

SNOMED
International

Delivering
SNOMED CT

Data Analytics with SNOMED CT

SNOMED CT in Ireland

January 31st, 2022

Anne Højen and Kai Kewley
SNOMED International

snomed.org



[@snomedct](https://twitter.com/snomedct)



linkedin.com/company/ihtsdo/

Outline

- **Introduction**
 - Clinical data analytics
 - Meaning-based retrieval with SNOMED CT
- **Analytics scenarios**
 - Population health monitoring
 - Designing preventative measures
 - Assessing treatments
- **Interpreting the Results**
- **What's next?**

(Tuesday)
January 31

SNOMED
International

SNOMED International: Delivering SNOMED CT

Introduction to Data Analytics and Meaning-based Data Retrieval

snomed.org



@snomedct



[linkedin.com/company/ihtsdo/](https://www.linkedin.com/company/ihtsdo/)

Data Analytics

“The discovery and communication of meaningful patterns in data”



Data Analytics

Population health monitoring
What are the trends?

Patient care and treatment



Population health



Research



Assessing treatments
What will happen to me?

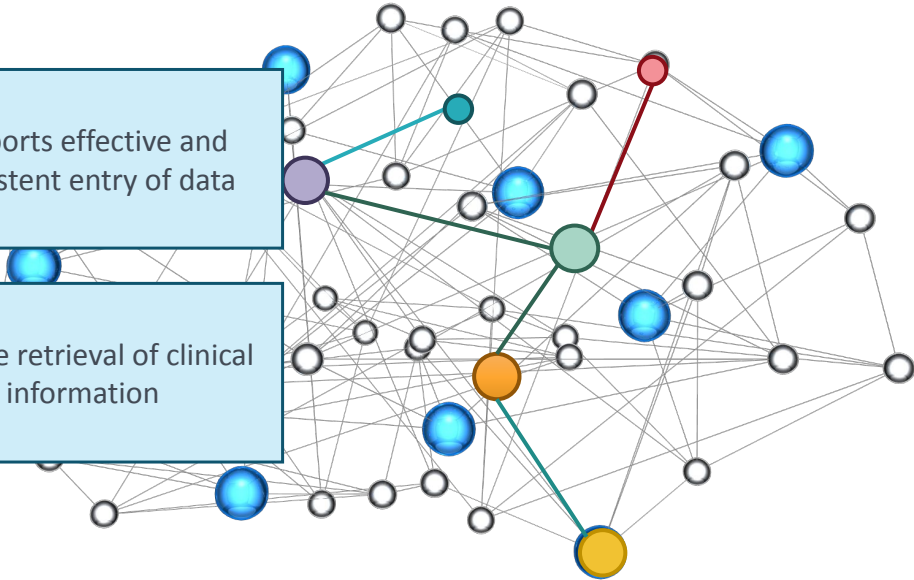


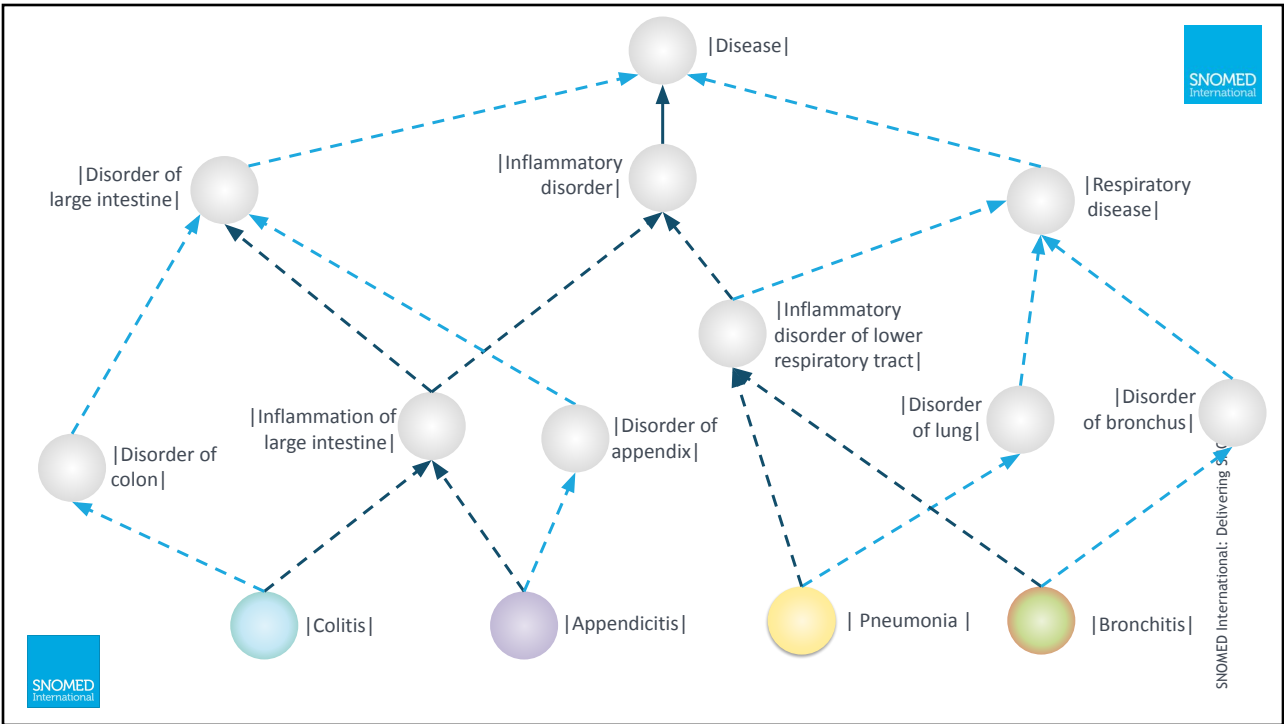
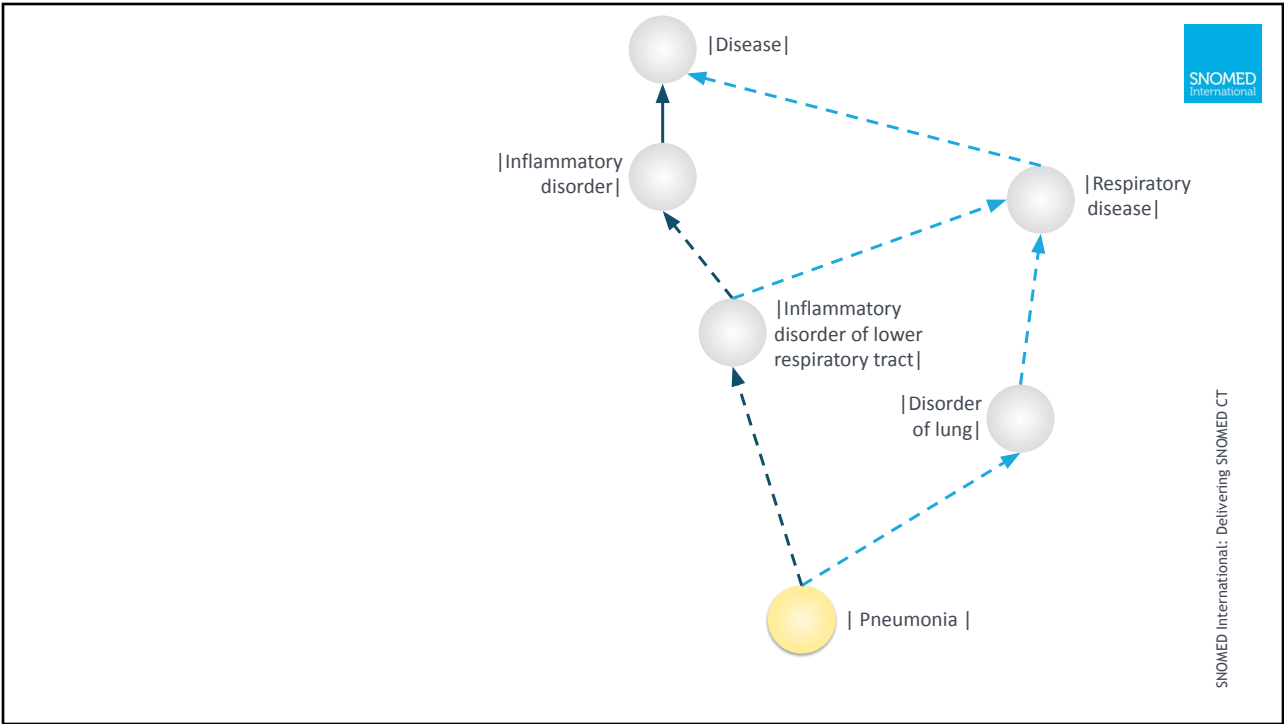
Improving the quality and efficiency of care
What are the causal effects?

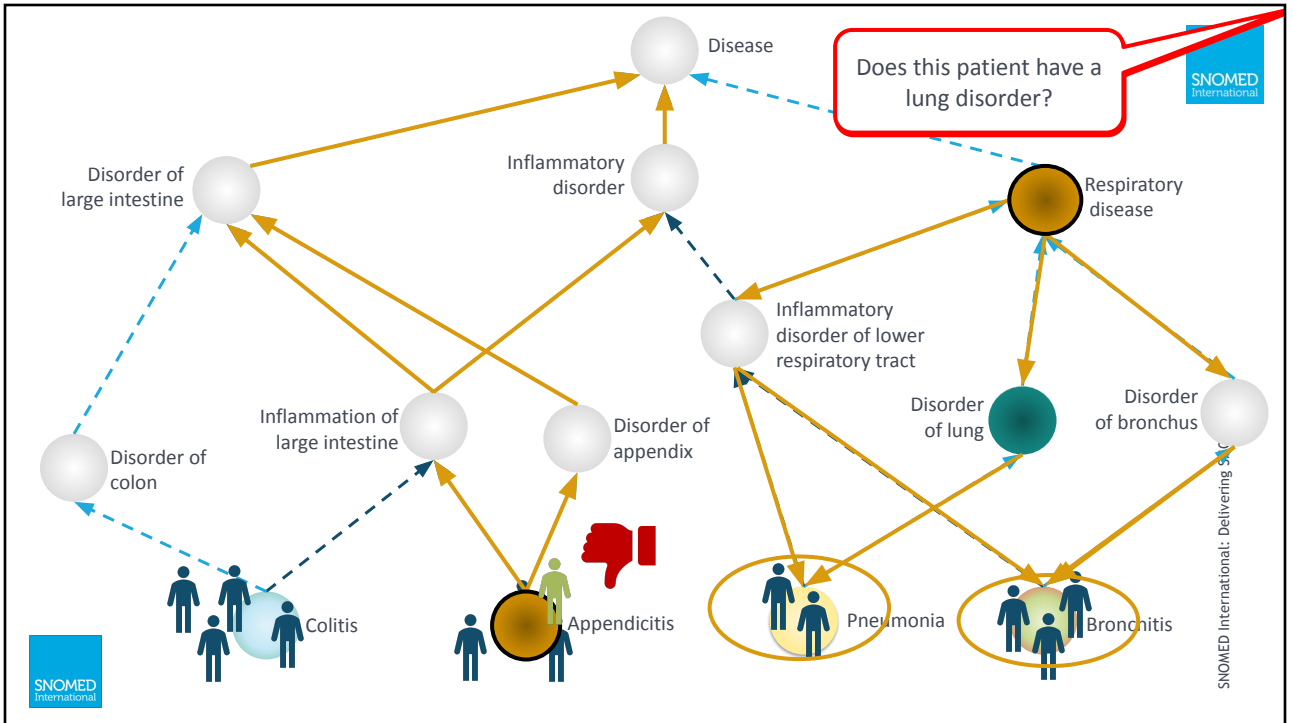
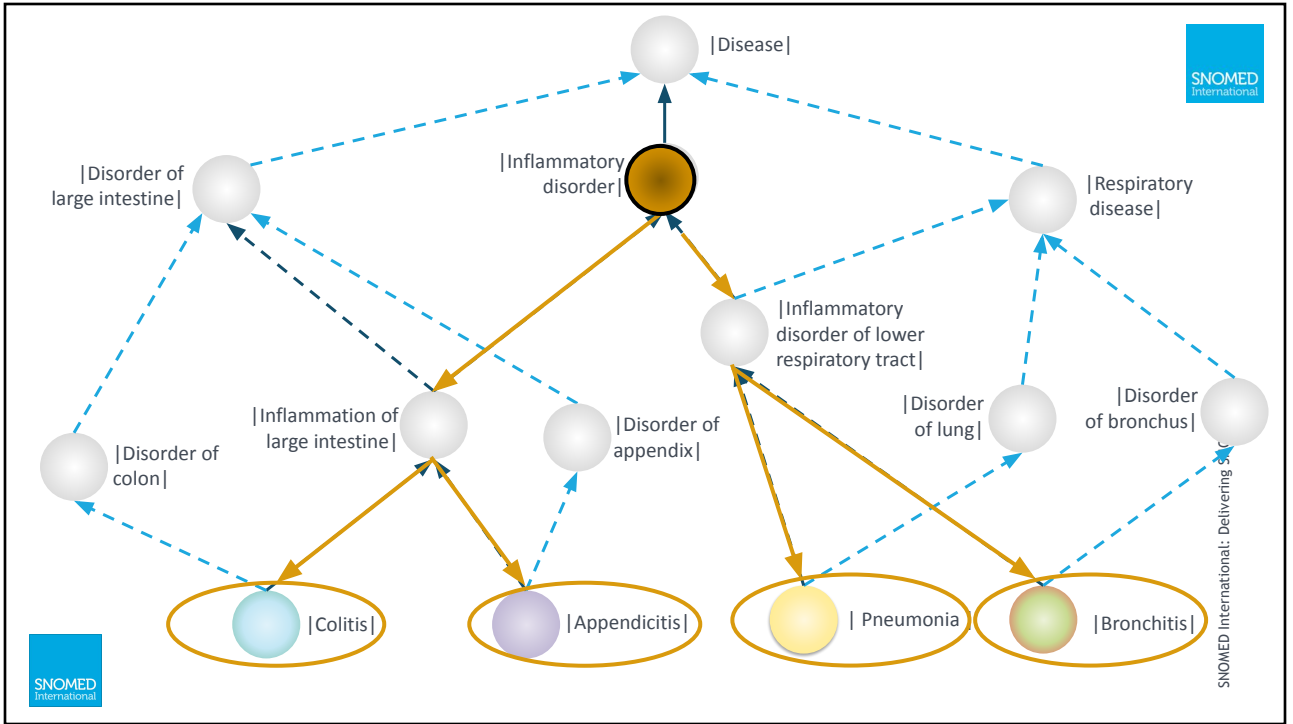
... A Semantic Network of Clinical Meanings

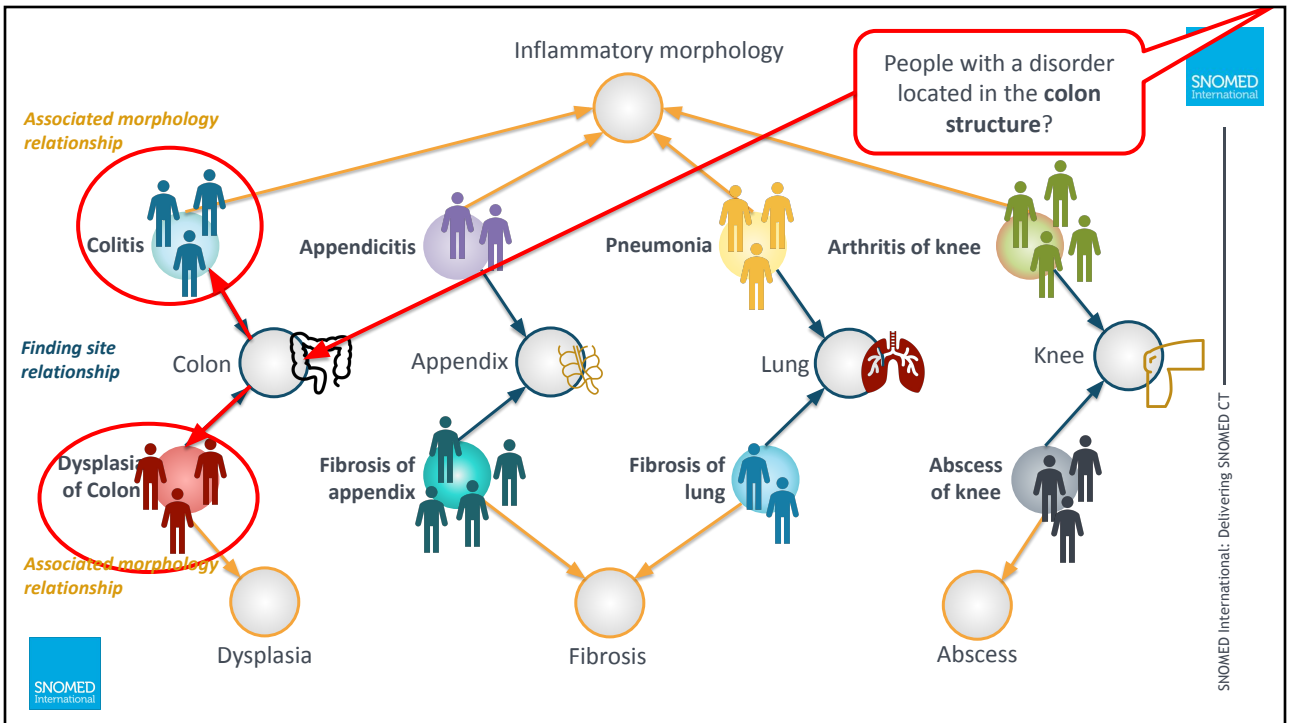
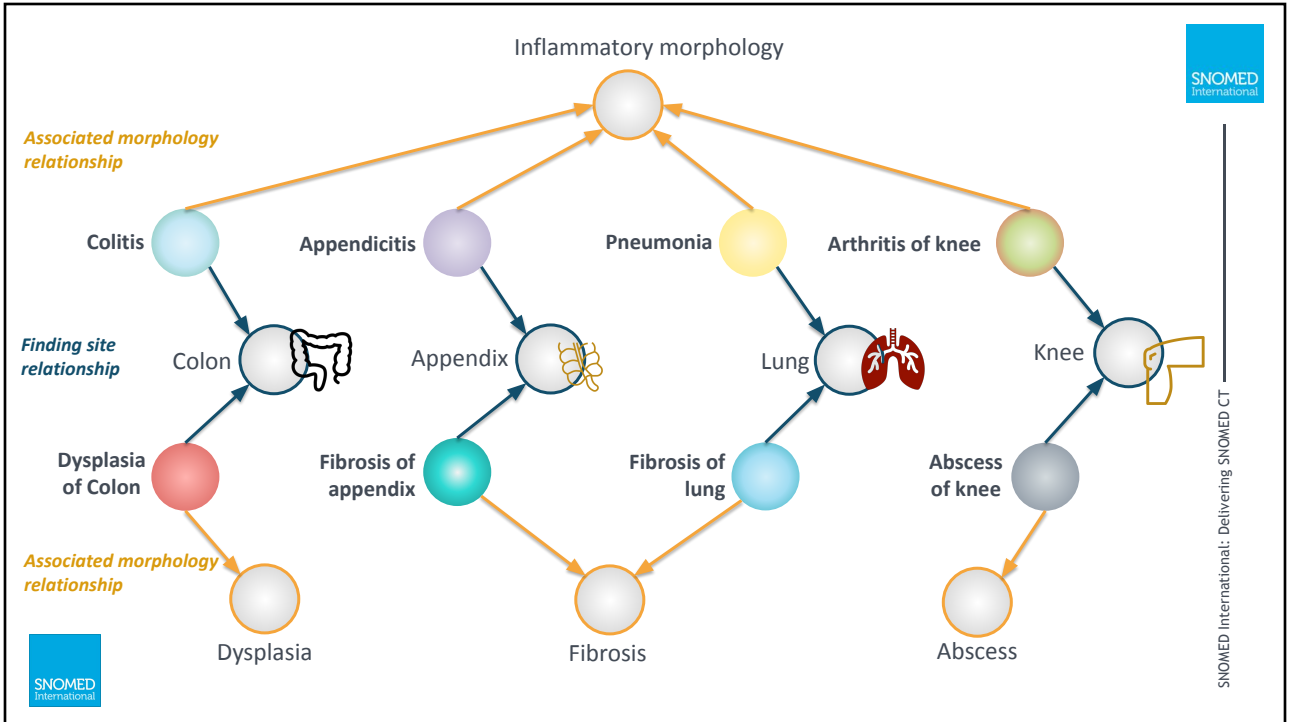
Supports effective and consistent entry of data

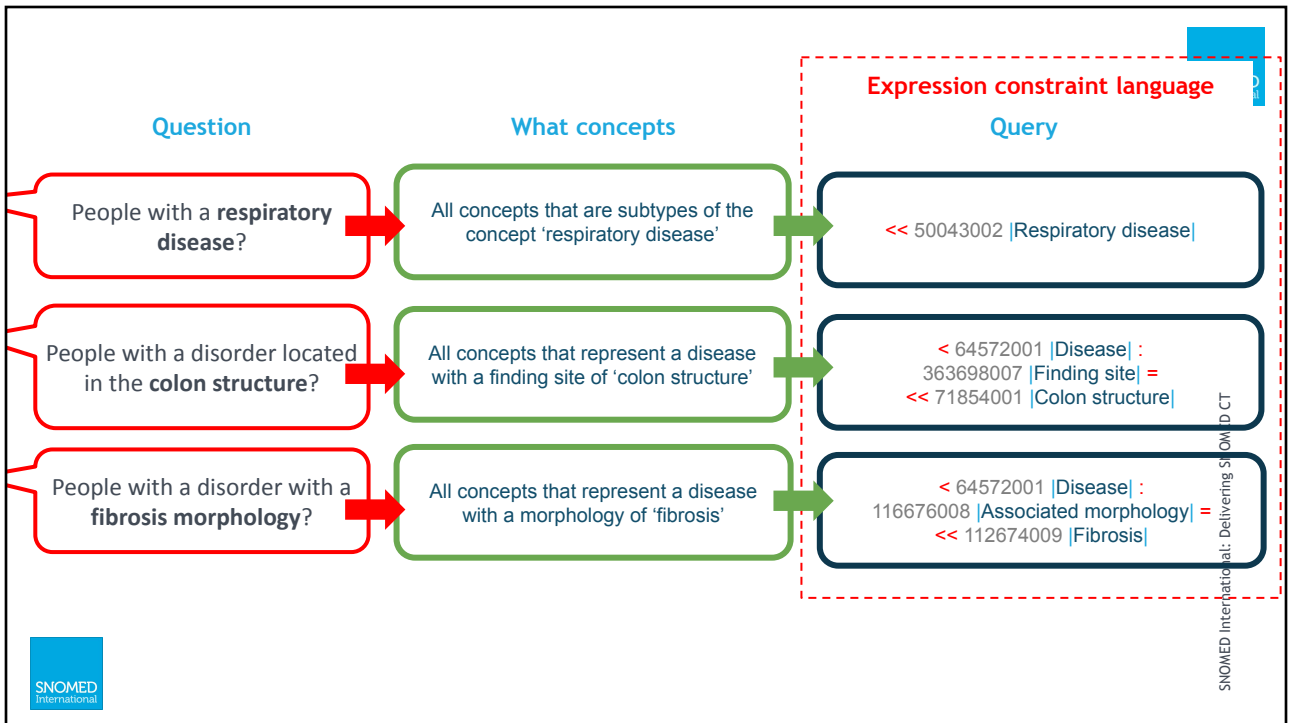
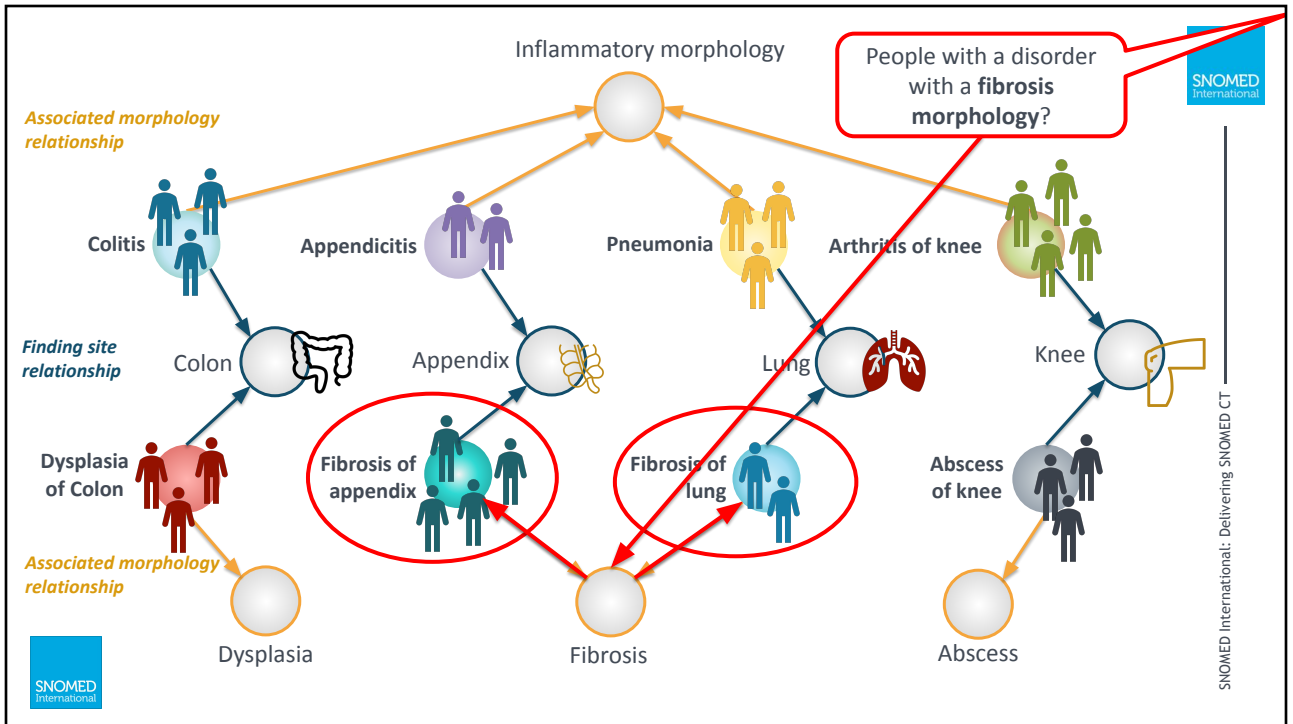
Flexible retrieval of clinical information











| Symbol | Name |
|----------------|--------------------------------|
| < | Descendant of |
| << | Descendant or self of |
| > | Ancestor of |
| >> | Ancestor or self of |
| <! | Child of |
| ^ | Member of |
| ^[x,y] | Member of with field selection |
| * | Any |
| : | Refinement |
| AND | Conjunction |
| OR | Disjunction |
| MINUS | Exclusion |
| [x..y] | Cardinality |
| R | Reverse attribute |
| . | Dotted attribute |
| {{ D }} | Description filter |
| {{ C }} | Concept filter |
| {{ M }} | Member filter |
| {{ +HISTORY }} | History supplement |

Expression constraint language

Query

<< 50043002 |Respiratory disease|

< 64572001 |Disease| :
363698007 |Finding site| =
<< 71854001 |Colon structure|

< 64572001 |Disease| :
116676008 |Associated morphology| =
<< 112674009 |Fibrosis|



To learn more visit:

<http://snomed.org/ecl>

Expression Constraint Language



<< 254837009 |Malignant tumor of breast|

Enter an ECL query (ECL Version: 2.0)

<< 254837009 |Malignant tumor of breast|

ECL Builder

Execute

Results: Found 147 concepts

| Concept | Preferred Term | Id |
|---|--|-----------------|
| Metastatic malignant neoplasm to lymph node from primary malignant neoplasm of female breast (disorder) | Metastatic malignant neoplasm to lymph node from primary malignant neoplasm of female breast | 162606310001191 |
| Primary malignant neoplasm of skin of left breast (disorder) | Primary malignant neoplasm of skin of left breast | 159502210001191 |
| Primary basal cell carcinoma of skin of left breast (disorder) | Primary basal cell carcinoma of skin of left breast | 159501410001191 |
| Primary basal cell carcinoma of skin of right breast (disorder) | Primary basal cell carcinoma of skin of right breast | 159501010001191 |

Expression Constraint Language

Refinements < 64572001 |Disease| :
363698007 |Finding site| = << 76752008 |Breast structure|,
116676008 |Associated morphology| = <<< 367651003 |Malignant Neoplasm (Morphology)|

Enter an ECL query (ECL Version: 2.0)

Results: Found 147 concepts

```
< 64572001 |Disease| :
363698007 |Finding site| = << 76752008
116676008 |Associated morphology| = <<<
```

ECL Builder

Execute

| Concept | Preferred Term | Id |
|---|--|-------------------|
| Metastatic malignant neoplasm to lymph node from primary malignant neoplasm of female breast (disorder) | Metastatic malignant neoplasm to lymph node from primary malignant neoplasm of female breast | 16260631000119101 |
| Primary malignant neoplasm of skin of left breast (disorder) | Primary malignant neoplasm of skin of left breast | 15950221000119108 |
| Primary basal cell carcinoma of skin of left breast (disorder) | Primary basal cell carcinoma of skin of left breast | 15950141000119105 |
| Primary basal cell carcinoma of skin of right breast (disorder) | Primary basal cell carcinoma of skin of right breast | 15950101000119108 |
| Primary malignant neoplasm of skin of right breast | Primary malignant neoplasm of skin of right | 15950061000119105 |

17

Technique: Patient Data Analytics

<<< 254837009 |Malignant tumor of breast|

Terminology Server

| Patient_Id | Diagnosis | Diagnosis term |
|------------|-----------------|---|
| 001 | 145501000119108 | Metastatic malignant neoplasm of breast |
| 002 | 722223000 | Cyst of kidney |
| 003 | 254840009 | Inflammatory carcinoma of breast |
| 004 | 64226004 | Colitis |
| 005 | 1197732001 | Colorectal Crohn disease |
| 006 | 278050001 | Sarcoma of breast |
| 007 | 1197732001 | Colorectal Crohn disease |
| 008 | 254837009 | Malignant tumor of breast |
| 009 | 405944004 | Asthmatic bronchitis |
| 010 | 46635009 | Type 1 diabetes mellitus |

EHR or Data Warehouse

18

Population Health Monitoring

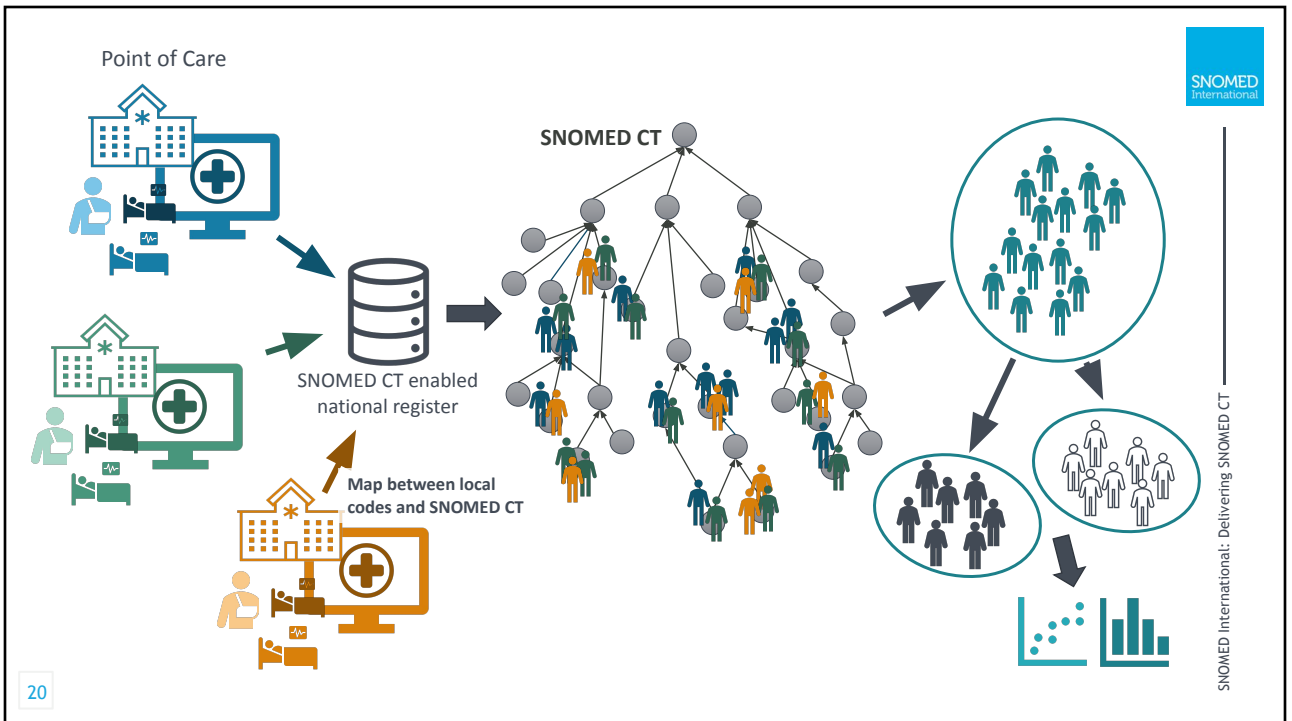
snomed.org



@snomedct



linkedin.com/company/ihtsdo/



Data Analytics - Scenario 1

Population health



Population health monitoring
What are the trends?

Data Analytics - Scenario 1

Summarize and aggregate health-related information

Identify health trends and patterns across a population



Monitor the incidence and prevalence of diseases

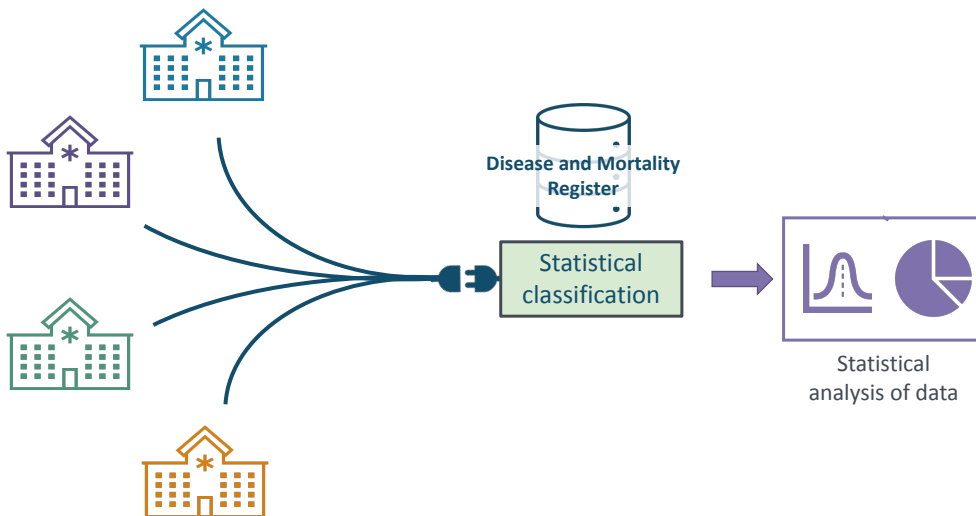
Monitor effect of national programmes and initiatives

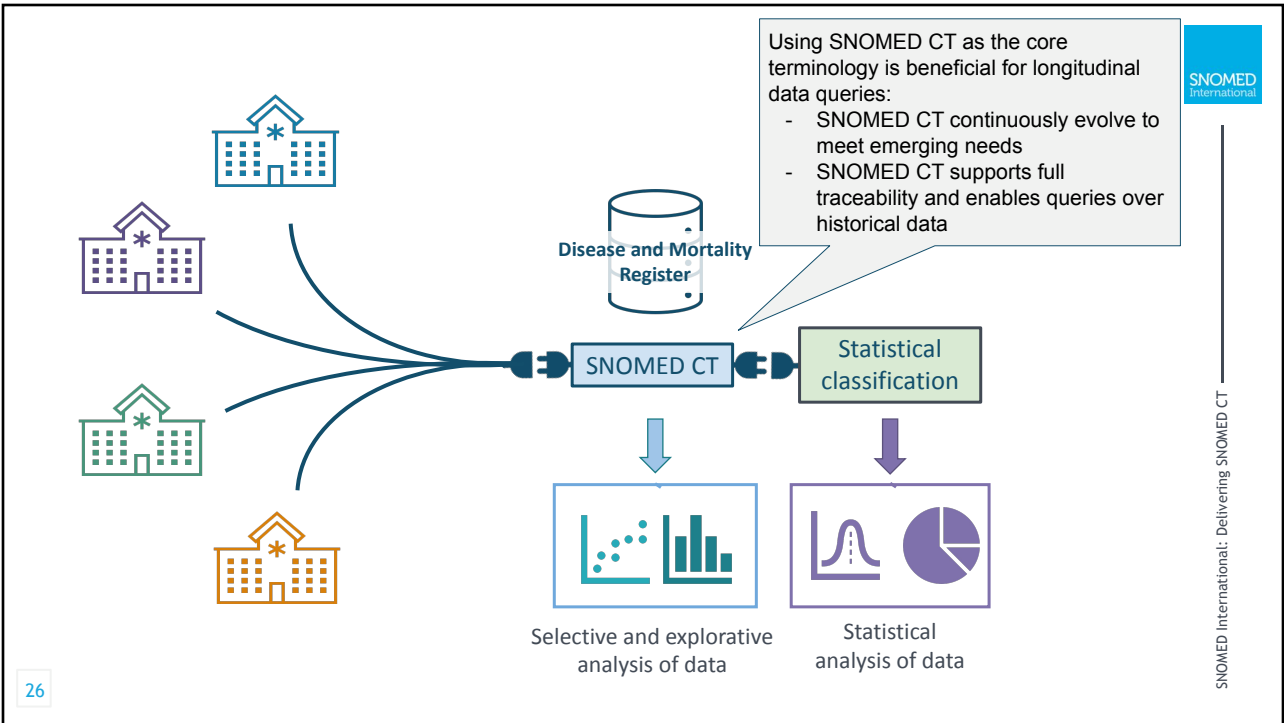
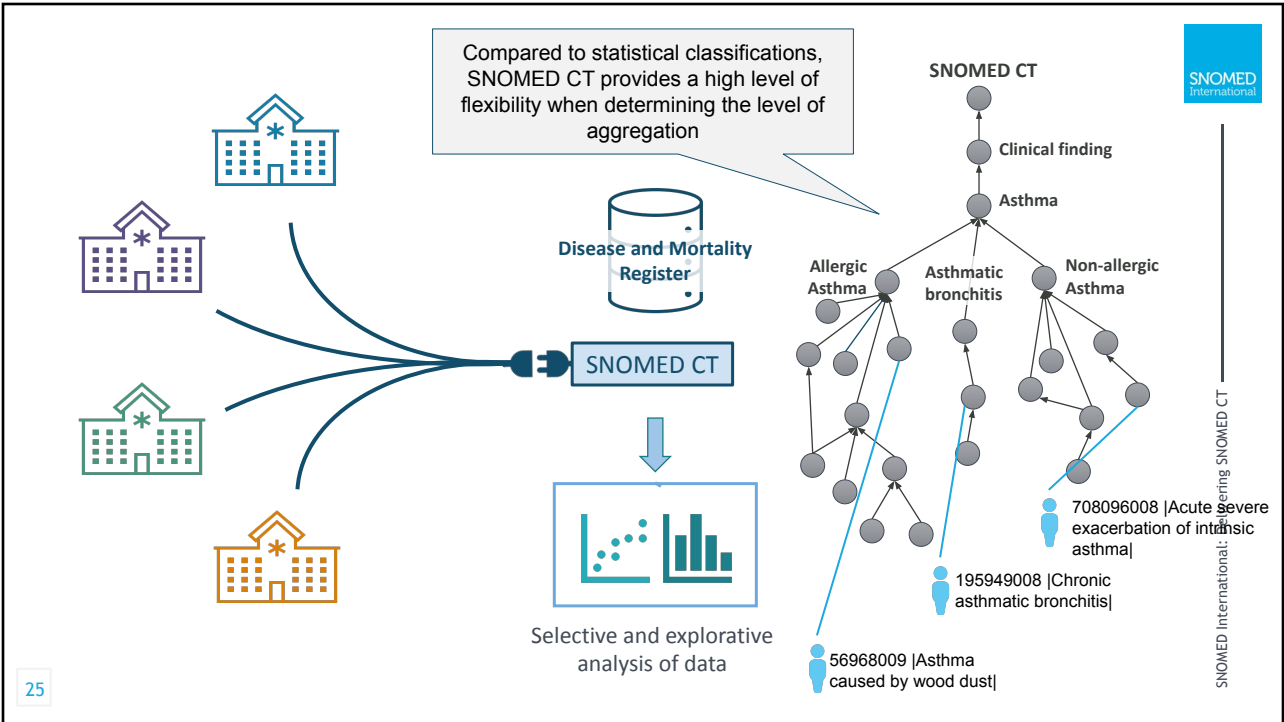
Balance and prioritize healthcare related costs

Demonstration

Use a synthetic data set inspired by Danish National Statistics for the **incidence rate** of selected disorders

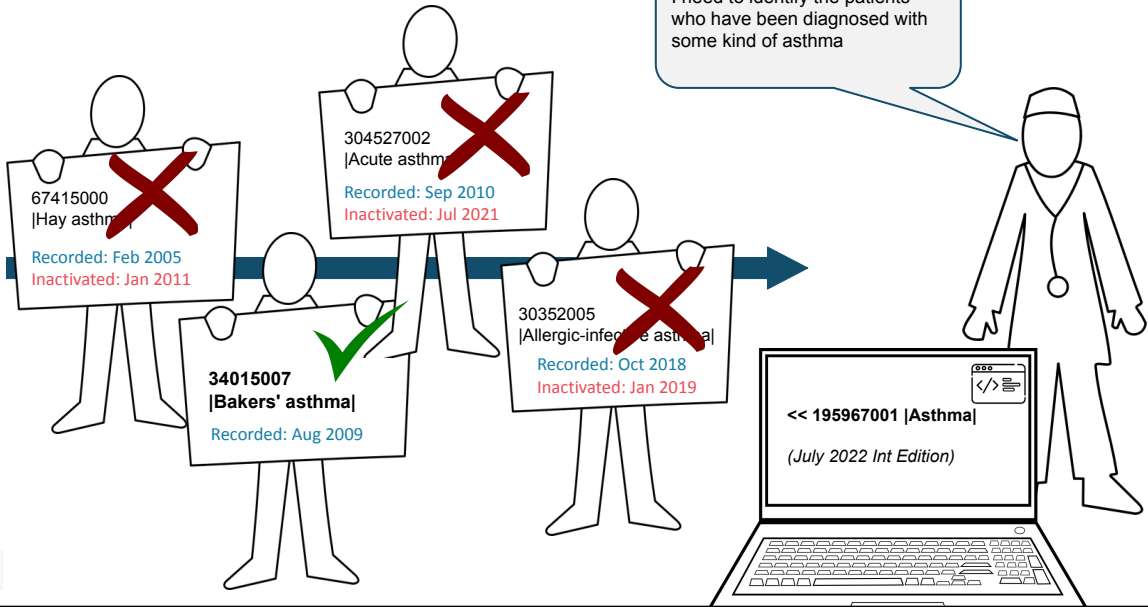
Small 1 million person population for demo





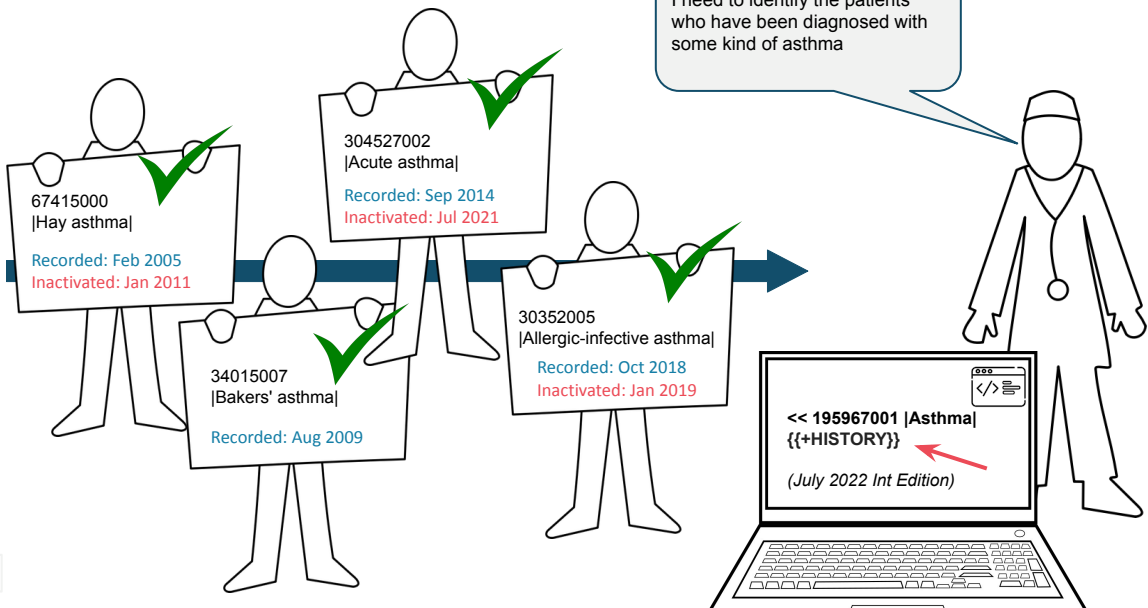
Querying Historical data (ECL)

I need to identify the patients who have been diagnosed with some kind of asthma



Querying Historical data (ECL)

I need to identify the patients who have been diagnosed with some kind of asthma



History Supplements (ECL v2.0)

Parents

No parents

Allergic-infective asthma (disorder)
 SCTID: 30352005
 30352005 | Allergic-infective asthma (disorder) |
 en Allergic-infective asthma (disorder)
 en Allergic-infective asthma

No attributes

Why are concepts inactivated?

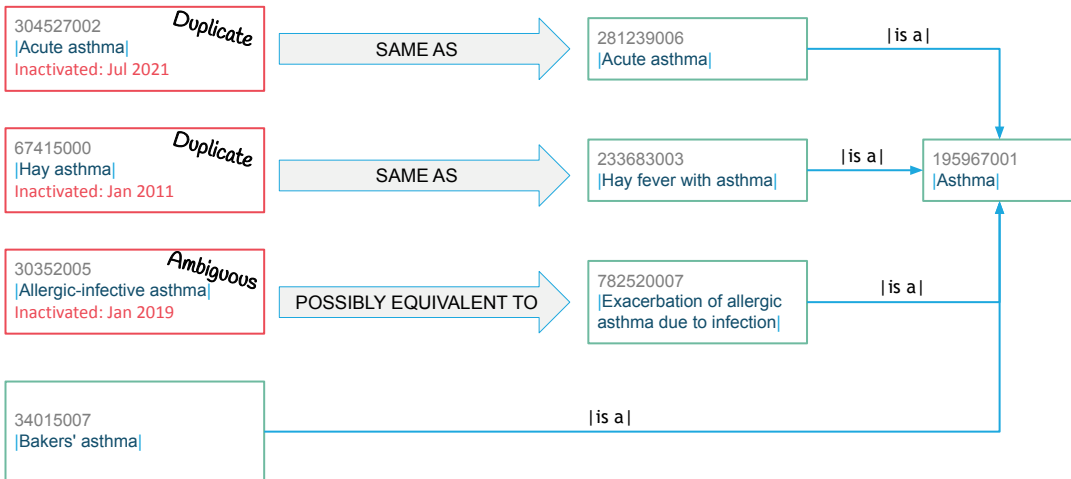
Inactivations are required to ...
Correct errors and keep pace with
changing clinical knowledge

Important to retain access to
inactivated content to support
historical records

Children

No children

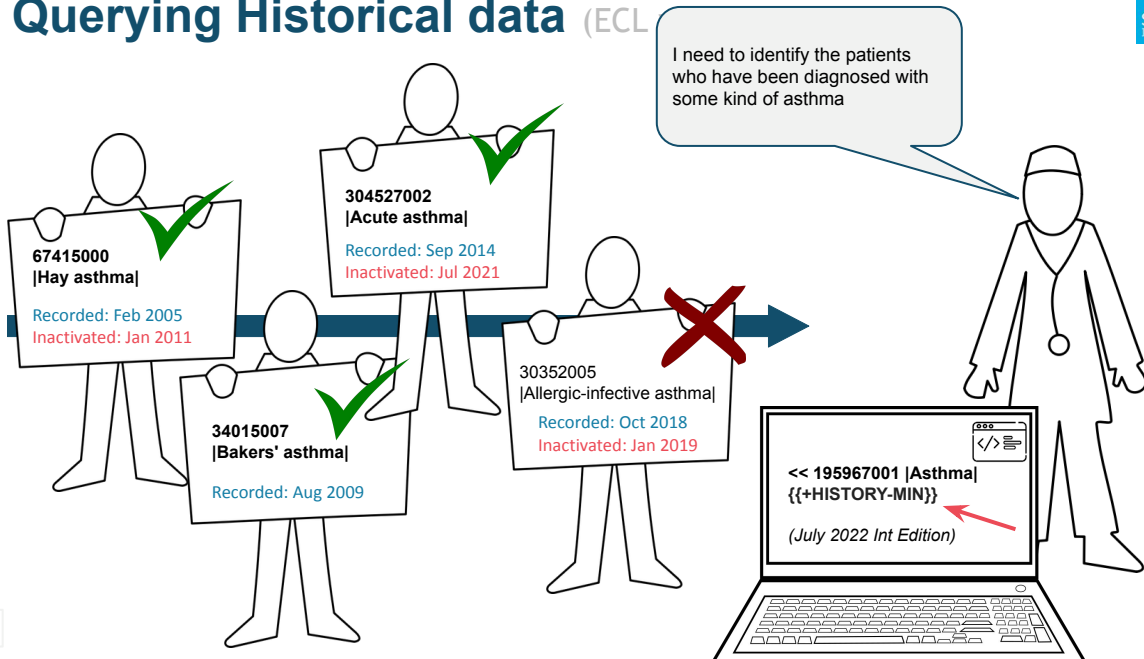
History Supplements (ECL v2.0)



History Supplements (ECL v2.0)

| History Profile | Historical Association Reference Sets |
|----------------------------|--|
| HISTORY-MIN | <ul style="list-style-type: none"> 900000000000527005 SAME AS association reference set |
| HISTORY-MOD | <ul style="list-style-type: none"> 900000000000527005 SAME AS association reference set 900000000000526001 REPLACED BY association reference set 900000000000528000 WAS A association reference set 1186924009 PARTIALLY EQUIVALENT TO association reference set |
| HISTORY-MAX HISTORY (*) | <ul style="list-style-type: none"> < 900000000000522004 Historical association reference set |

Querying Historical data (ECL



Enabling Preventive Care Measures

snomed.org



[@snomedct](https://twitter.com/snomedct)



[linkedin.com/company/ihtsdo/](https://www.linkedin.com/company/ihtsdo/)

Data Analytics - Scenario 2

Research



Improving the quality and efficiency of care

*Which groups are most at risk?
Consider preventative measures?*

Data Analytics - Scenario 2

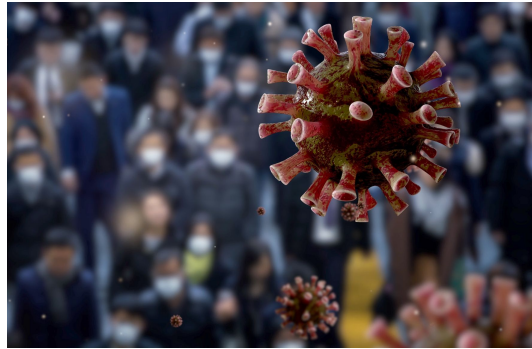
Patient group

People with COVID-19 (any variant)

Outcomes

People with pneumonia due to COVID-19

People died



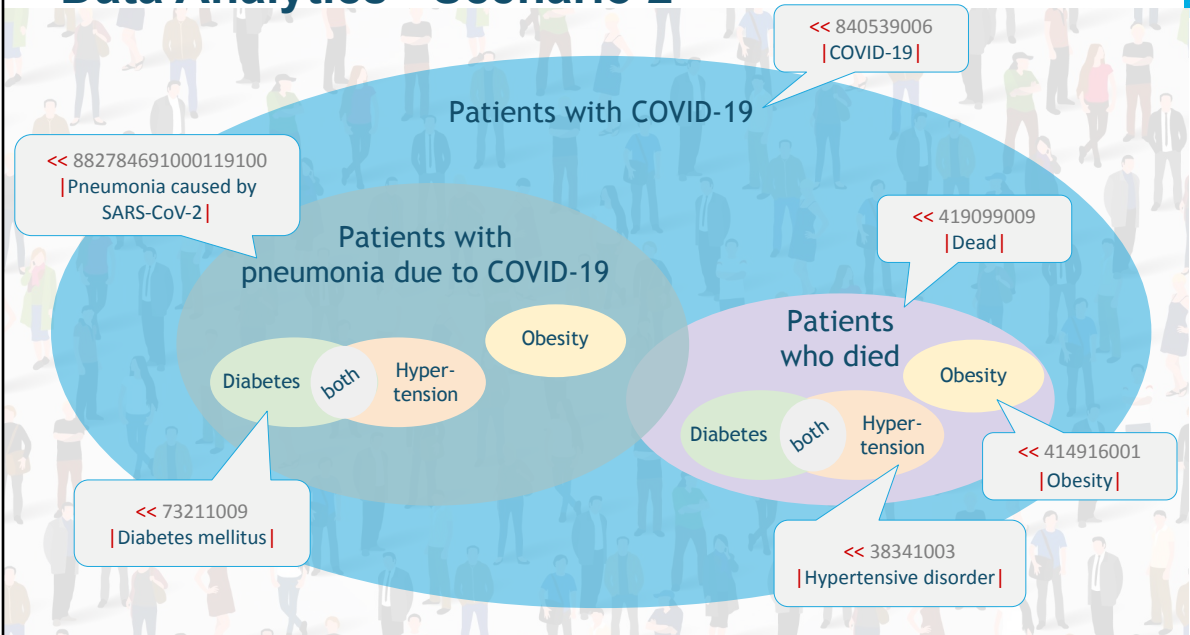
Risk factors

Obesity

Diabetes

Hypertension

Data Analytics - Scenario 2



Demonstration



Data Analytics - Scenario 3



Assessing treatments
How effective is each treatment option?

Data Analytics - Scenario 3

Patient cohort

BRCA1 gene mutation

Increased risk of breast cancer

Treatment

Drug prevention available

Risk of severe side effects



Question

Does the medication significantly reduce the risk of cancer?

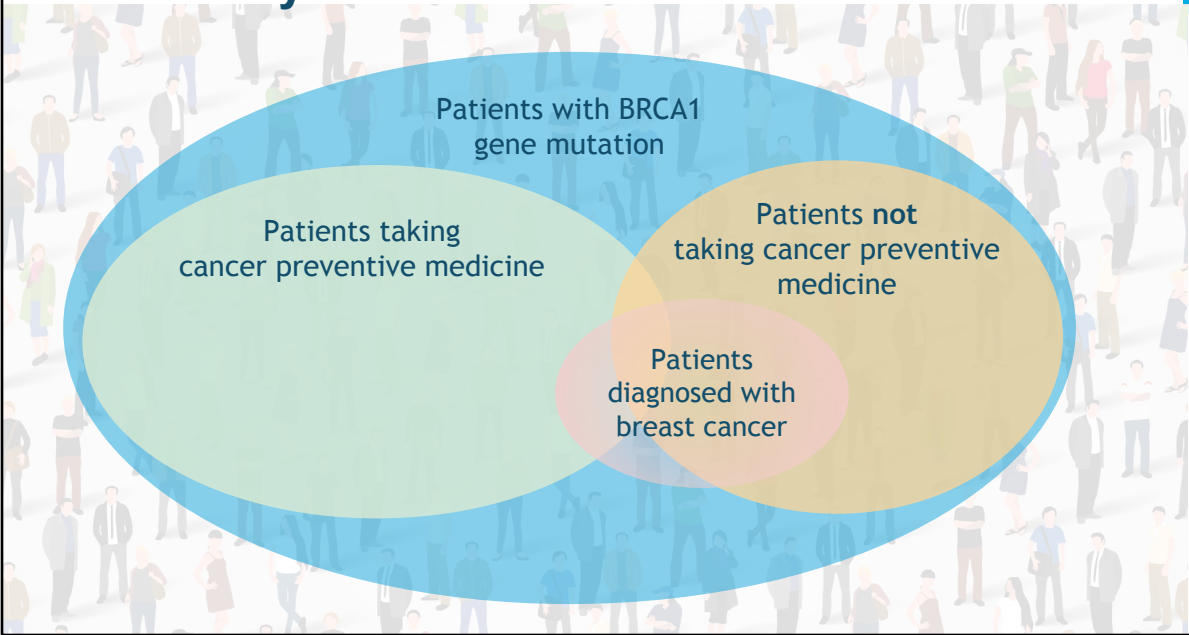
39

Data Analytics - Scenario 3

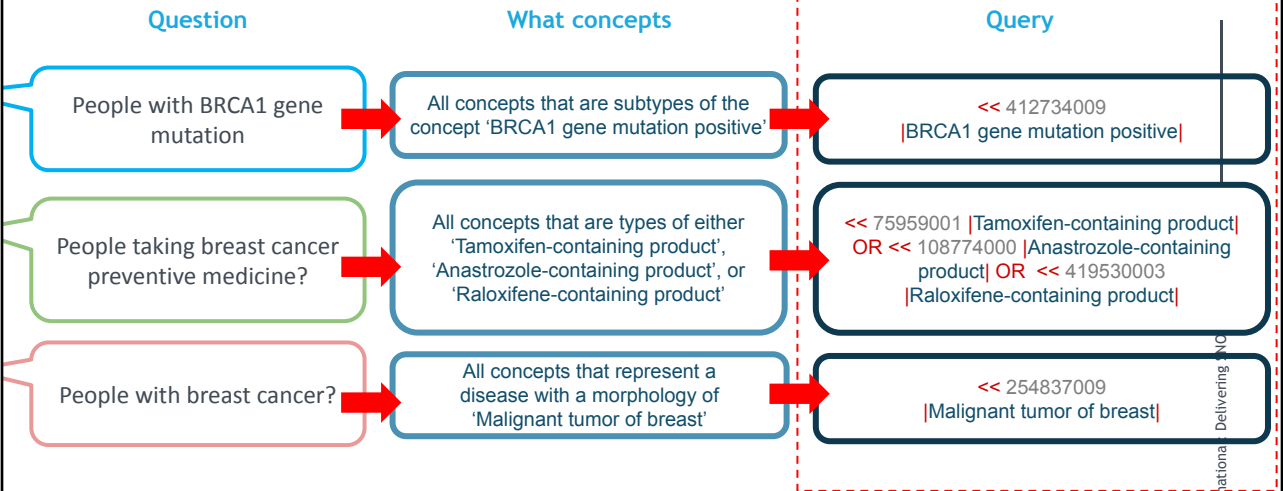


40

Data Analytics - Scenario 3



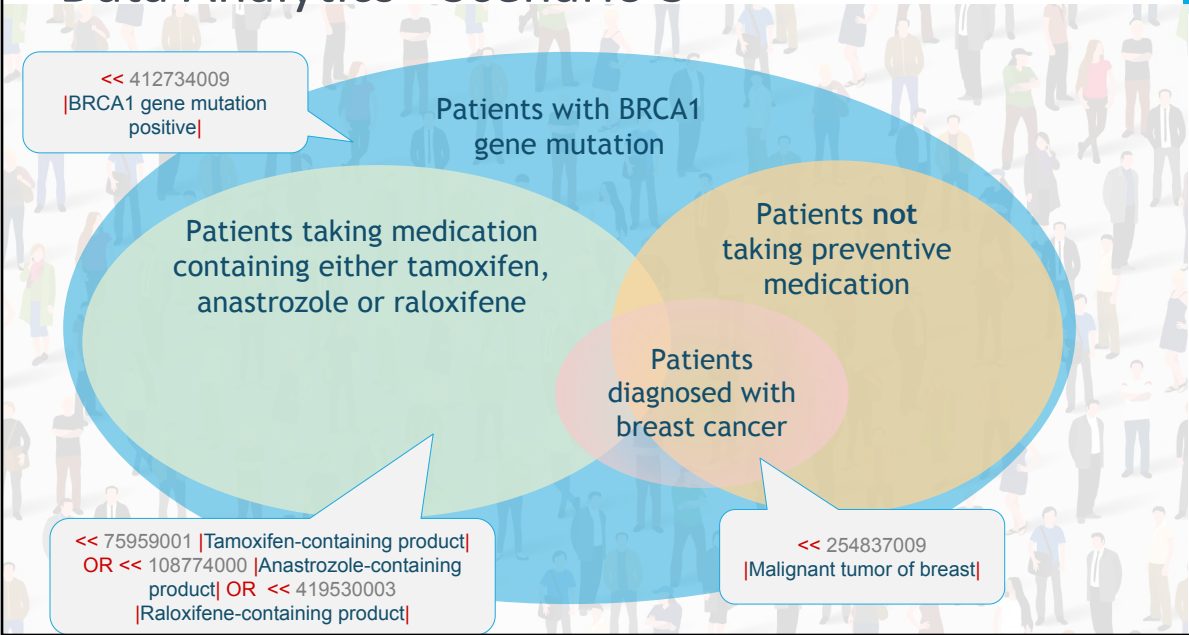
SNOMED CT Queries



Expression constraint language

Query

Data Analytics - Scenario 3



Patient Data Analytics

<< 254837009 |Malignant tumor of breast|

Electronic data (E)

| Patient_Id | Diagnosis | Diagnosis term |
|------------|-----------------|---|
| 001 | 145501000119108 | Metastatic malignant neoplasm of breast |
| 002 | 722223000 | Cyst of kidney |
| 003 | 254840009 | Inflammatory carcinoma of breast |
| 004 | 64226004 | Colitis |
| 005 | 1197732001 | Colorectal Crohn disease |
| 006 | 278050001 | Sarcoma of breast |
| 007 | 1197732001 | Colorectal Crohn disease |
| 008 | 254837009 | Malignant tumor of breast |
| 009 | 405944004 | Asthmatic bronchitis |
| 010 | 46635009 | Type 1 diabetes mellitus |

Patient Data Analytics

```
SELECT Patient_Id FROM EHR WHERE Diagnosis =
(<< 254837009 |Malignant tumor of breast|)
```

Electronic data (EHR)

| Patient_Id | Diagnosis | Diagnosis term |
|------------|-----------------|---|
| 001 | 145501000119108 | Metastatic malignant neoplasm of breast |
| 002 | 722223000 | Cyst of kidney |
| 003 | 254840009 | Inflammatory carcinoma of breast |
| 004 | 64226004 | Colitis |
| 005 | 1197732001 | Colorectal Crohn disease |
| 006 | 278050001 | Sarcoma of breast |
| 007 | 1197732001 | Colorectal Crohn disease |
| 008 | 254837009 | Malignant tumor of breast |
| 009 | 405944004 | Asthmatic bronchitis |
| 010 | 46635009 | Type 1 diabetes mellitus |

| ECL Expansion |
|-------------------|
| 15950061000119105 |
| 353421000119109 |
| 145501000119108 |
| 354591000119108 |
| 448435005 |
| 254840009 |
| 286896005 |
| 278050001 |
| 271467005 |
| 403458008 |
| 373082000 |
| 373081007 |
| 254837009 |
| 254841008 |
| 188159008 |
| 188159008 |
| ... |

SNOMED International: Delivering SNOMED CT

Patient Data Analytics

```
SELECT Patient_Id FROM EHR WHERE Diagnosis =
(<< 254837009 |Malignant tumor of breast|)
```

Electronic data (EHR)

| Patient_Id | Diagnosis | Diagnosis term |
|------------|-----------------|---|
| 001 | 145501000119108 | Metastatic malignant neoplasm of breast |
| 002 | 722223000 | Cyst of kidney |
| 003 | 254840009 | Inflammatory carcinoma of breast |
| 004 | 64226004 | Colitis |
| 005 | 1197732001 | Colorectal Crohn disease |
| 006 | 278050001 | Sarcoma of breast |
| 007 | 1197732001 | Colorectal Crohn disease |
| 008 | 254837009 | Malignant tumor of breast |
| 009 | 405944004 | Asthmatic bronchitis |
| 010 | 46635009 | Type 1 diabetes mellitus |

| ECL Expansion |
|-------------------|
| 15950061000119105 |
| 353421000119109 |
| 145501000119108 |
| 354591000119108 |
| 448435005 |
| 254840009 |
| 286896005 |
| 278050001 |
| 271467005 |
| 403458008 |
| 373082000 |
| 373081007 |
| 254837009 |
| 254841008 |
| 188159008 |
| 188159008 |
| ... |

SNOMED International: Delivering SNOMED CT

Patient Data Analytics

```
SELECT Patient_Id FROM EHR WHERE Diagnosis =
(<< 254837009 |Malignant tumor of breast|)
```

Electronic data (EHR)

| Patient_Id | Diagnosis | Diagnosis term |
|------------|-----------------|---|
| 001 | 145501000119108 | Metastatic malignant neoplasm of breast |
| 002 | 722223000 | Cyst of kidney |
| 003 | 254840009 | Inflammatory carcinoma of breast |
| 004 | 64226004 | Colitis |
| 005 | 1197732001 | Colorectal Crohn disease |
| 006 | 278050001 | Sarcoma of breast |
| 007 | 1197732001 | Colorectal Crohn disease |
| 008 | 254837009 | Malignant tumor of breast |
| 009 | 405944004 | Asthmatic bronchitis |
| 010 | 46635009 | Type 1 diabetes mellitus |

| ECL Expansion |
|-------------------|
| 15950061000119105 |
| 353421000119109 |
| 145501000119108 |
| 354591000119108 |
| 448435005 |
| 254840009 |
| 286896005 |
| 278050001 |
| 271467005 |
| 403458008 |
| 373082000 |
| 373081007 |
| 254837009 |
| 254841008 |
| 188159008 |
| 188159008 |
| ... |

SNOMED International: Delivering SNOMED CT



Interpreting The Results

snomed.org



@snomedct



linkedin.com/company/ihtsdo/

— Interpreting Results (General)

- Correlation does not equal causation!
 - These reports create correlations which provide an important first step in clinical research, however a correlation on it's own does not provide enough evidence to support decision making
 - Additional statistical techniques should be used to verify the results
 - The Snolytical API supports accessing the raw data for this purpose
- We must check for alternative patterns and explanations for the results
 - For example, when comparing two drugs:
 - **Drug A** may appear to perform much better than **Drug B** when measuring outcomes alone.
 - However **Drug B** may be routinely chosen for patients with existing severe comorbidities because it has less side effects. Therefore which drug is prescribed is **not the only factor**.
 - Examples of factors that can influence outcomes:
existing conditions, lifestyle, family history, age, genetics, drug interactions.. many others

What's Next?

snomed.org



@snomedct



linkedin.com/company/ihtsdo/

What's Next?

Develop an Algorithm for
**Automatic Discovery of
Correlations**
within Healthcare Data

Use case:
Automatically identify the greatest
risk factors

Use case:
Automatically identify the most effective
treatment for a specific patient group

Use case:
Validate manually created reports
by scanning for alternative correlations
(generating evidence)

The algorithm will use
hierarchical clustering and
statistical significance techniques

Questions?

SNOMED
International

SNOMED International: Delivering SNOMED CT

snomed.org



[@snomedct](https://twitter.com/snomedct)



linkedin.com/company/ihtsdo/

THANK YOU

SNOMED
International

SNOMED International: Delivering SNOMED CT

snomed.org



[@snomedct](https://twitter.com/snomedct)



linkedin.com/company/ihtsdo/

Data Analytics

“The discovery and communication of meaningful patterns in data”

