data
  - Techniques
  - Tasks
  - Challenges
- Decision Support
  - Introduction
  - Logical architecture
  - Knowledge base
  - Inference engine
  - Communication
- Case studies

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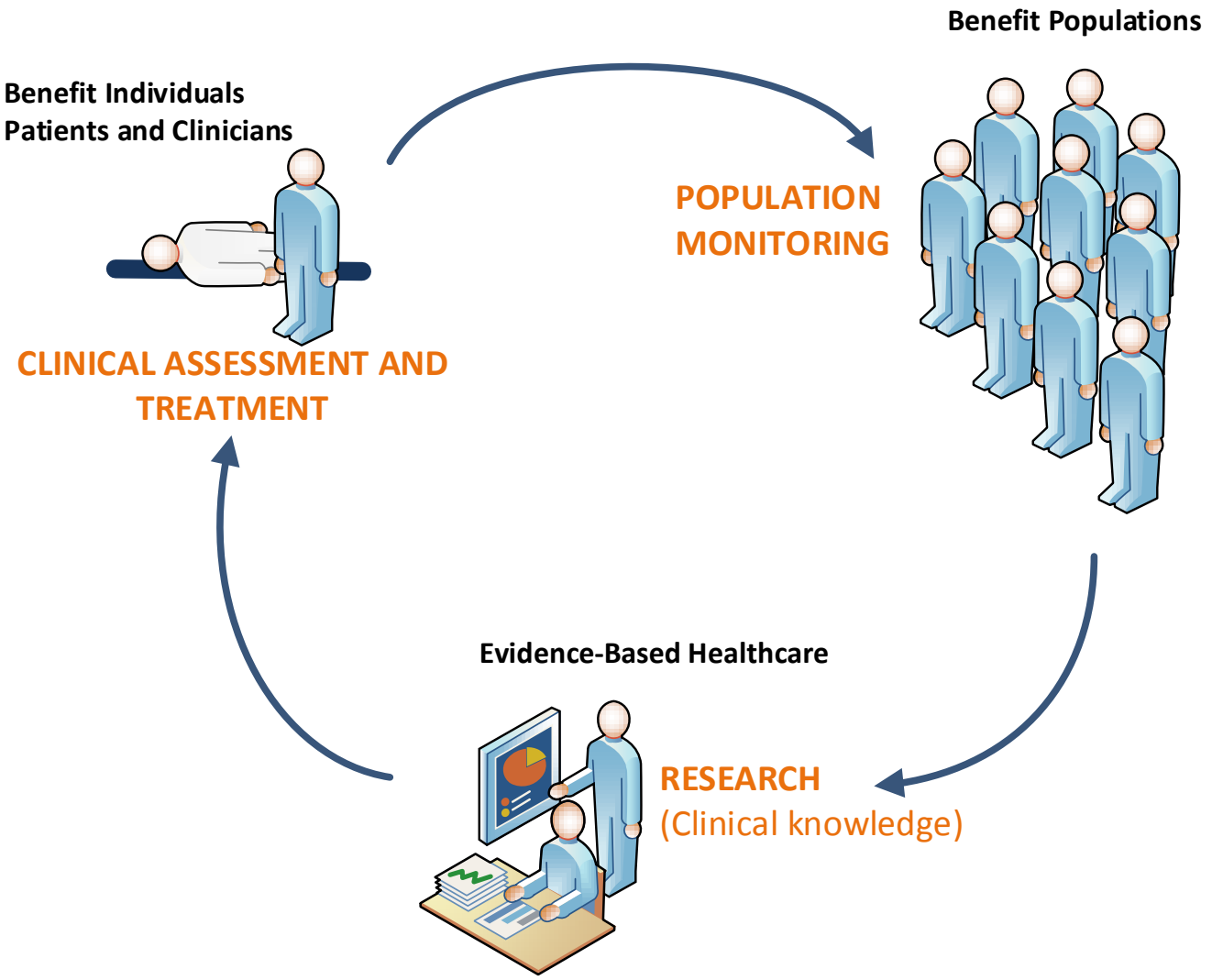
Introduction

Data Analytics

Discovery & communication of meaningful patterns in data

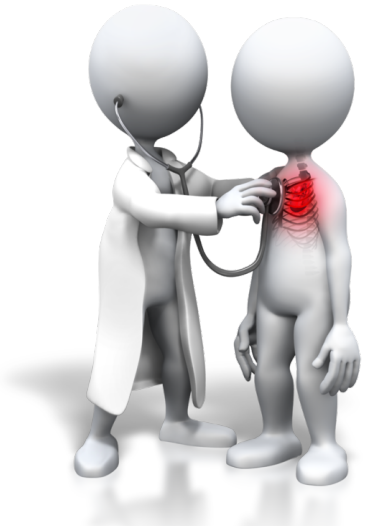
- May describe, predict and improve performance
- May recommend action or guide decision making
- Scope
  - Individual patients / healthcare workers
  - Patient groups / cohorts
  - Enterprise / geographic groups
- Substrate
  - Unstructured free text documents
  - Structured documents using SNOMED CT
  - Structured documents using other coding systems
  - Big data with a combination of the above

Analytics Purposes - Overview



Analytics Purposes – Individual Care

- SNOMED CT may be used to support analytics that
  - Improves care for individuals by enabling
    - Retrieval and sharing of information to better support care
    - Reduction in duplication of investigations and interventions
    - Integration with decision support tools to guide care
    - Context sensitive presentation of guidelines and care pathways
    - Identification of patients requiring follow-up or treatment changes
    - Professional logs and performance tracking
    - Work list generation and workload monitoring



Analytics Purposes – Population Care

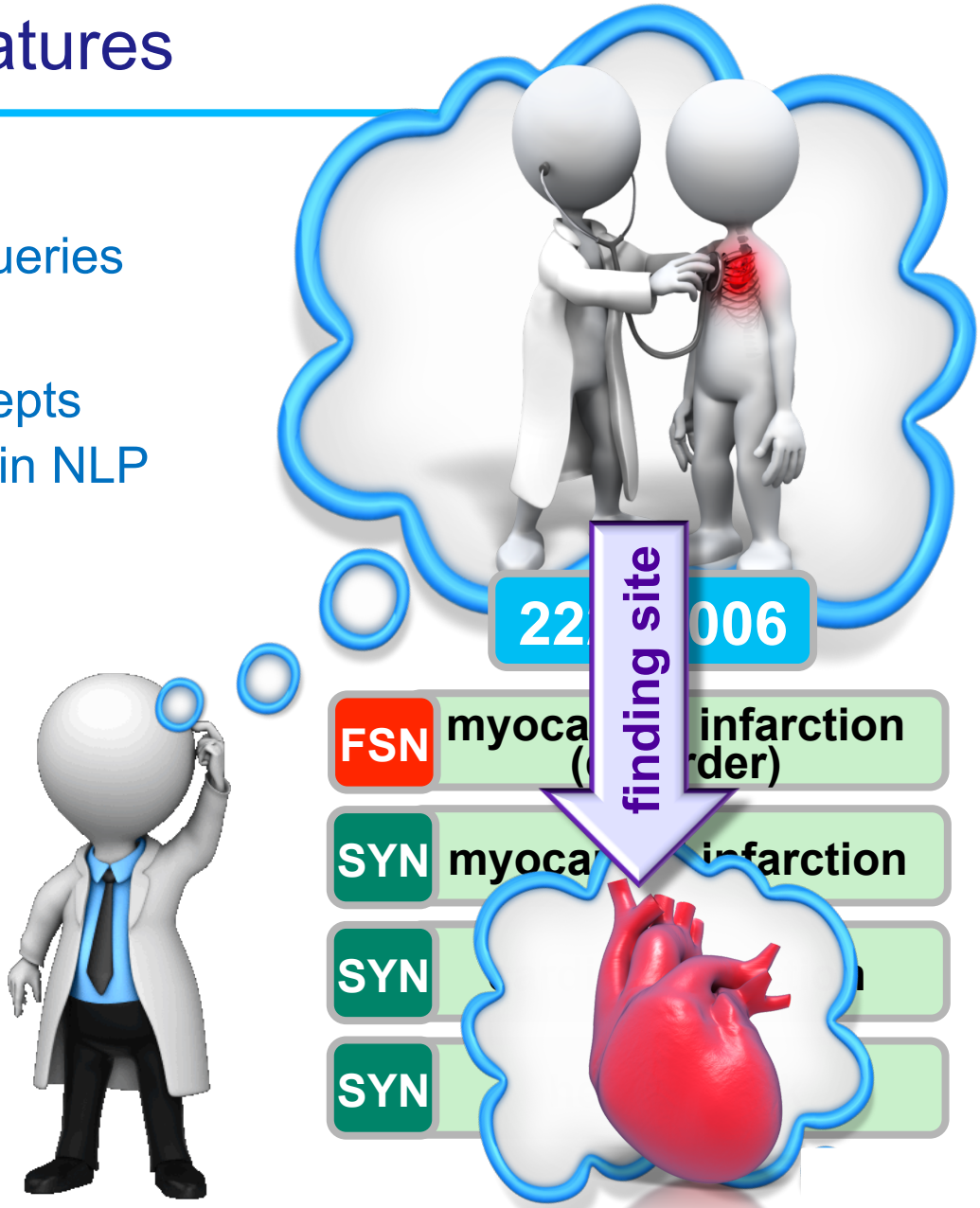
- SNOMED CT may be used to support analytics that
  - Improves the care of populations by enabling
    - Epidemiological monitoring and reporting
    - Audit of clinical care and service delivery
    - Systems that measure and maximize the delivery of cost-effective treatments and minimize the risk of costly errors

Analytics Purposes – Evidence Based Healthcare

- SNOMED CT may be used to support analytics that
  - Supports evidence-based healthcare and clinical knowledge research by enabling
    - Identification of clinical trial candidates
    - Research into the effectiveness of different approaches to disease management
    - Clinical care delivery planning
    - Planning for future service delivery provision

SNOMED CT Core Features

- Concepts
  - Enable meaning-based queries
- Descriptions
  - Assist searching for concepts
  - Enhance string-matching in NLP
  - Multi-lingual support
- Relationships
  - Support queries based on defined meaning
  - Aggregation
  - Query detailed content stored in EHRs using more abstract concepts



SNOMED CT Additional Features

- Concept Model
  - Provides foundation for processing clinical meaning
- Expressions
  - Enable meaning-based queries over more than just concepts
- Reference sets
  - Represent subsets of concepts to help define query criteria
  - Represent non-standard aggregations for specific use cases
  - Define maps from other code systems to SNOMED CT
  - Define sets of language or dialect specific descriptions
- Description Logic
  - Supports computation of subsumption and equivalence

SNOMED CT Other Benefits

- Broad domain coverage
  - Enables queries across disciplines, specialties and domains
- Robust versioning
  - Helps to manage queries over longitudinal health records
- International
  - Enables queries, subsets, rules and maps to be shared and reused between countries
- Localization mechanisms
  - Allows queries to be applied to data from different countries, dialects, regions & applications

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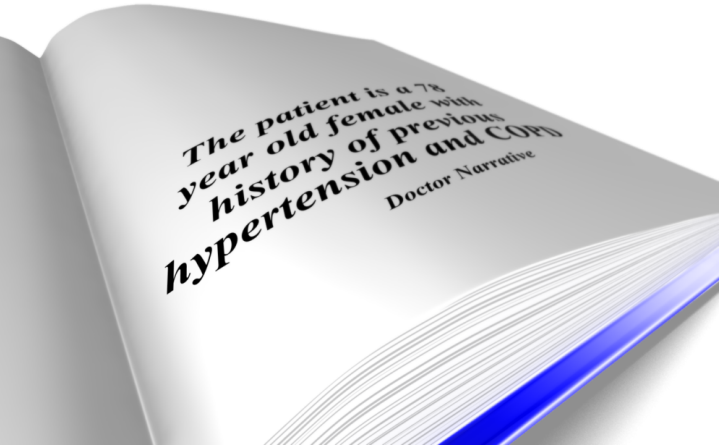
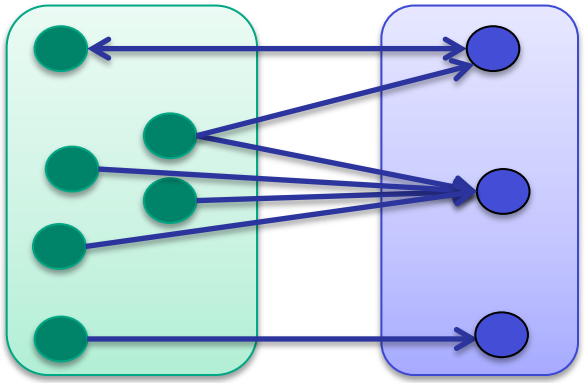
Data Analytics

Preparing Data for Analytics

Preparing Data for Analytics

1. Natural Language Processing
   - Enables a computer to analyse and extract meaning from human language
   - Automatic coding of free text is not always reliable
   - Context that is not coded can lead to incorrect query results
2. Mapping Other Code Systems to SNOMED CT
   - SNOMED CT can be used as a common reference terminology for querying over data sources that use different coding systems
   - Direction and correlation of map effect the quality of analytics





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Data Analytics

Analytics Techniques

SNOMED CT Analytics Techniques

- Subsets
- Subsumption
- Defining relationships
- Description logic

Subsets - Overview

- Create subsets of concepts for a specific clinical purpose
  - Manual inclusion using search and browse
  - Using an existing subset as a starting point
  - Lexical queries (string matching) to identify candidates
  - Hierarchical queries to select descendants of a concept
  - Attribute queries to find concepts with a specific attribute value
  - SNOMED CT queries using a combination of features
- Subsets may be defined:
  - Extensionally
    - Flat list of concept identifiers
    - Distributed using a simple or ordered refset
  - Intensionally
    - Using a machine processable query
    - Distributed using a query refset
- Test the codes in patient records for membership

Subsets – Example

Find the patients with a diagnosis of tuberculosis

Patient Record

- Patient id: 1755
- Diagnosis: 38115001 |Tuberculosis of spinal meninges|

Subset: Tuberculosis disorders

Concept ID	Description
56717001	tuberculosis (disorder)
58437007	tuberculosis of meninges (disorder)
90302003	tuberculosis of cerebral meninges (disorder)
38115001	tuberculosis of spinal meninges (disorder)
447332005	tuberculous abscess of epidural space (disorder)
11676005	tuberculous leptomeningitis (disorder)
447253004	tuberculous arachnoiditis (disorder)
31112008	tuberculous meningoencephalitis (disorder)

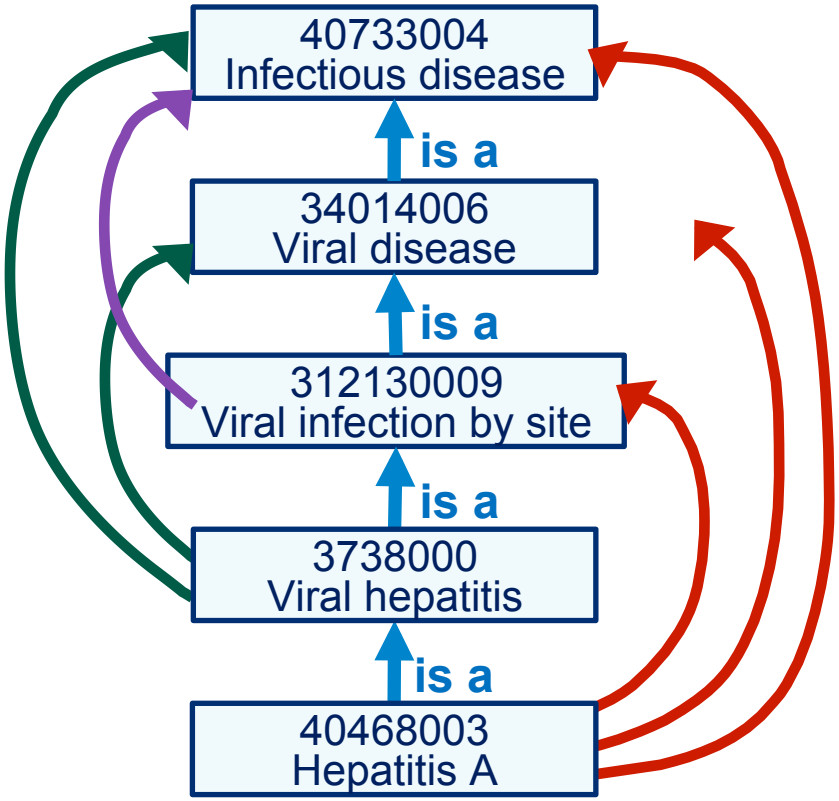
Subsumption - Overview

- Subsumption occurs when one clinical meaning is a subtype of another clinical meaning
  - Example: Which patients have an infectious disease?
    - Involves finding all patients with *any kind* of infectious disease including 75570004 |Viral pneumonia|
- Using the SNOMED CT Expression Constraint Language
  - Uses '<' (descendantOf) and '<<' (descendantOrSelfOf)
  - Example

    << 40733004 |Infectious disease|
- Techniques for testing subsumption include
  - Precomputed transitive closure table
  - Using a Description Logic reasoner

Subsumption - Example

Hospital Audit for Patients with Infectious Diseases



Relationship Query Store Table

sourceId	destinationId
34014006	4073304
312130009	34014006
3738000	312130009
40468003	3738000
40468003	4073304
40468003	34014006
40468003	312130009
3738000	4073304
3738000	34014006
312130009	4073304
. . .	. . .
. . .	. . .

Subsumption - Example

Hospital Audit for Patients with Infectious Diseases

```
SELECT * FROM health_records
WHERE diagnosis =
      (<< 40733004 |Infectious disease|)
```

patientID	Diagnosis
634711	71620000 |Fracture of femur|
634711	40468003 |Hepatitis A|
634711	66308002 |Fracture of humerus|
158775	415353009 |Rotavirus food poisoning|
889125	75570004 |Viral pneumonia|
456872	22298006 |Myocardial infarction|
456872	195967001 |Asthma|

subtype	supertype
34014006	4073304
312130009	34014006
3738000	312130009
40468003	3738000
40468003	4073304
40468003	34014006
40468003	312130009
3738000	4073304
3738000	34014006
312130009	4073304
415353009	4073304
75570004	4073304

Defining Relationships - Overview

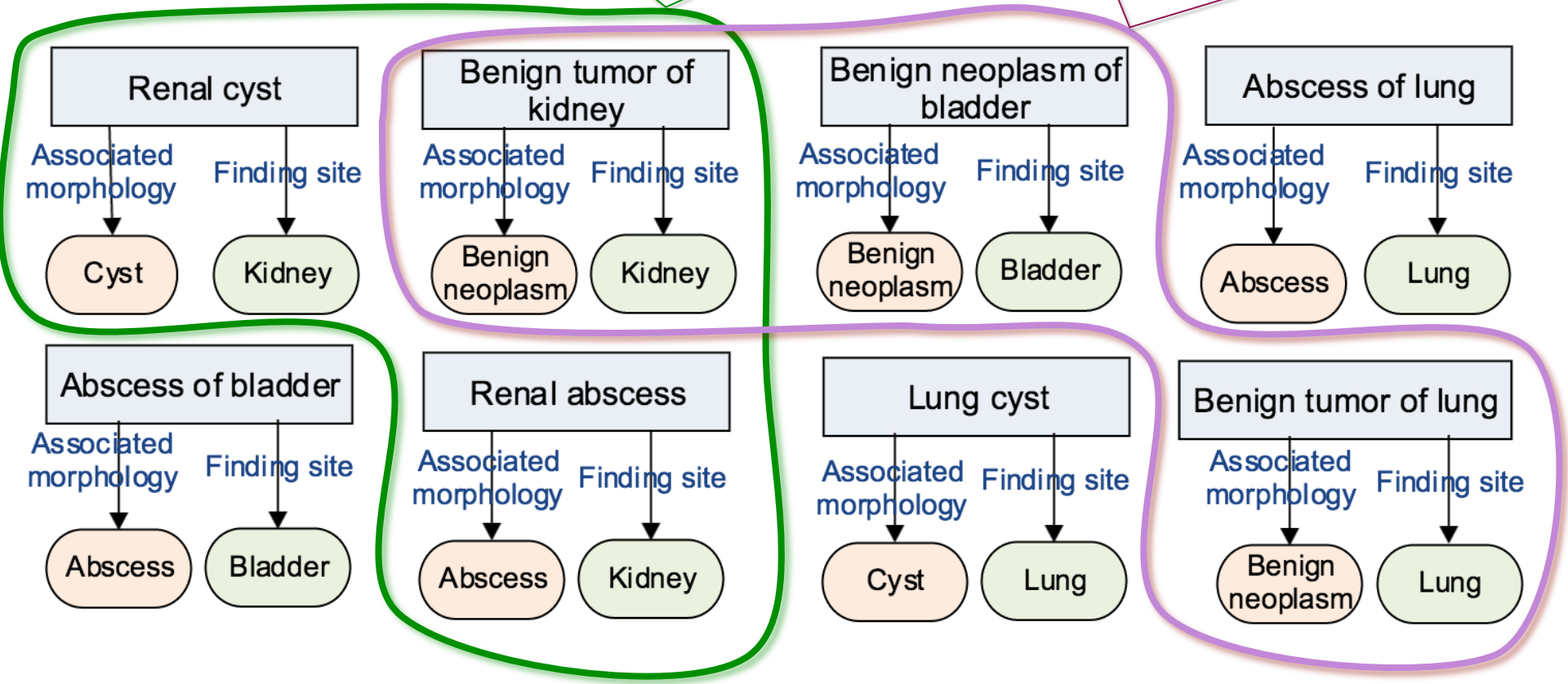
- Represent a characteristic of the meaning of a concept
- More than 50 attributes, including:
  - 363698007 |Finding site|
  - 116676008 |Associated morphology|
  - 246075003 |Causative agent|
  - 363704007 |Procedure site|
  - 260686004 |Method|
  - 272741003 |Laterality|
- Concept Model provides rules
- Implementation approaches include
  - Using the distributed Relationships file
  - Using a Description Logic Reasoner

Defining Relationships – Example

Queries Based on Computable Meaning

Query: Disorders with finding site kidney

Query: Disorders with associated morphology benign neoplasm



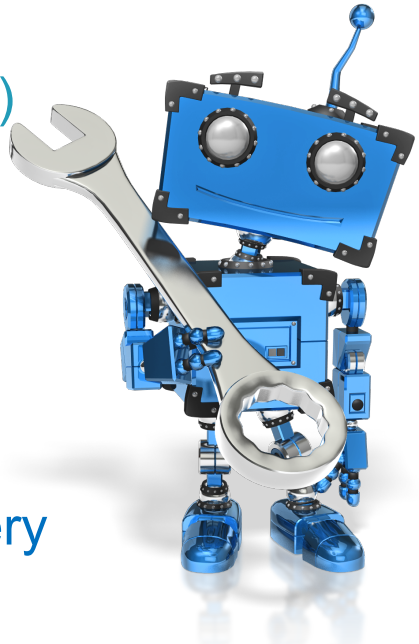
Defining Relationships – Example

< 404684003 |Clinical finding|:
116676008 |Associated morphology| = << 3898006 |Benign neoplasm|
AND 363698007 |Finding site| = << 64033007 |Kidney structure|

Concept ID	Preferred Term
254925008	Benign tumor of renal calyx
254919009	Cortical adenoma of kidney
269489006	Benign tumor of renal parenchyma
254920003	Cystadenoma of kidney
254922006	Oncocytoma of kidney
276866009	Benign tumor of pelviureteric junction
254927000	Benign papilloma of renal pelvis
92319008	Benign neoplasm of renal pelvis
307618001	Juxtaglomerular tumor
254923001	Hemangiopericytoma of kidney
254921004	Angiomyolipoma of kidney
92165001	Benign neoplasm of kidney

Description Logic

- SNOMED CT semantics are based on Description Logic
- This enables
  - The automation of reasoning across SNOMED CT
  - The implementation of more powerful analytics operations
    - Testing subsumption and equivalence
    - Testing defining attribute values
    - Property chaining
    - Advanced reasoning (concrete values and GCIs)
- Implementation
  - Translate SNOMED CT into OWL 2
    - Use Perl transform script
  - Load OWL files into a DL enabled service
  - Use DL reasoner – e.g. FACT++, ELK, Snorocket
  - Semantic query languages – e.g. SPARQL, DL Query



Terminology APIs and Services

- Used to request the execution of SNOMED CT queries by SNOMED CT enabled terminology server
- Standards
  - SNOMED International's Snapshot REST API
  - HL7 FHIR Terminology Services
- Proprietary
  - B2i's Snow Owl Terminology Server

Patient Record Queries with SNOMED CT and SQL

Query options

- List all possible SNOMED CT codes in query

```
SELECT DISTINCT patientID FROM ProblemList
 WHERE code IN (140004, 181007, 222008, 490008 etc)
```

- Load SNOMED CT subset into a separate table

```
SELECT DISTINCT patientID FROM ProblemList
 WHERE code IN (SELECT code FROM RespiratoryDisorders)
```

- Use Transitive Closure Table to test susumption

```
SELECT DISTINCT patientID FROM ProblemList PL
 INNER JOIN TransitiveClosure TC ON TC.sourceId = PL.code
 WHERE TC.targetId = 50043002
```

- Embed a terminology query language in record query

```
SELECT DISTINCT patientID FROM ProblemList
 WHERE code in (< 50043002 |disorder of respiratory system|)
```

Queries over Patient Records

Query

Retrieve

```
SELECT patientId FROM health_records
    WHERE diagnosis =
        (<< 73211009 |diabetes mellitus|)
```

Select patients with diabetes

Patient Records

Patient Id	Date	Diagnosis
456872	29th Apr 2012	73211009
456872	4th Jul 2014	44065006
456872	18th Sep 2014	237599002

<< 73211009 |diabetes mellitus|

Terminology Service

73211009 |diabetes mellitus|

46635009 |type 1 diabetes mellitus|

44054006 |type 2 diabetes mellitus|

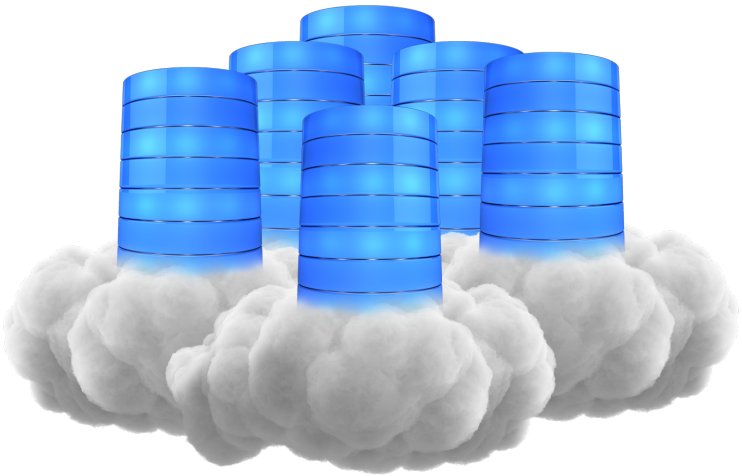
23045005 |insulin dependent diabetes mellitus type 1A|

28032008 |insulin dependent diabetes mellitus type 1B|

237599002 |insulin treated type 2 diabetes mellitus|

Querying “Big Data”

- Large volumes of structured and unstructured data sets
- Tools for distributed storage and processing of big data
  - NoSQL (Not Only SQL) systems – e.g. RDFox
    - Store and retrieve data in a variety of structures, including relational, key-value, graph or documents
  - Apache Hadoop
    - Open source software which splits files into large blocks and distributes these blocks amongst nodes in cluster
    - Processes nodes in parallel; supports horizontal scaling



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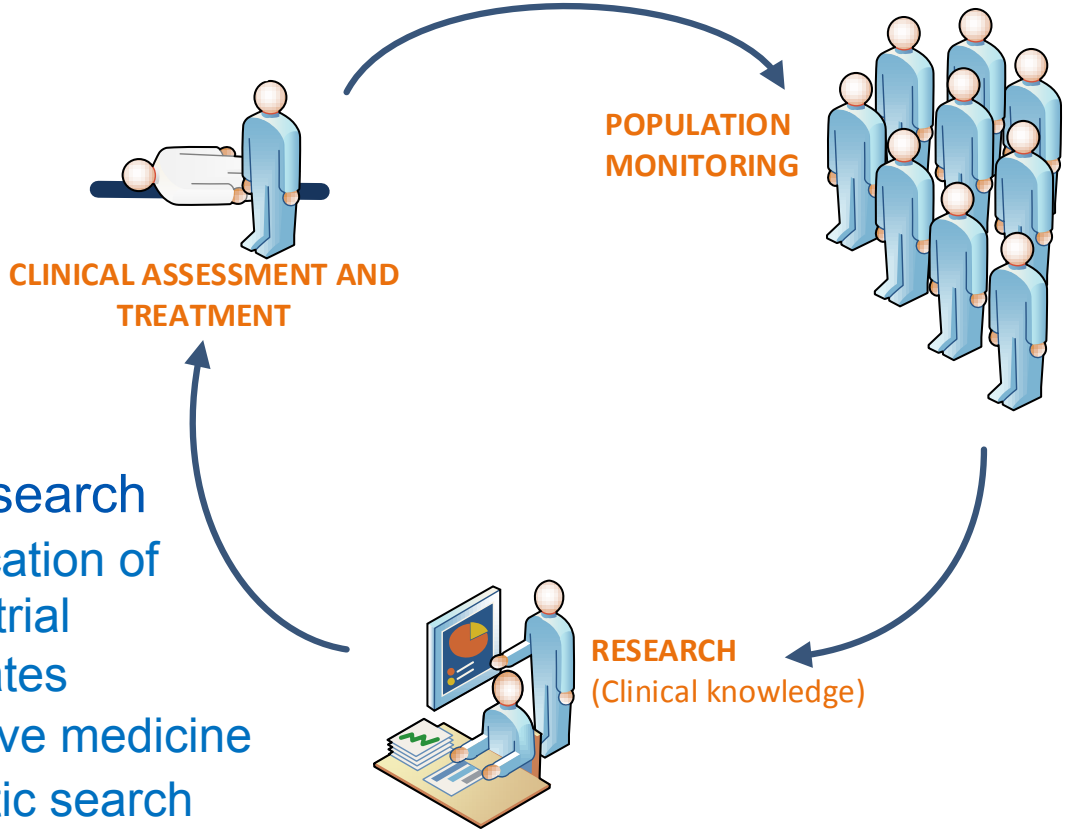
Data Analytics Tasks

SNOMED CT Analytics Tasks

- Point of care analytics
  - Historical summaries
  - Point of care reporting
  - Clinical decision support
- Population based analytics
  - Trend analysis
  - Pharmacovigilance
  - Clinical audit



- Clinical research
  - Identification of clinical trial candidates
  - Predictive medicine
  - Semantic search

Point of Care Analytics

- Historical Summaries
  - Summaries of a patient's clinical history
  - Aggregated data from various institutions, models & code systems
  - SNOMED CT Techniques
    - SNOMED CT as a common reference terminology (mapping)
    - Encode free text clinical data (NLP)
    - Group codes into more general categories (subsumption)
    - Use defining relationships to filter relevant records

Point of Care Analytics

- Point of Care Reporting
  - SNOMED CT enables ‘collect once and use many times’ goal
  - Examples include
    - Helping clinicians remember preventative services (reminders)
    - Identifying patients with care gaps and risk factors
    - Monitoring patient compliance with prescribed treatments
    - Reporting clinical data to disease registries
  - SNOMED CT techniques
    - Mapping to SNOMED CT, Subsets, Subsumption, Defining Relationships, Description Logic, Mapping to classifications

Population-based Analytics

- Trend Analysis
  - The process of extracting underlying patterns or trends in data
  - Can be used to detect changes in incidence or prevalence of a disease, treatment, procedure or intervention over time
    - For population health monitoring, prediction of demand, and effective resource allocation
  - SNOMED CT techniques
    - Subsumption testing using SNOMED CT's polyhierarchy
      - Helps to distinguish minor changes in coding style from real changes in disease incidence
      - Which level of aggregation to use can be arbitrary
  - UK Data Migration Workbench
    - Identifies most frequently used types of codes using a novel algorithm where each subtree has around 1% of all codes

Population-based Analytics

- Pharmacovigilance
  - Collection, detection, assessment, monitoring and prevention of adverse effects with pharmaceutical products
  - Uses a number of data sources including
    - Clinical trial data, Medical literature, Reporting databases, Prescription events, Electronic Health Records, Patient registries
  - SNOMED CT Techniques
    - NLP and mapping to support homogeneous approach to querying diseases, signs, symptoms, lab results, medications, devices, procedures, allergies, adverse reactions, body sites and substances
    - Subsumption and defining relationships
    - Maps to MedDRA for alternative form of analysis

Population-based Analytics

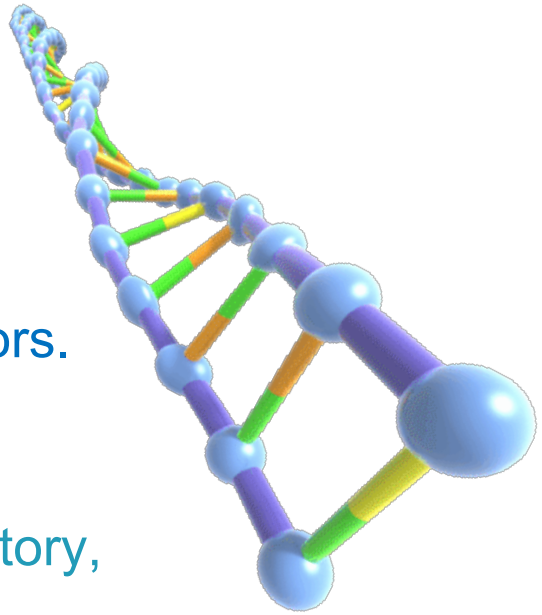
- Clinical Audit
  - Seeks to improve patient care and outcomes through systematic review of care against defined standards and the implementation of change
  - Questions asked in audit may include
    - What proportion of patients invited to attend cervical screening did so?
    - How many patients with ischemic heart disease are receiving appropriate drug treatments?
    - Are all patients with diabetes mellitus reviewed within a stated time interval?
  - SNOMED CT Techniques
    - NLP, Mapping, Subset, Subsumption, Defining relationships, Description Logic

Clinical Research

- Identification of Clinical Trial Candidates
  - For recruitment into formal clinical trials
  - SNOMED CT techniques
    - Subsets of findings, procedures or medications
    - Subsumption
    - Defining relationships – for example:
      - Patients with diseases of specific anatomical site or morphology
      - Patients taking medications with specific ingredients or forms
      - Patients who have had procedures on a specific body site
    - Description Logic

Clinical Research

- Predictive Medicine
  - Predicting the probability of disease and implementing measures to either prevent or significantly decrease its impact, such as
    - Lifestyle modifications
    - Increased physician surveillance
      - E.g. Regular skin exams, mammograms, colonoscopies
  - Focuses on genetic markers, phenotypic, environmental factors and other lifestyle factors.
  - SNOMED CT can help with
    - Identifying clinical trial candidates
    - Analyzing clinical data, such as family history, lifestyle and environmental findings
    - Linking patient data and risk assessment rules, so that rules can be triggered based on codes recorded in clinical data



Clinical Research

- Semantic Search
  - Searching medical literature and clinical reports
  - Indexes collections of free text transcripts and documents
  - Supports topic specific searches – for example:
    - Show me articles related to inflammatory bowel disease
    - Does this patient have transcripts in their record suggesting a heart rhythm disturbance?
  - SNOMED CT techniques
    - Synonyms (vocabulary mismatch)
    - Subsumption (granularity mismatch)
    - Defining relationships (conceptual implication)
    - Subsets (inferences of similarity)
    - Assign weight to each relationship type to determine relevance of each document

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Challenges

Challenges for Clinical Analytics

- Reliability of patient data
- Terminology / information model boundary issues
- Concept definition issues
- Versioning

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Clinical Decision Support with SNOMED CT

Overview

- Introduction
- Data analytics
  - Preparing data
  - Techniques
  - Tasks
  - Challenges
- Decision Support
  - Introduction
  - Logical architecture
  - How SNOMED CT helps
- Case studies

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Introduction

What is Clinical Decision Support (CDS)

- How does it enhance your decision making?
  - Helps healthcare providers make
    - More informed decisions
    - Faster
- What information does it provide?
  - Supplies patient-specific information, guidance, and knowledge
- When can it be used?
  - At relevant points in the patient journey, such as
    - Diagnosis
    - Treatment
    - Follow-up

Clinical Decision Support Systems (CDSS)

- A system which IMPROVES the decision making process
- By responding to TRIGGERS at the right time, such as
  - Specific diagnoses
  - Laboratory results
  - Medication choices
  - Complex combinations of these
- Provides information RELEVANT to an encounter

*Definition from U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality

Types Of CDS

- Alerts

- Clinical guidelines / reference information

- Conditional order sets / pathway support

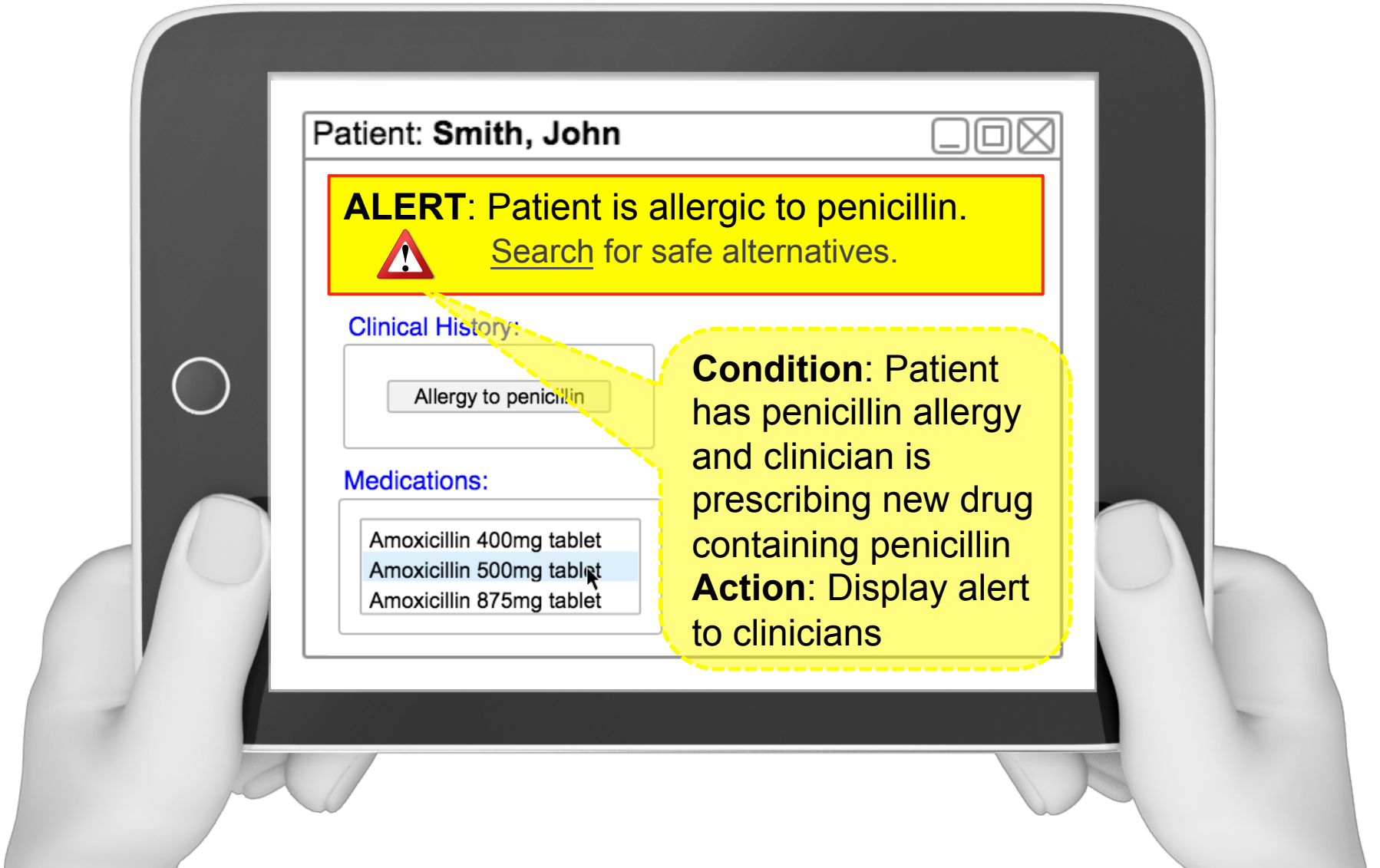
- Automatically triggered reports, summaries, or smart forms

- Diagnostic support tools

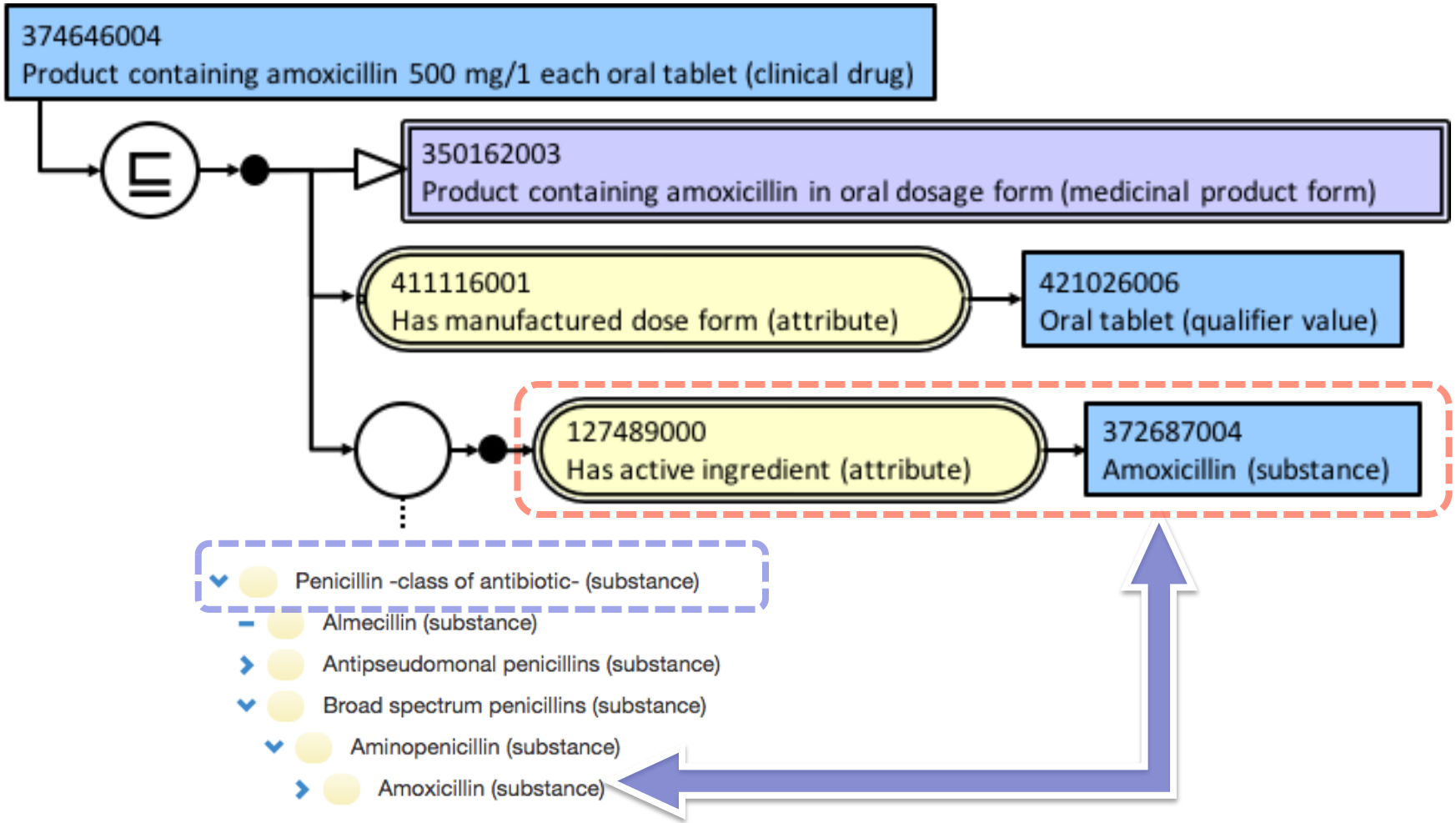
Clinical Areas Where CDS is Used

- Medication management
- Diagnosis (e.g. diabetes)
- Laboratory results
- Radiology
  - *Contraindication*
  - *Appropriate imaging*
- Emergency department
- Infectious disease reporting
- Chronic asthma management
- Nursing interventions
- Clinical treatment audit (e.g. quality improvement)
- *And many more…*

CDS Example – Penicillin Allergy Alert



Using SNOMED CT – Penicillin Allergy Alert



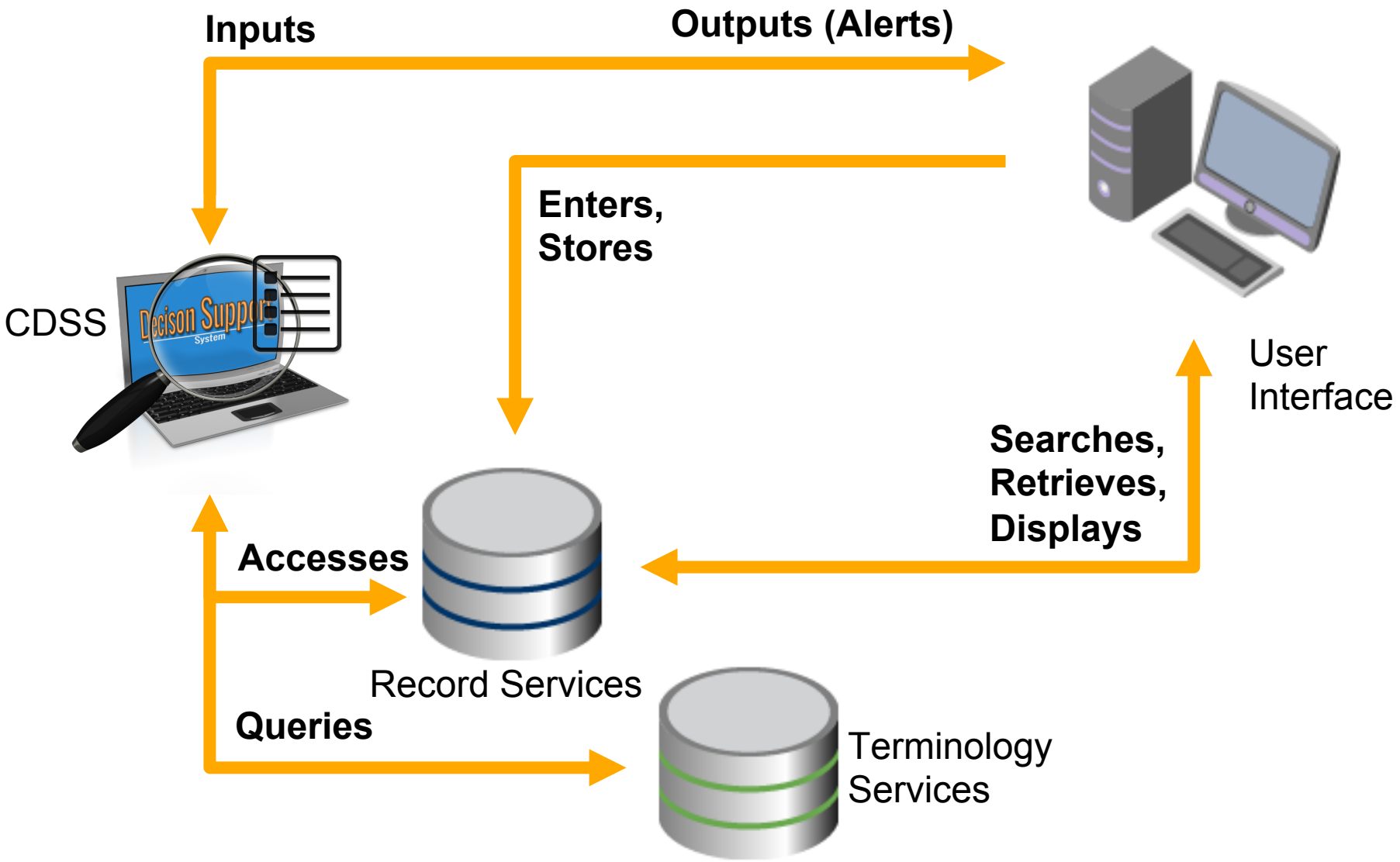
< 373873005 |Pharmaceutical / biologic product|:
127489000 |Has active ingredient| = << 373270004 |Penicillin|

Logical Architecture

Components of an EHR with CDS

- User Interface
  - For inputs (e.g. medication order) and outputs (e.g. alerts)
- Record Services
  - Stores health records
  - Responds to health records queries
- Terminology Services
  - Responds to system queries
- Clinical Decision Support System
  - Executes decision support logic

How the Components Work Together



CDSS High Level Architecture

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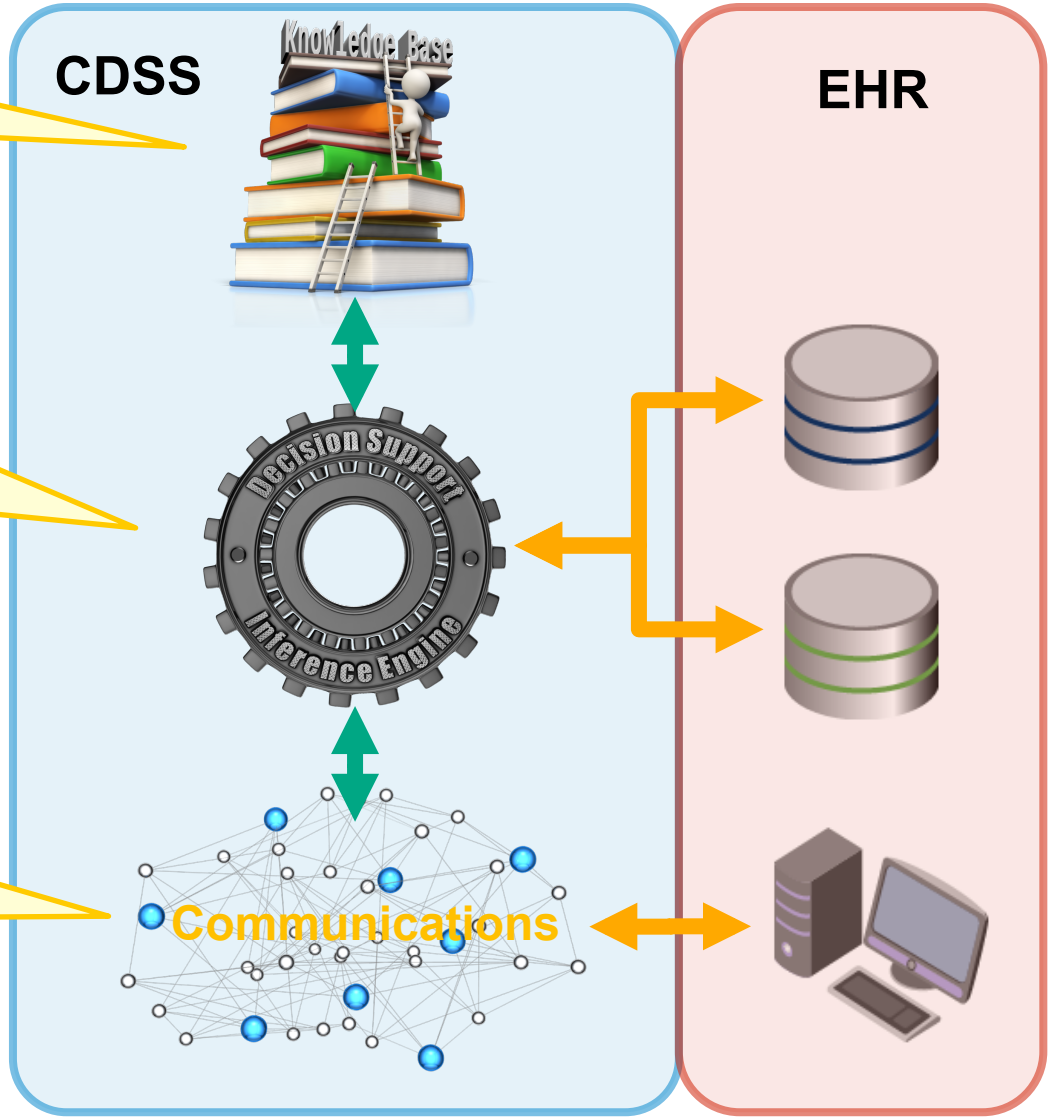
Knowledge Base

Inference Engine

Communications



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Knowledge Base

Knowledge Base – The Brains of a CDSS

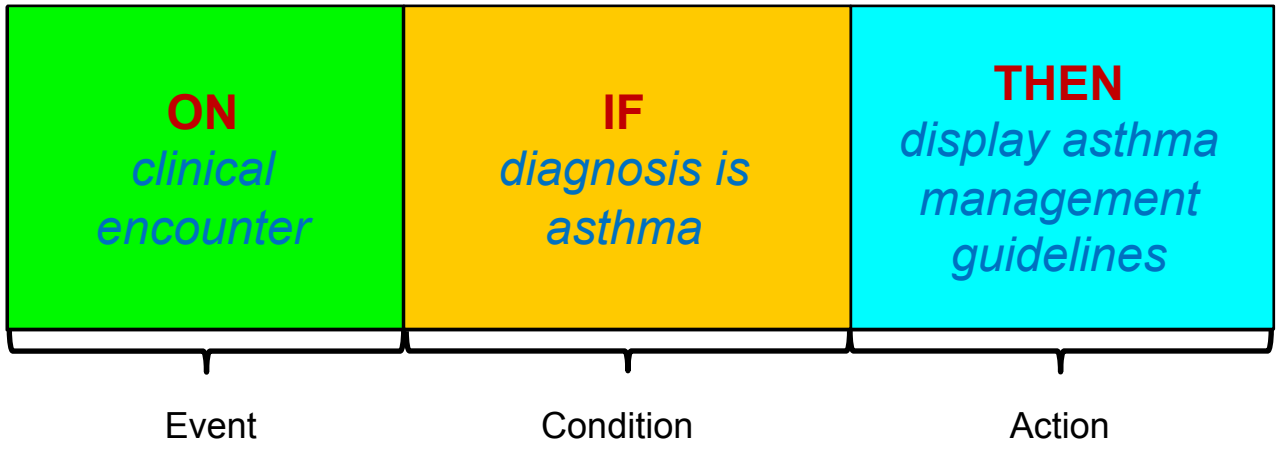
Clinical Knowledge:
Documented

Rules and Guidelines:
Loaded

CDS Logic:
Executed

Machine Readable Rules and Guidelines:
Processed

Knowledge Base – Rules



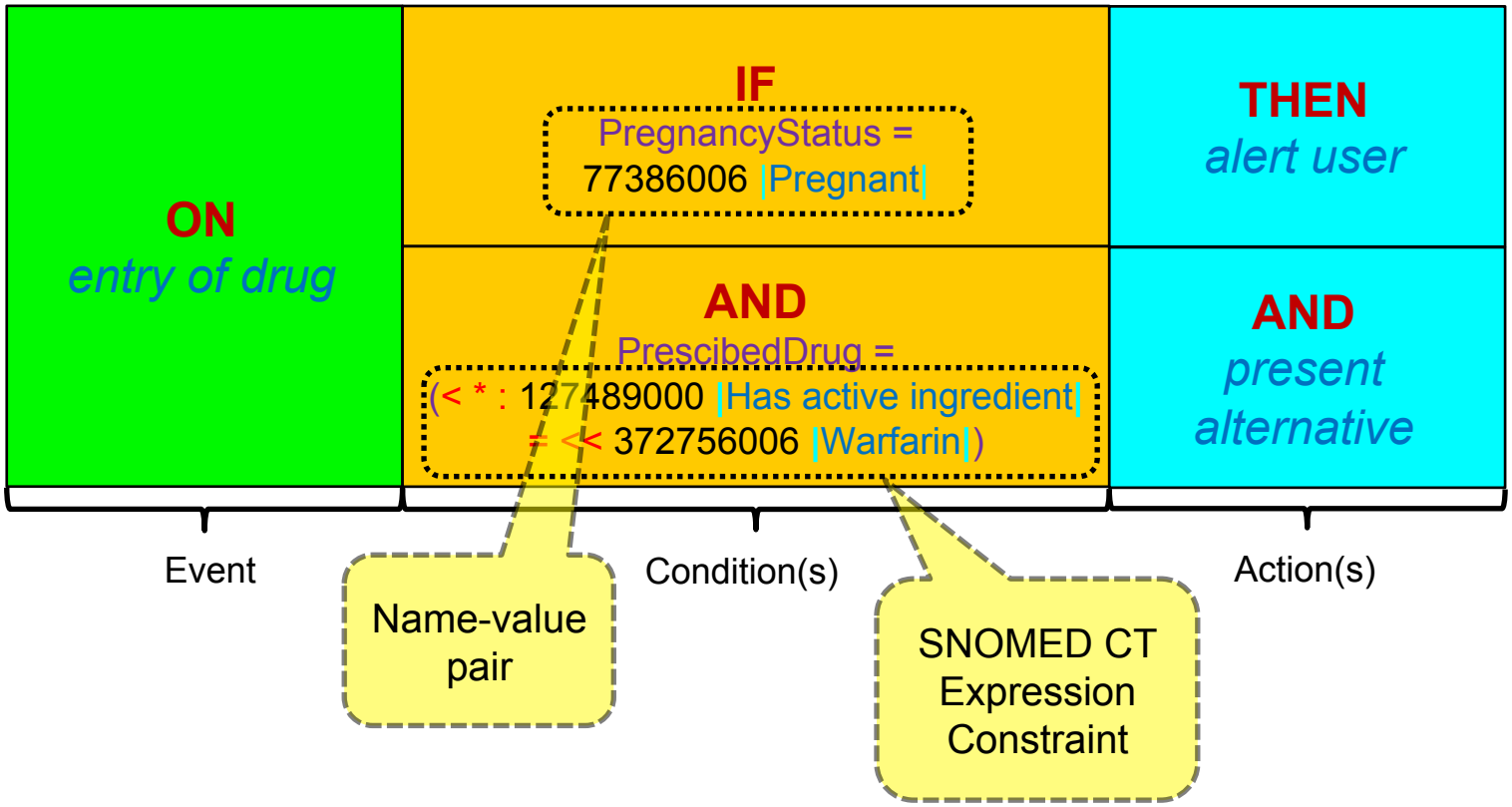
Note: Rules may reference both health records and terminology

Rules – Additional Considerations

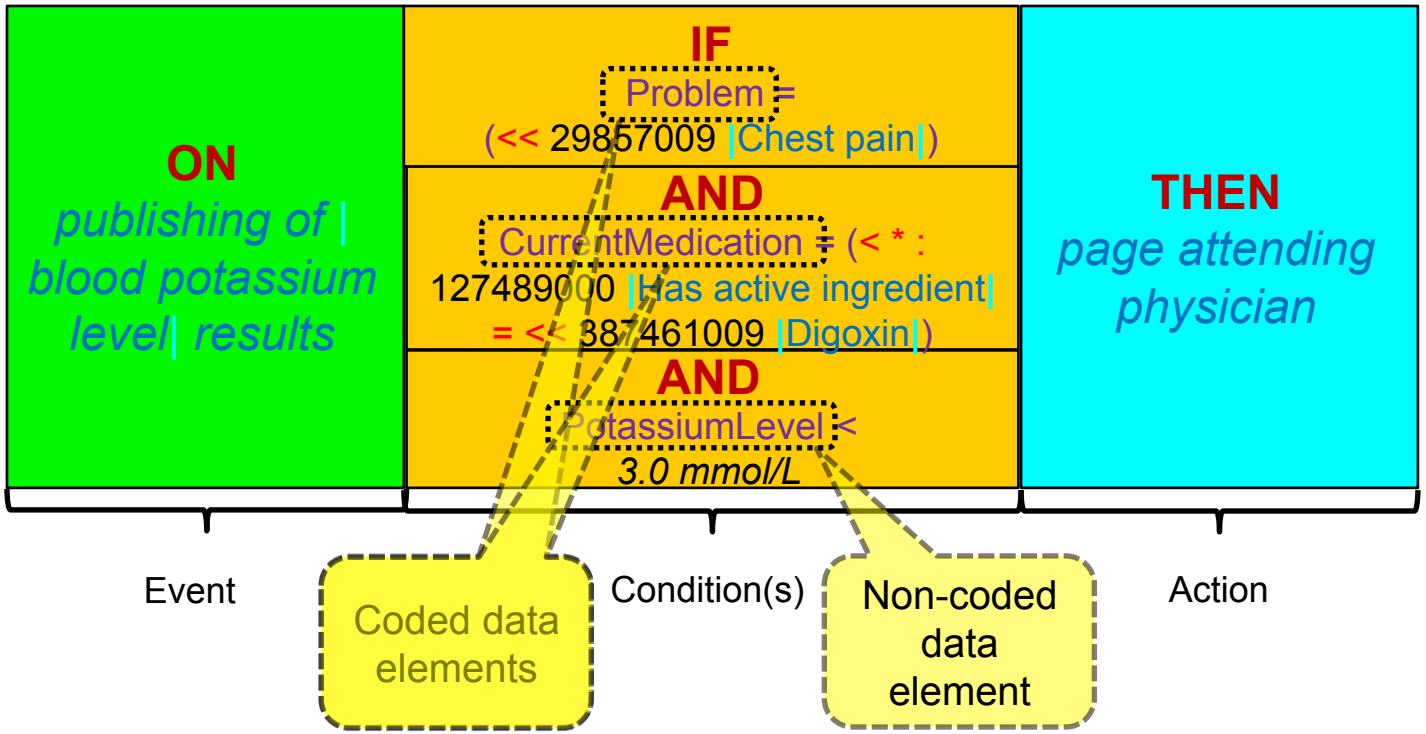
- Rules can have multiple conditions and actions
- Together, the conditions in a rule form the rule criteria
- Each condition consists of a name-value pair

Criterion Name	Criterion Value
Pregnancy status	|Pregnant|
Drug prescribed	|Codeine|
Hematocrit result	41 |%|

Example: Medication Order



Example: Emergency Department



Knowledge Base Guidelines – Linking Guidelines to SNOMED CT

SNOMED CT Semantic Tagging:

195967001 |Asthma (disorder)|
406162001 |Asthma management (regime/therapy)|
445531003 |Asthma control questionnaire (assessment scale)|

Document header (contains concept identifiers)

STEPWISE APPROACH FOR MANAGING ASTHMA LONG TERM

The stepwise approach tailors the selection of medication to the level of asthma severity (see page 5) or asthma control (see page 6). The stepwise approach is meant to help, not replace, the clinical decisionmaking needed to meet individual patient needs.

ASSESS CONTROL:

STEP UP IF NEEDED (first, check medication adherence, inhaler technique, environmental control, and comorbidities)

STEP DOWN IF POSSIBLE (and asthma is well controlled for at least 3 months)

		STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6
	At each step: Patient education, environmental control, and management of comorbidities						
0–4 years of age		**Intermittent Asthma**	**Persistent Asthma: Daily Medication** Consult with asthma specialist if step 3 care or higher is required. Consider consultation at step 2.				
	Preferred Treatment†	SABA* as needed	low-dose ICS*	medium-dose ICS*	medium-dose ICS* + either LABA* or montelukast	high-dose ICS* + either LABA* or montelukast	high-dose ICS* + either LABA* or montelukast + oral corticosteroids
	Alternative Treatment†‡		cromolyn or montelukast				
	If clear benefit is not observed in 4–6 weeks, and medication technique and adherence are satisfactory, consider adjusting therapy or alternate diagnoses.						
	Quick-Relief Medication	▪ SABA* as needed for symptoms; intensity of treatment depends on severity of symptoms. ▪ With viral respiratory symptoms: SABA every 4–6 hours up to 24 hours (longer with physician consult). Consider short course of oral systemic corticosteroids if asthma exacerbation is severe or patient has history of severe exacerbations. ▪ Caution: Frequent use of SABA may indicate the need to step up treatment.					

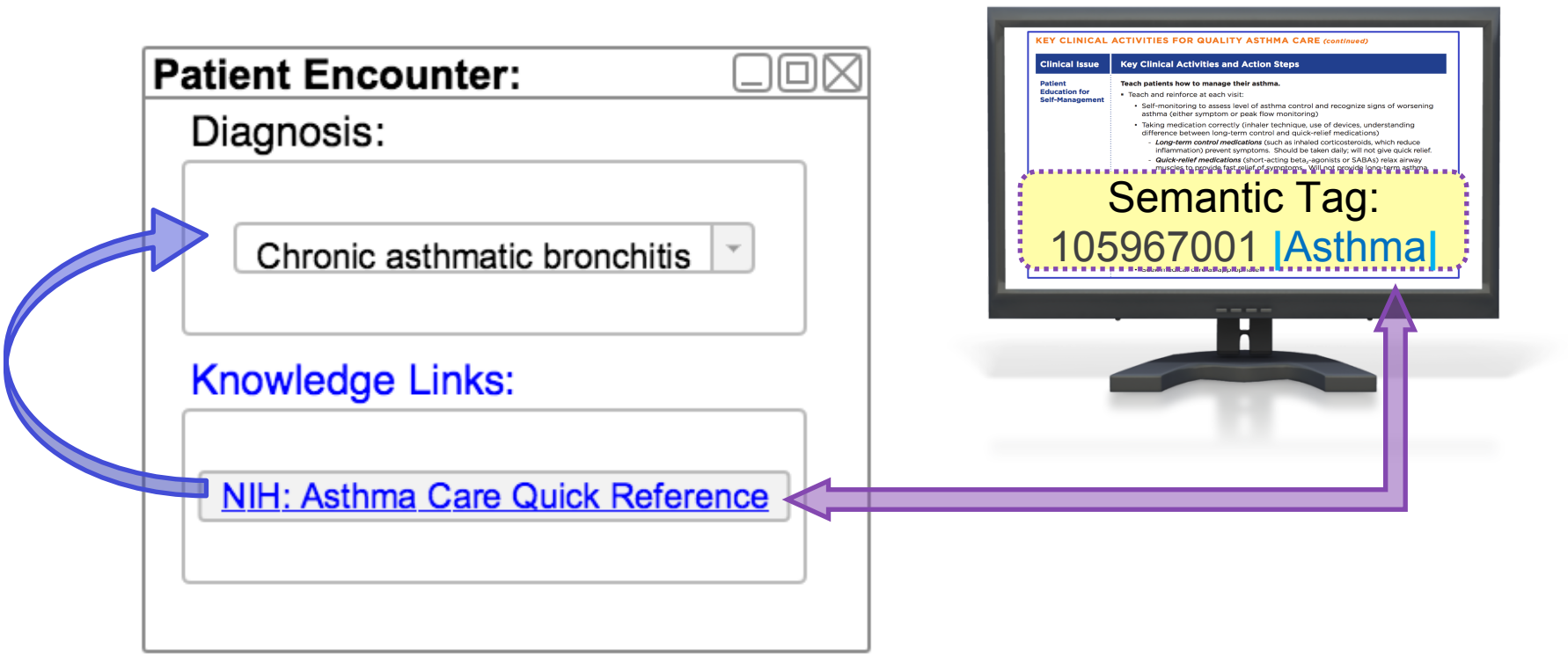
Document body (contains clinical guidelines)

*Asthma Care Quick Reference, Asthma Management Guideline (US Department of Health and Human Services, National Institutes of Health, National Heart Lung and Blood Institute)

Selecting Relevant Guidelines

IF diagnosis = <<< 195967001 |Asthma|

THEN display NIH: Asthma Care Quick Reference



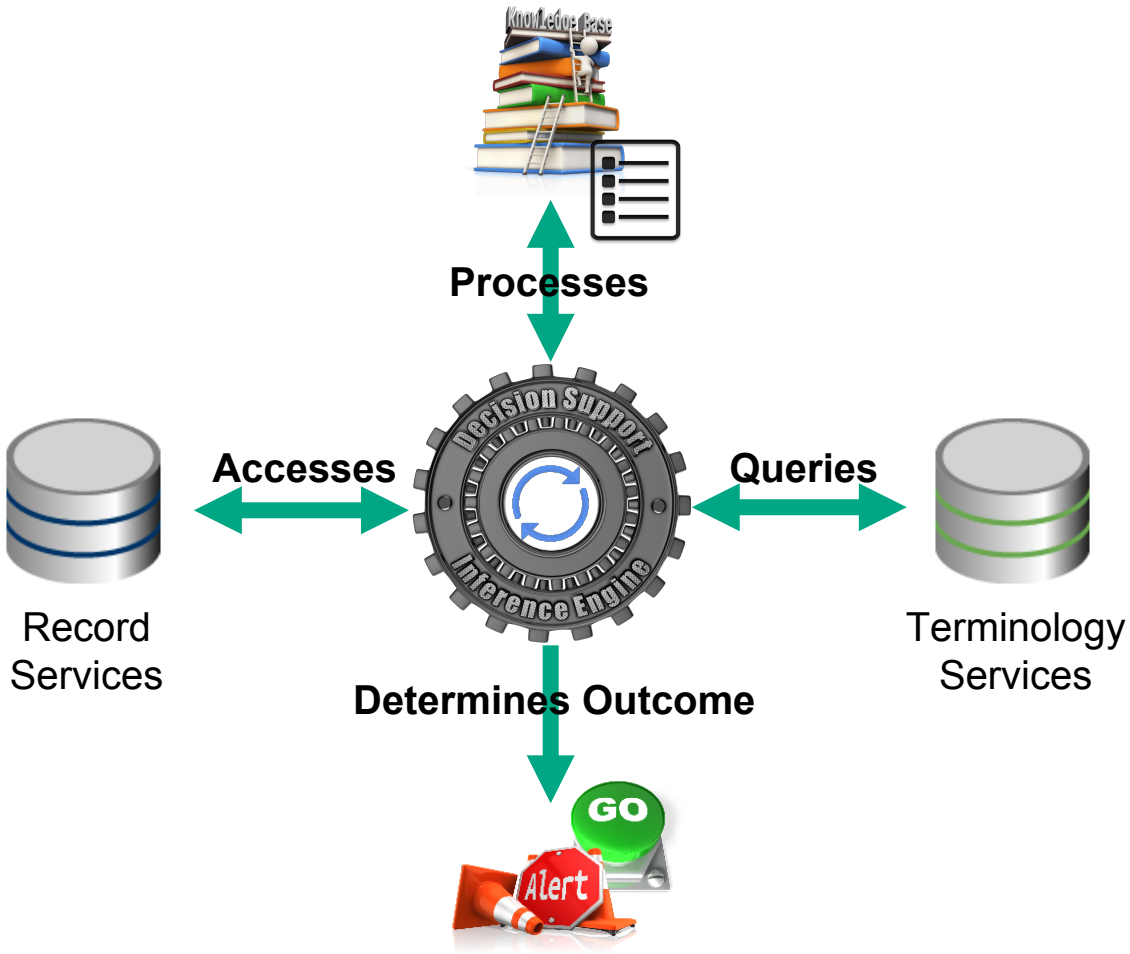
Knowledge Base – Representation Standards

- Rule representations and standards
  - Expression Constraint Language
    - http://snomed.org/ecl
  - Arden Syntax
    - HL7 Implementation Guide for Arden Syntax, Release 1
  - HL7 FHIR CDS Resource
    - http://build.fhir.org/plandefinition.html or
    - http://build.fhir.org/clinicalreasoning-module.html
- Guideline definition
  - Guideline Interchange Format (GLIF)
    - https://kb.medical-objects.com.au/display/PUB/GLIF
  - Guideline Definition Language (GDL)
    - http://www.openehr.org/releases/CDS/latest/docs/GDL/GDL.html

SNOMED International

Inference Engine

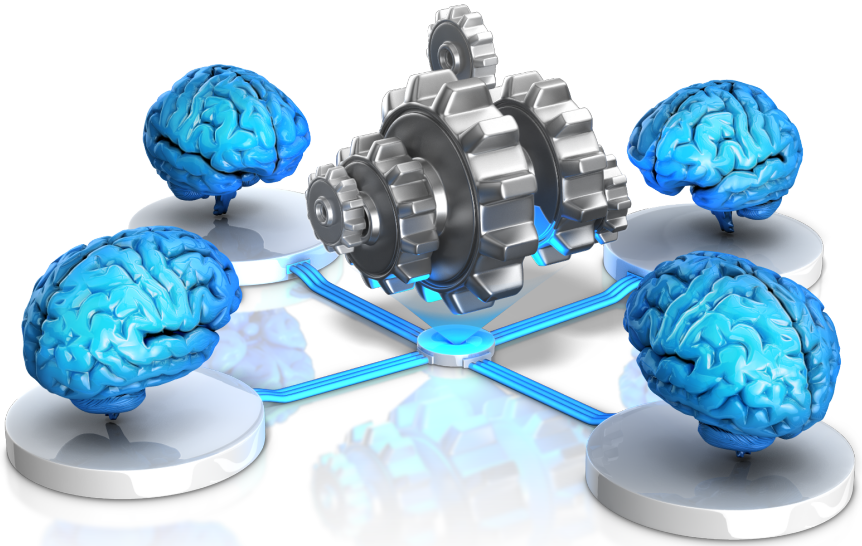
Inference Engine – The Heart of a CDSS



Reasoning with SNOMED CT

- *"The process of thinking about something in order to make a decision"*

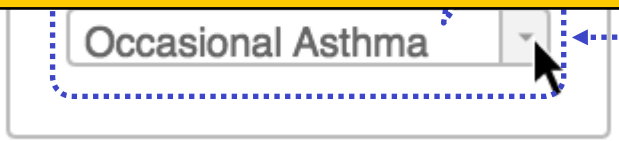
- Analytics techniques
  - Can be used by the inference engine to evaluate conditions in CDS rules
  - May include the use of
    - Subsets
    - Subsumption
    - Defining relationships
    - Description logic



Reasoning with Subsets

IF Diagnosis =
(^ 239999999106
|Asthma conditions reference set|)

THEN *display asthma management guidelines*



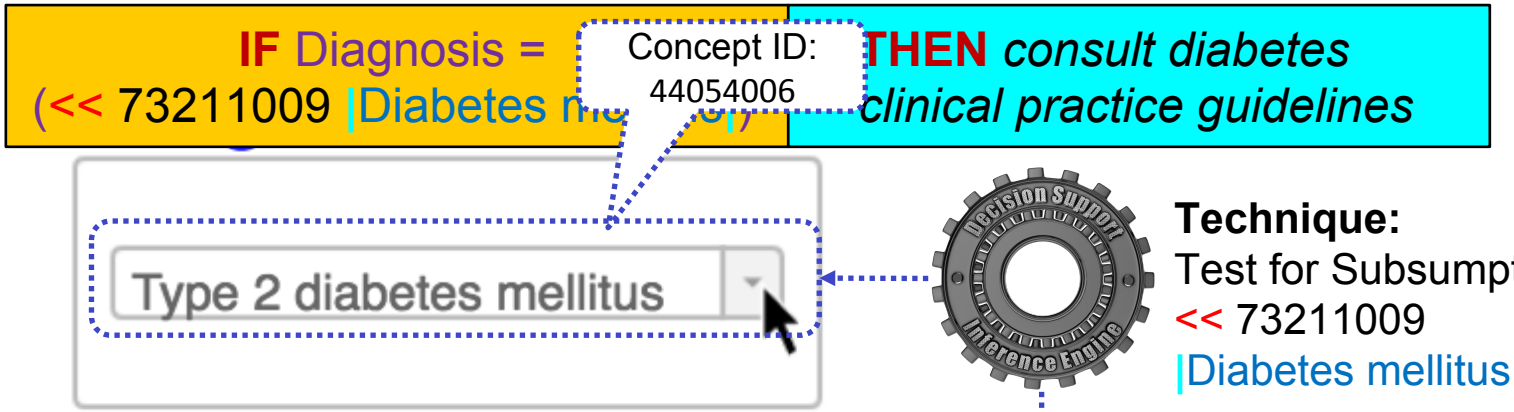
Checks for membership.
^ 239999999106 |Asthma conditions reference set|

- Match:
  - No
- Condition:
  - False
- Action:
  - Not triggered

Asthma Conditions Subset:

Id	Term
304527002	Acute asthma
389145006	Allergic asthma
233678006	Childhood asthma
445427006	Seasonal asthma
370221004	Severe asthma

Reasoning with Subsumption



Technique:
Test for Subsumption.
<< 73211009
|Diabetes mellitus|

Transitive Closure Table:

Subtype	Supertype
46635009	73211009
111552007	73211009
44054006	73211009
724136006	73211009
123763000	73211009

- Match:
  - Yes
- Condition:
  - True
- Action:
  - Triggered

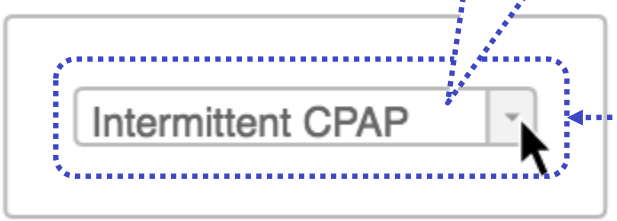
Reasoning with Defining Relationships

IF Procedure = (<< 71388002 |Procedure| : << 363704007 |Procedure site| = << 20139000 |Structure of respiratory system|)

THEN *consult respirologist*

Technique: Examine Defining Relationships.

<< 71388002 |Procedure| : << 363704007 |Procedure site| = << 20139000 |Structure of respiratory system|



SNOMED CT
Inferred Relationships Table:

sourceId	destinationId	typeId
229308003	128258000	363702006
229308003	302803009	363702006
229308003	262202000	363703001
229308003	20139000	363704007
229308003	20139000	405813007
229308003	47545007	116680003
229308003	20139000	363704007

- Match:
  - Yes
- Condition:
  - True
- Action:
  - Triggered

Accessing Clinical Records – Standards

- Quality Information & Clinical Knowledge model (QUICK)
  - http://hl7.org/fhir/us/qicore/2016Sep/
- HL7 Clinical Information Modelling Initiative (CIMI)
  - http://opencimi.org/
  - http://www.hl7.org/Special/Committees/cimi/index.cfm
- Virtual Medical Record (vMR)
  - http://www.hl7.org/implement/standards/product_brief.cfm?product_id=338
- GELLO
  - http://www.hl7.org/implement/standards/product_brief.cfm?product_id=5
  - http://gello.org

Accessing Terminology

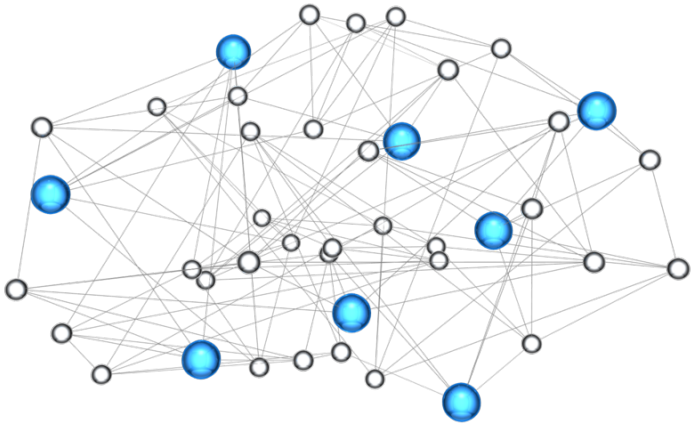
- Information about terminologies can be provided via **terminology services**

- Examples of terminology services used to execute CDS logic:
  - Find descendants of a concept
  - Find value of an attribute relationship
  - Execute rules written in Expression Constraint Language

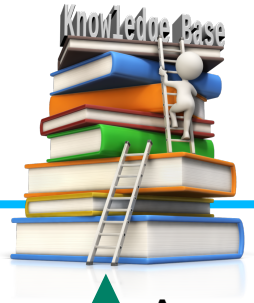
- Terminology APIs improve reusability and maintainability
  - SNOMED International's Snapshot Browser REST API
    - http://snomed.org/tools
  - FHIR Terminology Server
    - http://hl7.org/fhir/terminology-service.html

SNOMED International

Communications



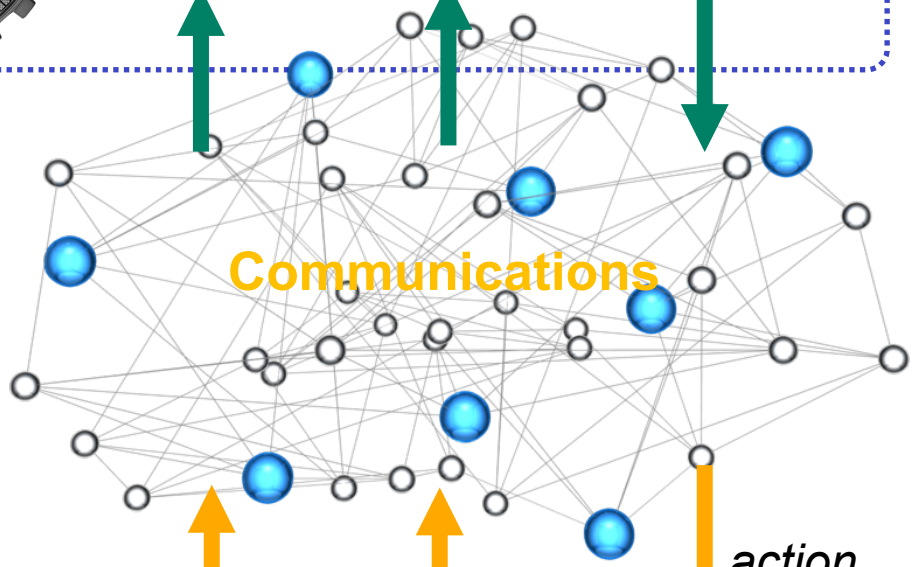
Communications



Access CDS rule

Execution of CDS rule

ON	IF	THEN
event	*condition*	*action*

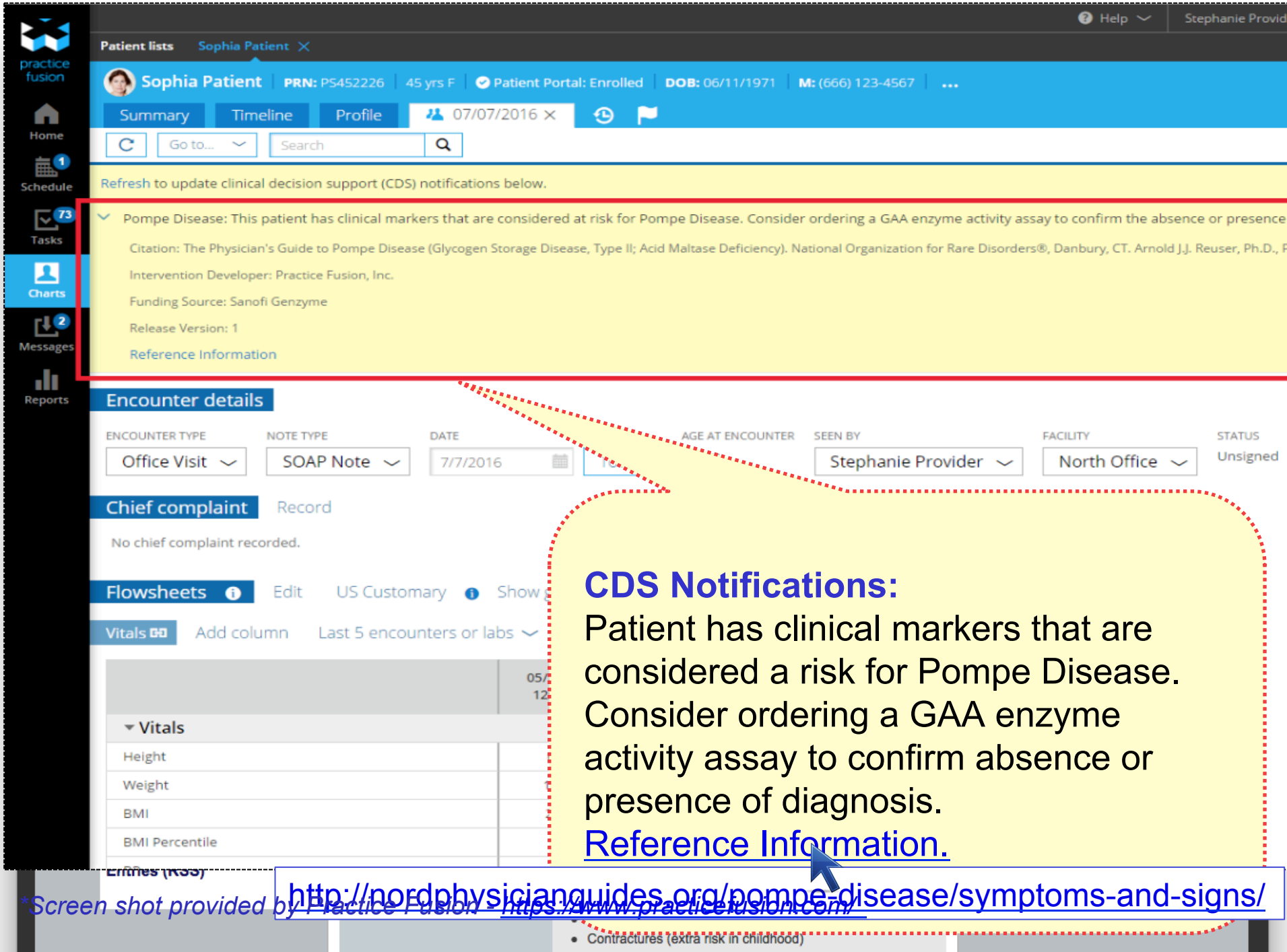


action

criterion values

event

User Interface



CDS Notifications:

Patient has clinical markers that are considered a risk for Pompe Disease. Consider ordering a GAA enzyme activity assay to confirm absence or presence of diagnosis.

Reference Information.

http://nordphysicianguides.org/pompe-disease/symptoms-and-signs/

*Screen shot provided by Practice Fusion - https://www.practicefusion.com/

Communications – Alert Fatigue

- Alert fatigue – **unwanted side effect** of CDS
- Clinicians become overwhelmed, distracted, desensitized
- Inherent **risk of missing something** important
- Strategies to minimize alert fatigue are needed
- **SNOMED CT can help** by
  - Increasing specificity of CDS conditions
  - Distinguishing between different types of interventions

Highlights

Features of SNOMED CT

- Link patient records to
  - Decision support rules
  - Clinical guidelines and knowledge

Knowledge Base

- Stores CDS rules and guidelines
  - SNOMED CT can be used to
    - Define conditions in rules
    - Link health records to clinical guidelines

Inference Engine

- Executes CDS logic to determine actions
  - SNOMED CT used to reason (test condition)

Communications

- Handles system inputs and outputs
  - e.g. alerts

SNOMED International

SNOMED CT Case Studies

National Institute of Health (USA)

- Largest biomedical research institution in the world
- Intramural Research Programs in 24 NIH institutes including
  - National Library of Medicine (NLM)
    - World's largest biomedical library
    - SNOMED CT National Release Centre for U.S.A.
    - Curates an extensive collection of medical knowledge used by millions of people around world
  - IRPs use SNOMED CT in their research
- Examples of IRP initiatives that use SNOMED CT include:
  - Value Set Authority Center (VSAC)
  - Medline Plus Connect
- Examples of NIH public-private partnerships include:
  - Observational Health Data Sciences and Informatics (OHDSI)

Value Set Authority Center (USA)

- An NLM service that maintains and distributes value sets defined in electronic Clinical Quality Measures (eCQMs)
- SNOMED CT value sets are used to support calculations of data quality measures, which provide feedback to clinicians about the quality of care

Medline Plus Connect (USA)

- An Infobutton resource used to request information on diagnosis (using SNOMED CT problem codes), medications, and lab tests and which returns related information from MedlinePlus

OHDSI (US)

- Observational Health Data Sciences and Informatics
  - Multi-stakeholder, interdisciplinary collaborative to bring out value of health data through large scale analytics
  - Aims to analyze medical records to better understand disease history, healthcare delivery and effects of medical interventions
  - Has access to more than 40 databases containing patient-level observational data for over 500 million people
  - http://www.ohdsi.org

OHDSI

OBSERVATIONAL HEALTH DATA SCIENCES AND INFORMATICS

OHDSI (US): Common Data Model

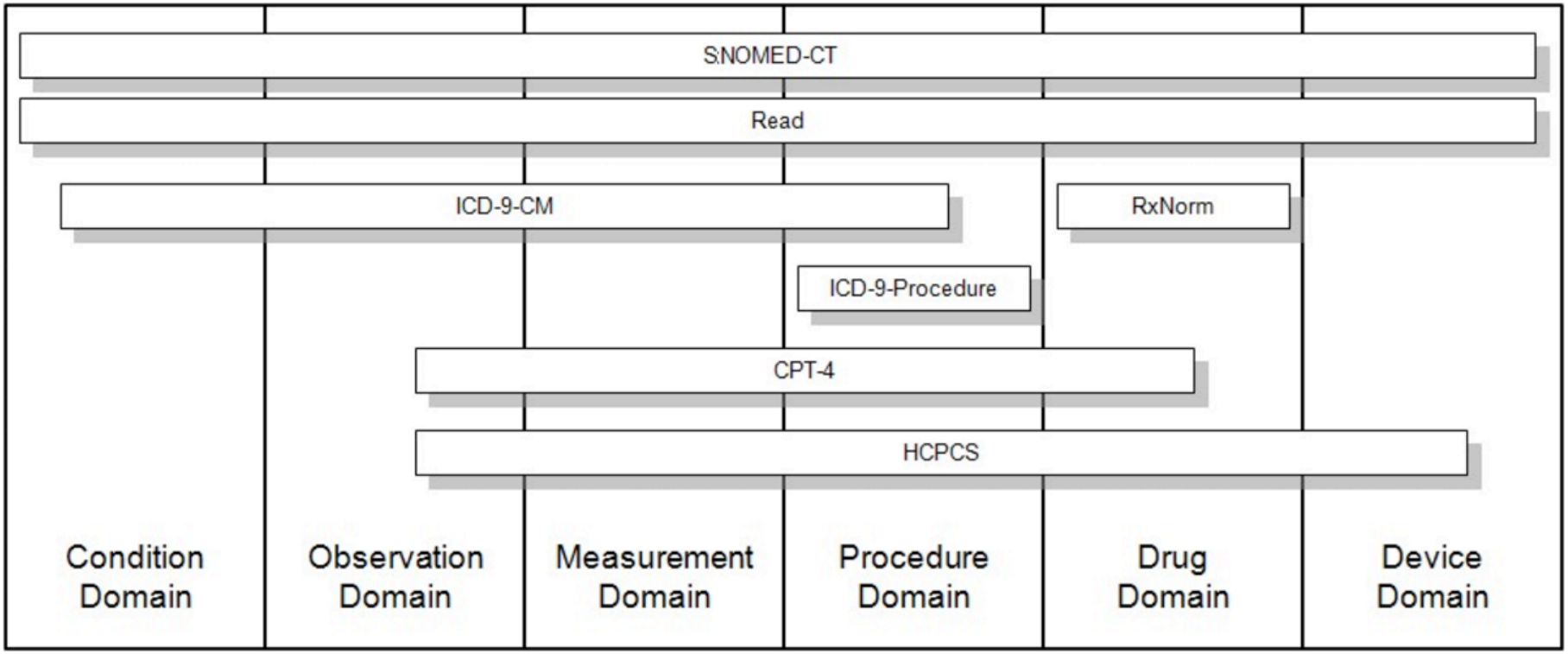
- Observational Health Data Sciences and Informatics
  - Has adopted a Common Data Model known as OMOP CDM
    - Standardizes structure and content to support a systematic and reproducible process to efficiently generate evidence
    - Used to integrate data from
      - Administrative claims, electronic health records
      - EHRs from both inpatient and outpatient settings
      - Registries and longitudinal surveys
      - Data sources both within and outside the US
  - SNOMED CT used to integrate diagnostic data

OHDSI

OBSERVATIONAL HEALTH DATA SCIENCES AND INFORMATICS

OHDSI (US): Vocabularies

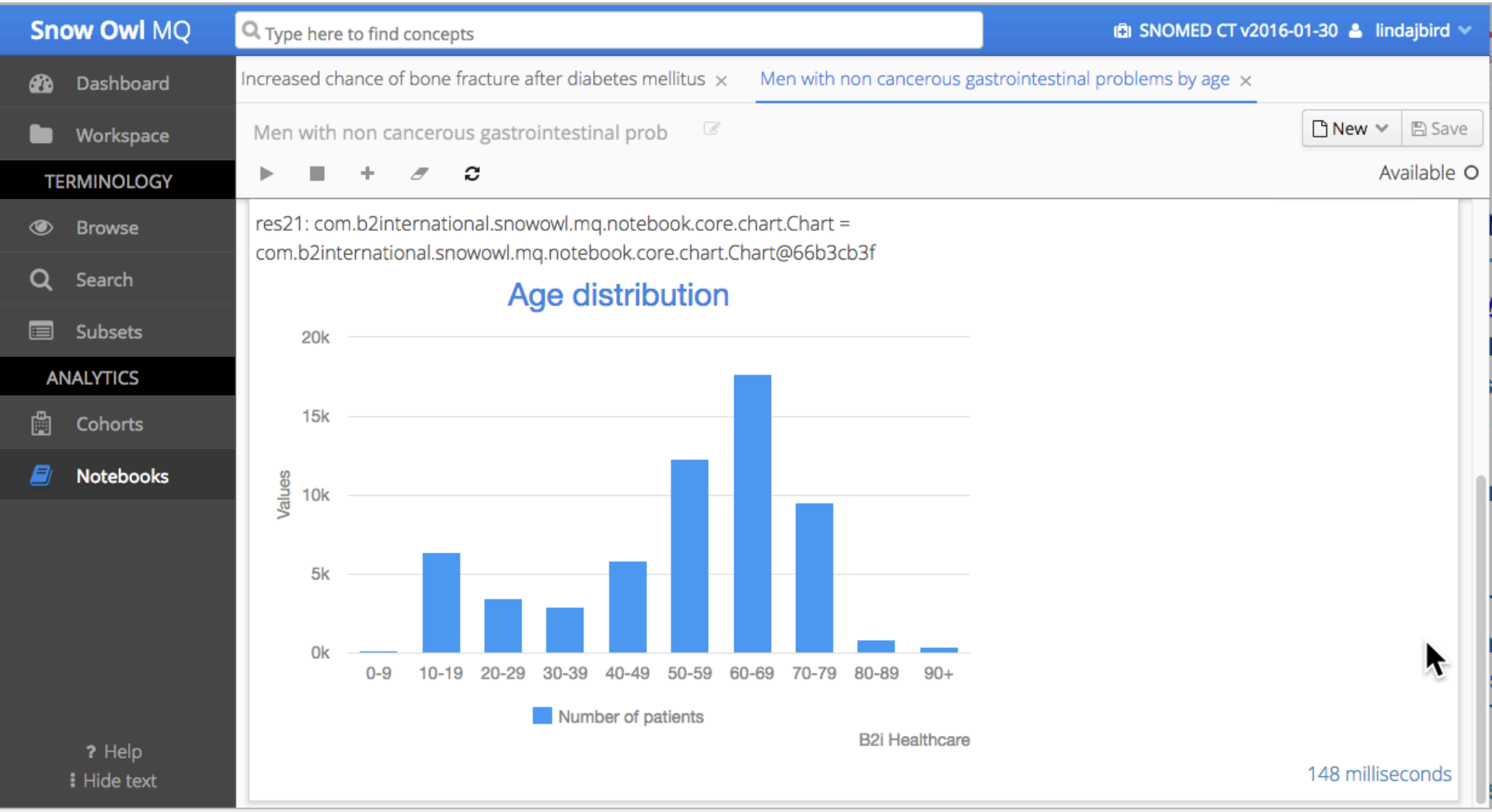
- Observational Health Data Sciences and Informatics
  - The OMOP Standardized Vocabularies combine different vocabularies that are used for different aspects of recording healthcare information (currently 81 vocabularies)



B2i Snow Owl MQ

- Online tool – https://mq.b2i.sg/snow-owl/
- A scalable big data software platform for
  - Searching and browsing health records
  - Grouping patients that share same characteristics into cohorts
  - Inspecting health records to identify trends and correlations
  - Statistical analysis of patient cohorts to test and verify clinical hypotheses
- Data extracted from EHR, transformed and loaded (ETL)
  - Internal EHR model is OMOP Common Data Model (CDM)
  - Supports over 70 different terminologies
  - Reference terminology is SNOMED CT
  - Dataset has 1.2 million patients and 43 million clinical encounters
    - Conditions, Procedures, Drug exposures

B2i Snow Owl MQ



Data Analysis & Reporting (Hong Kong)

Hong Kong Hospital Authority manages public hospitals and services, including 42 hospitals, 48 specialist outpatient clinics and 73 general outpatient clinics

Scope

- Clinical terminology tables used by all clinical systems
- Diagnosis, procedure, medication, laboratory, organisms

Why SNOMED CT

- Interest in increasing decision support and data retrieval capabilities
- Comprehensive domain coverage and underlying description logic
- Allows development of rich, criteria-based queries

Hong Kong Clinical Terminology Table (HKCTT)

SNOMED CT

ihtsdo

Diagnosis

Procedure

HKCTT

Drug

Laboratory

Others

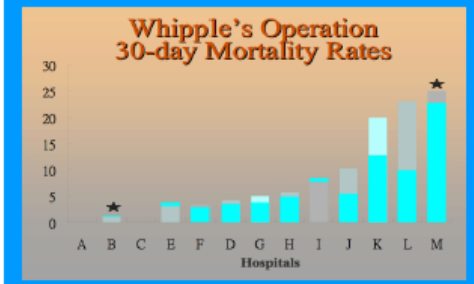
ICPC2

ICD 10

Registered Pharmaceutical Products

LOINC®

Secondary Use



Clinical Data Repository

eHR

eHR

Electronic Care Record (U.K.)

Electronic Care Record (ECR) implemented in 3 hospital sites in UK. All aspects of Cystic Fibrosis care documented using SNOMED CT. Performance and usability were assessed and benefits to patients and healthcare system quantified.

Scope

- A broad set of data elements including presenting diagnosis, health histories, examinations, microbiology, genetics, physiology, interventions, medications, allergies and pathology

Why SNOMED CT

- To correlate a patient's characteristics with causal factors
- To improve outcomes in Cystic Fibrosis care by enabling the early identification of problems
- To enable systematic analysis of clinical trends and risk factors
- To improve medication safety with drug allergy alerts
- To improve adherence to the standards of care

Rotherham NHS Trust (U.K.)

Rotherham NHS Foundation Trust operates a hospital and a large number of community services at other sites. They have introduced an electronic patient record system which utilizes SNOMED CT for diagnosis and procedure recording.

Scope

- Diagnosis & procedure data capture as part of the patient encounter.
- Uses 60 SNOMED CT subsets
- Codes then mapped to ICD-10 and OPCS-4 for national reporting.

Why SNOMED CT

- To implement the national objective of collecting data once, at source, and facilitating other processes from that data.
- SNOMED CT is the clinical code system of choice for NHS in England
- The Trust decided SNOMED CT was a good investment to:
  - Provide more useful information on outpatient activities
  - Deliver efficiency gains in the production of national reports

Links to Further Information

- Data Analytics with SNOMED CT
  - http://snomed.org/analytics
- Decision Support with SNOMED CT
  - http://snomed.org/cds
- SNOMED CT Languages
  - http://snomed.org/ecl
  - http://snomed.org/scg
- E-Learning Server
  - http://snomed.org/elearning