



Delivering
SNOMED CT

Data Analytics with SNOMED CT

SNOMED CT in Belgium

March 24st, 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**

(Friday)
March 24



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?

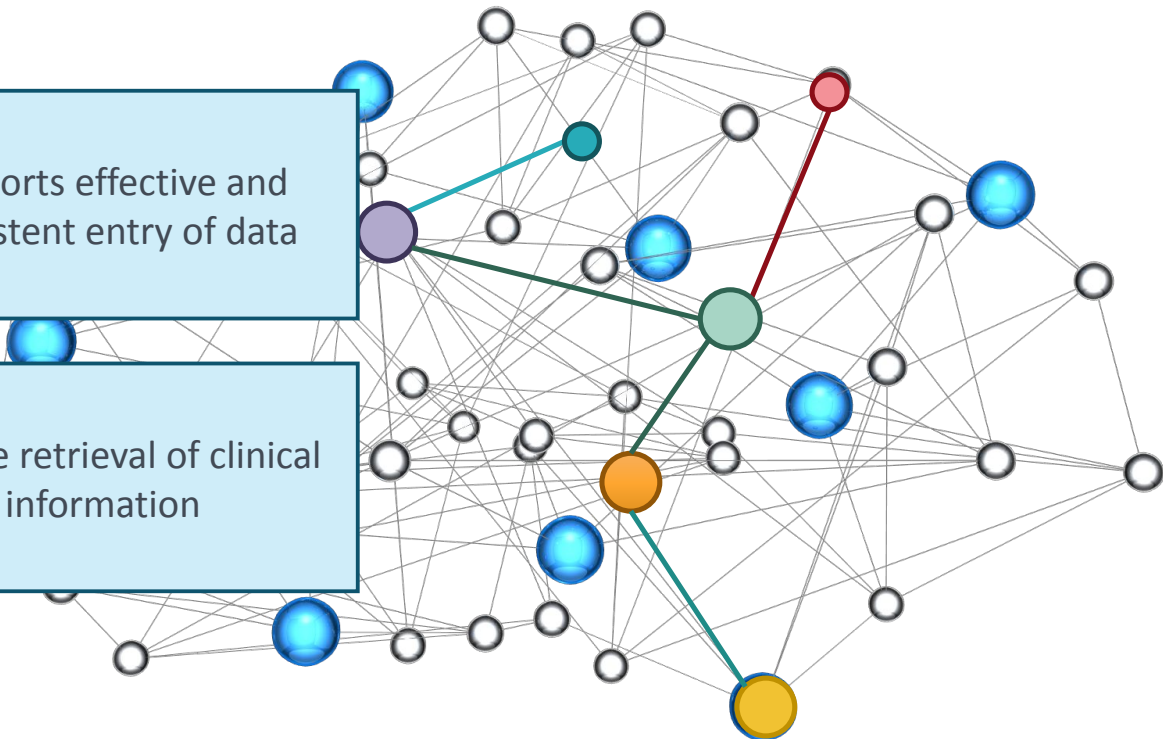


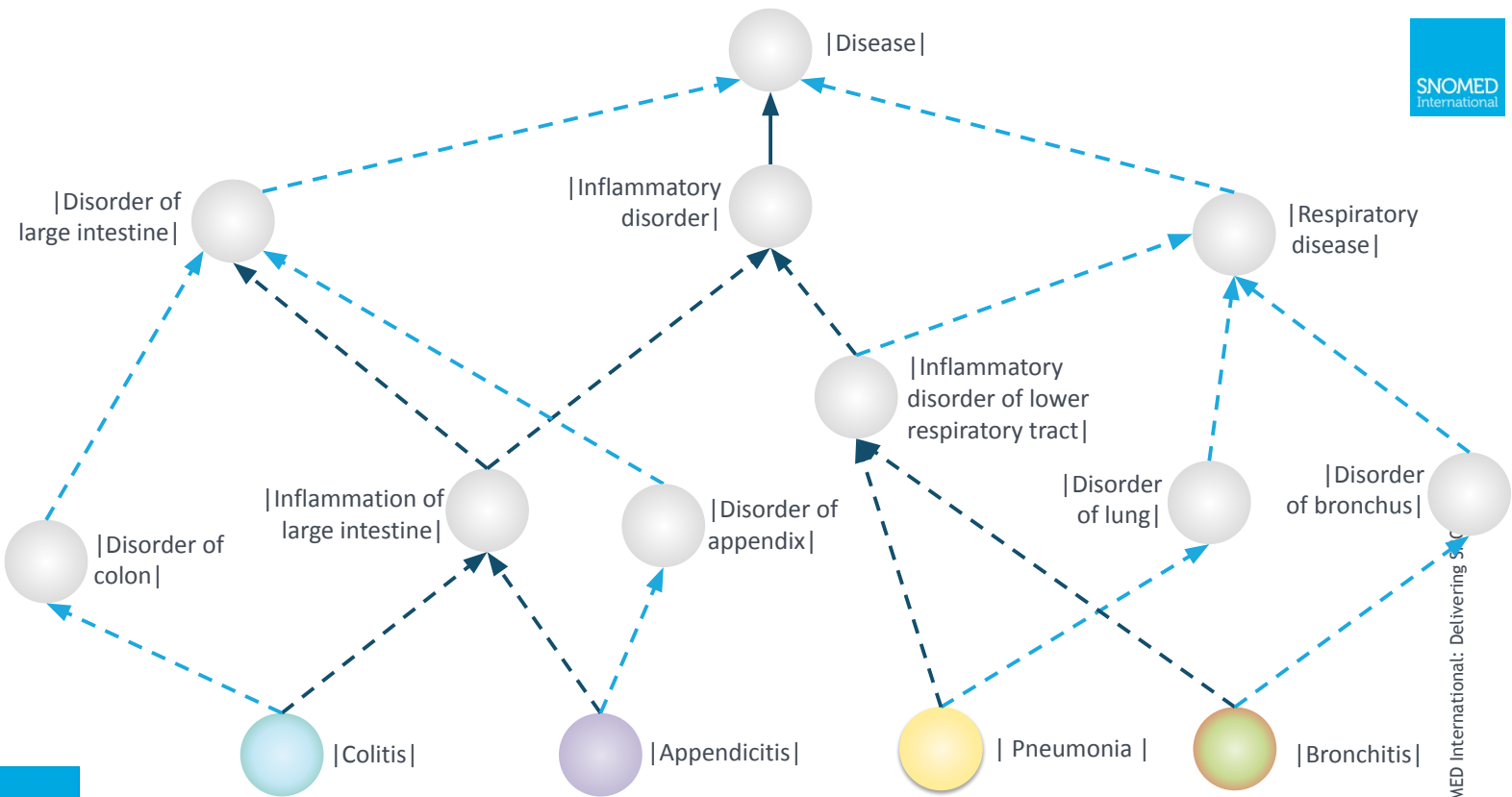
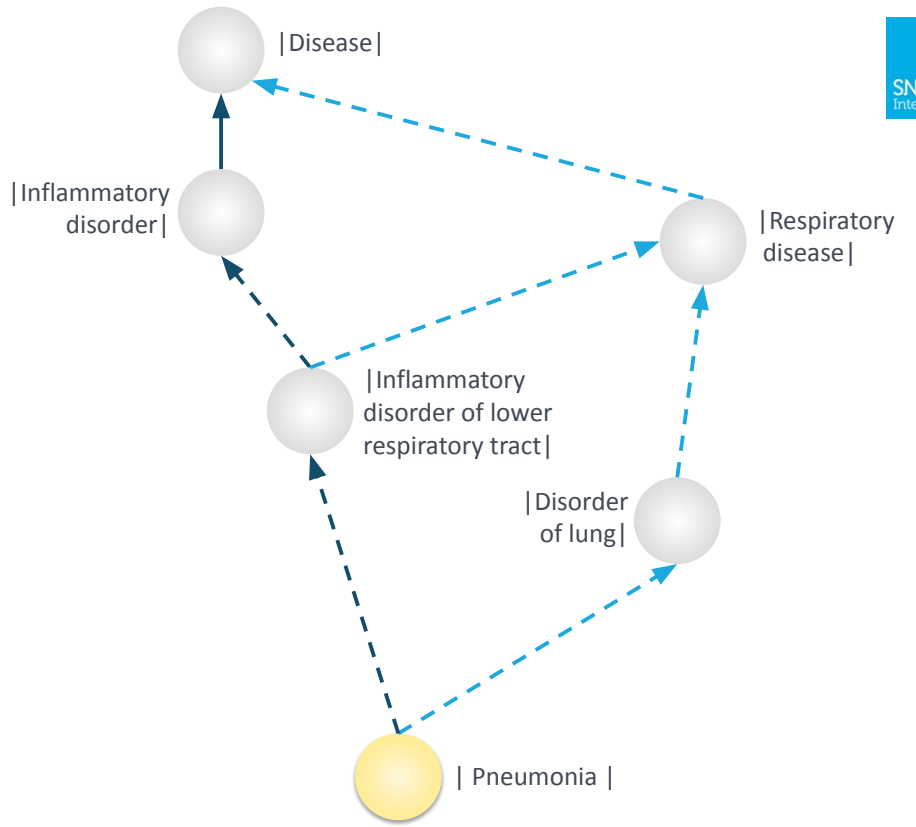
Improving the quality and efficiency of care
What are the causal effects?

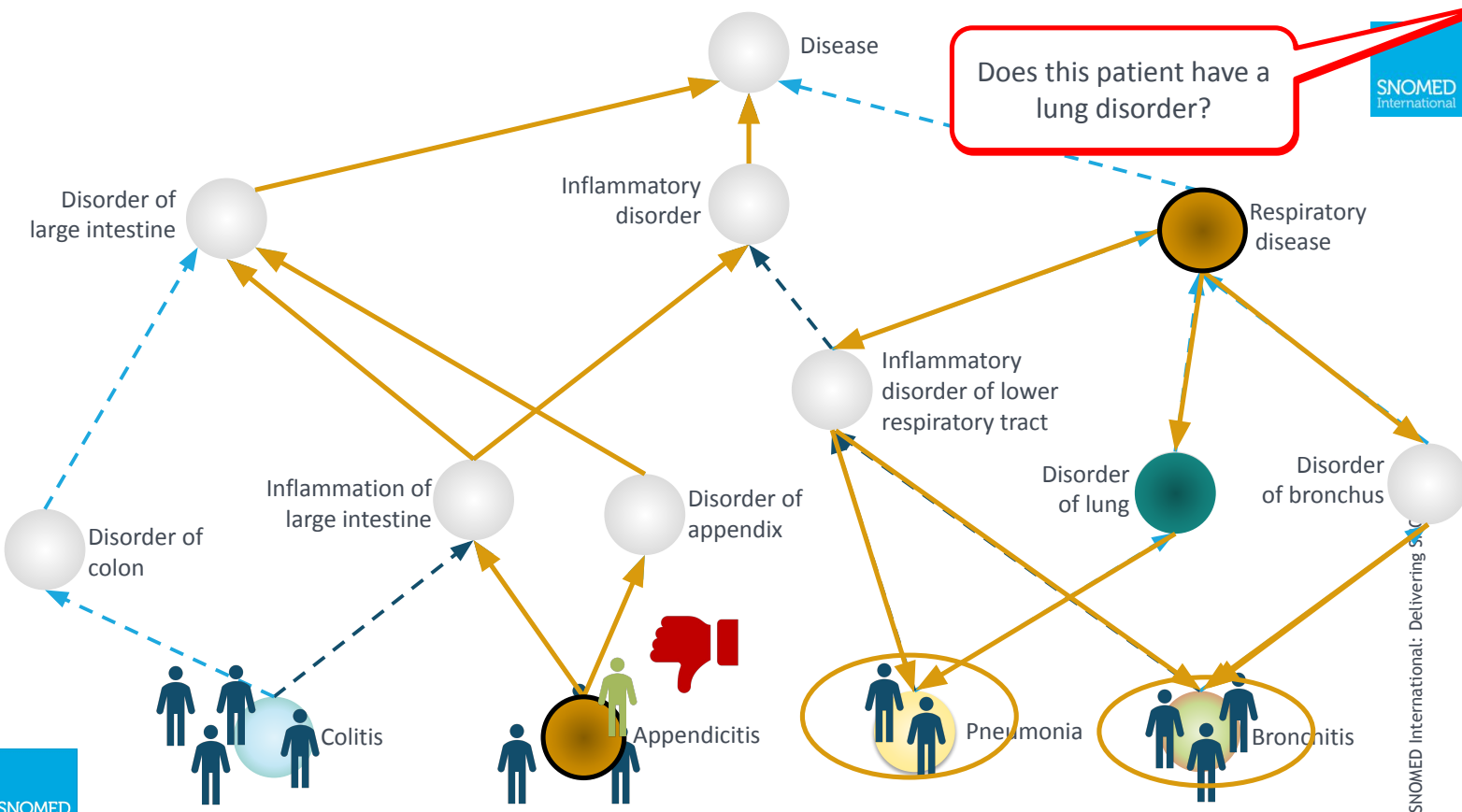
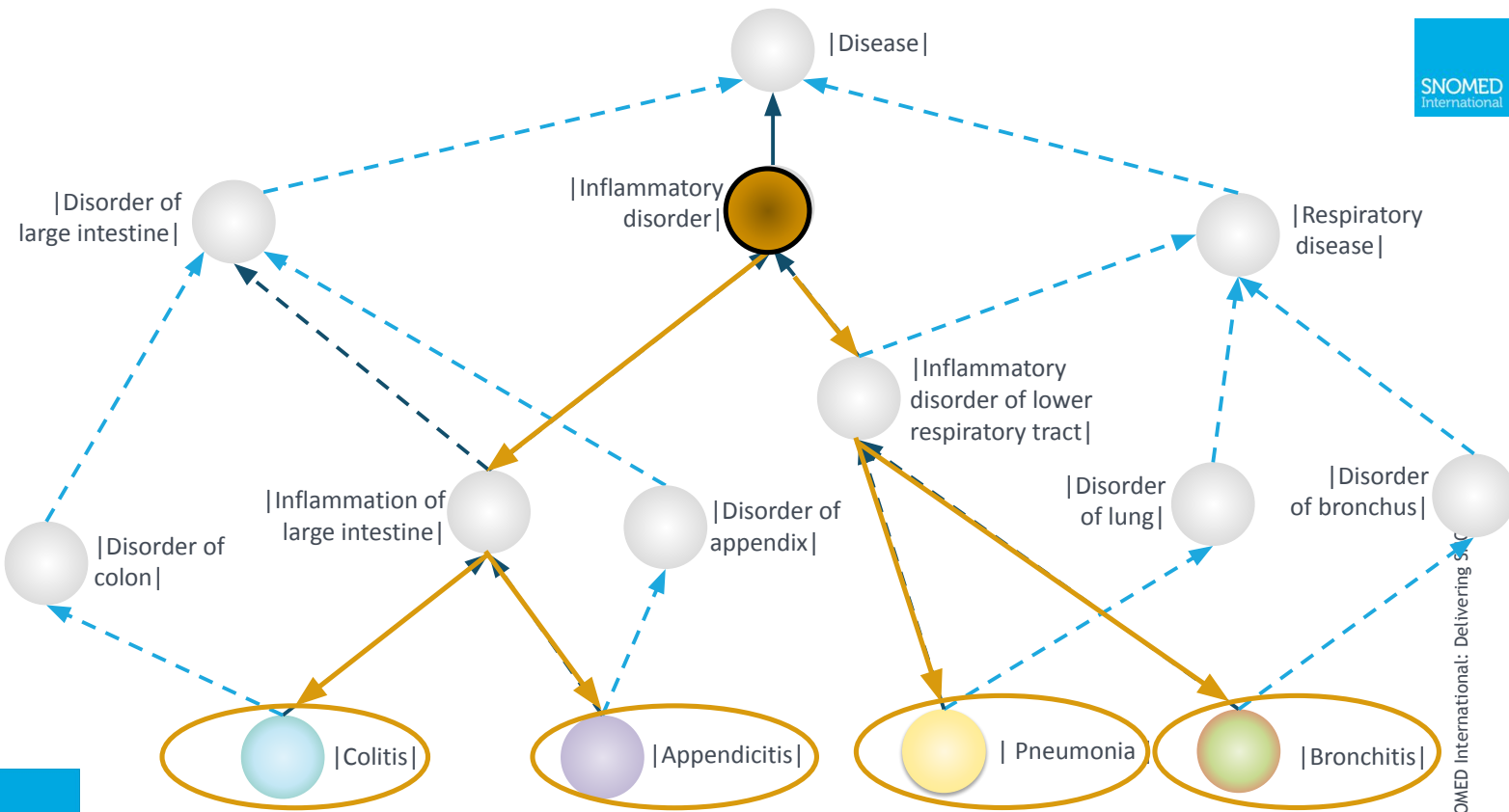
... A Semantic Network of Clinical Meanings

Supports effective and consistent entry of data

Flexible retrieval of clinical information







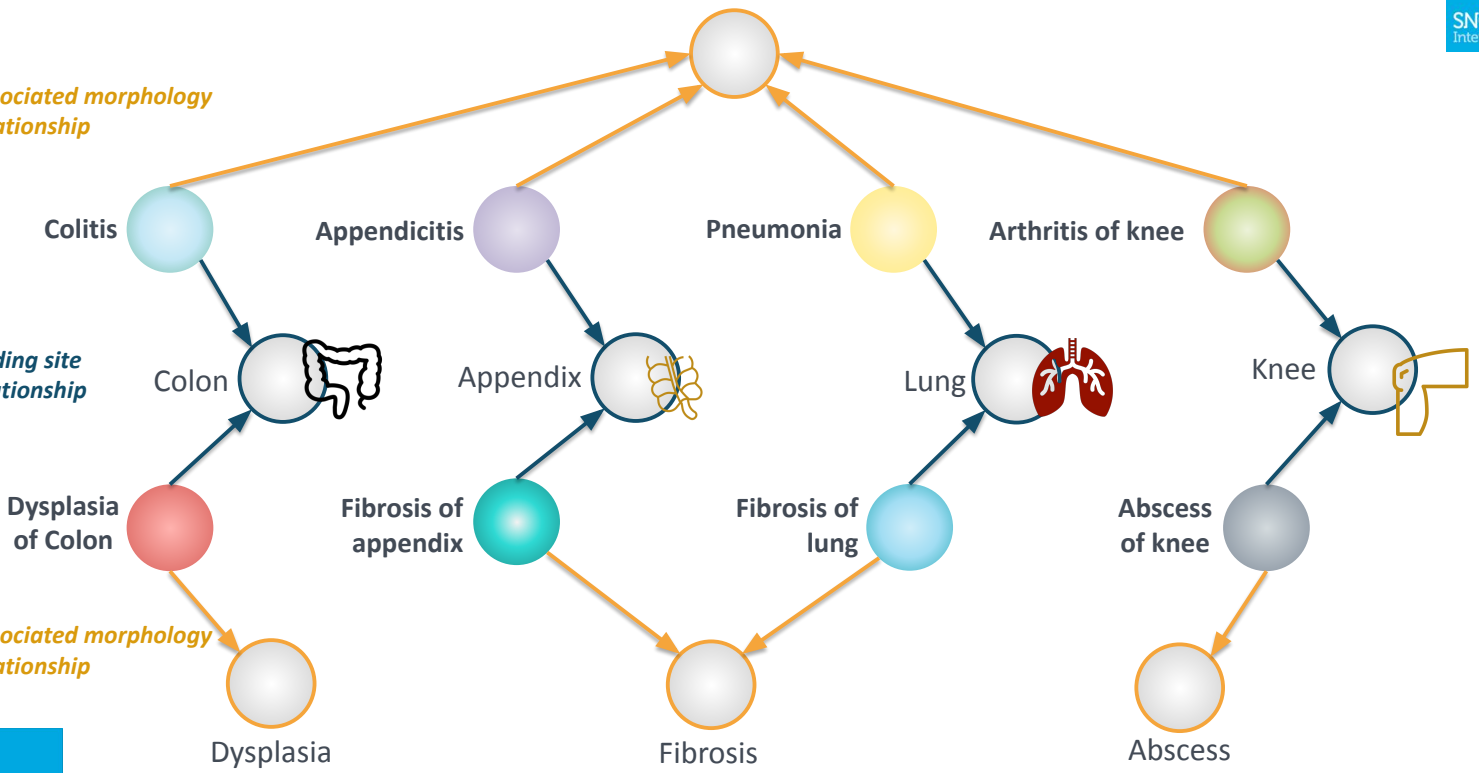
Associated morphology relationship

Finding site relationship

Associated morphology relationship



Inflammatory morphology



Associated morphology relationship

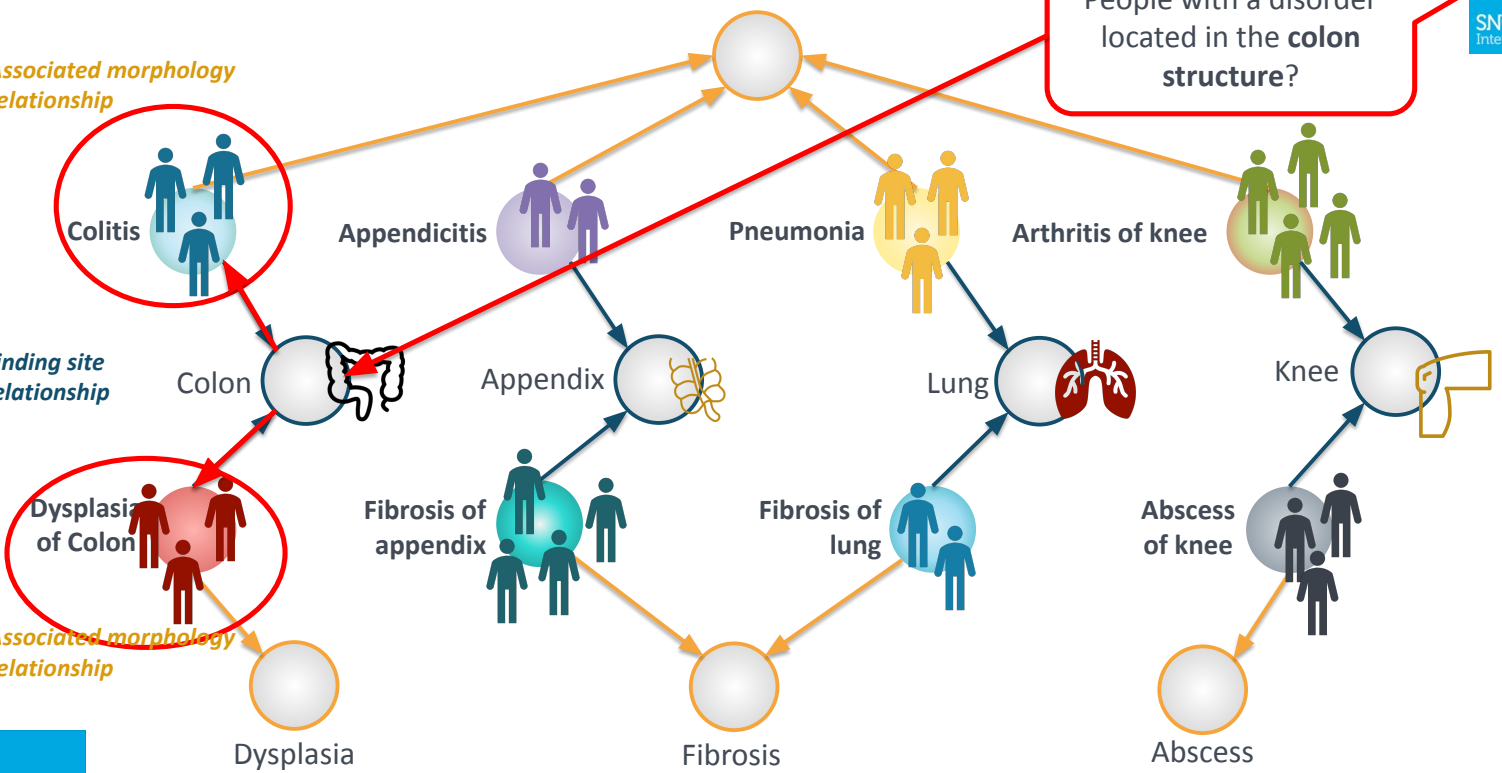
Finding site relationship

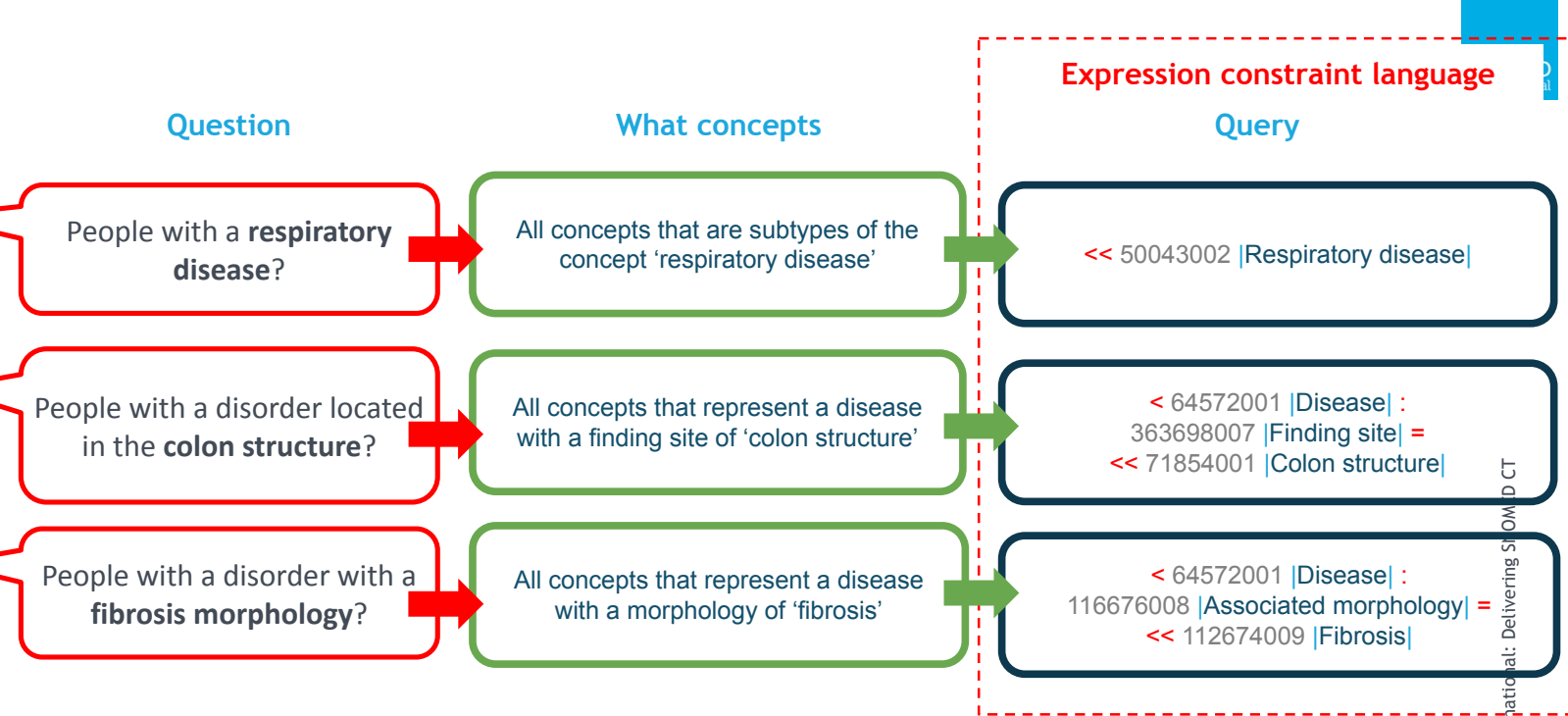
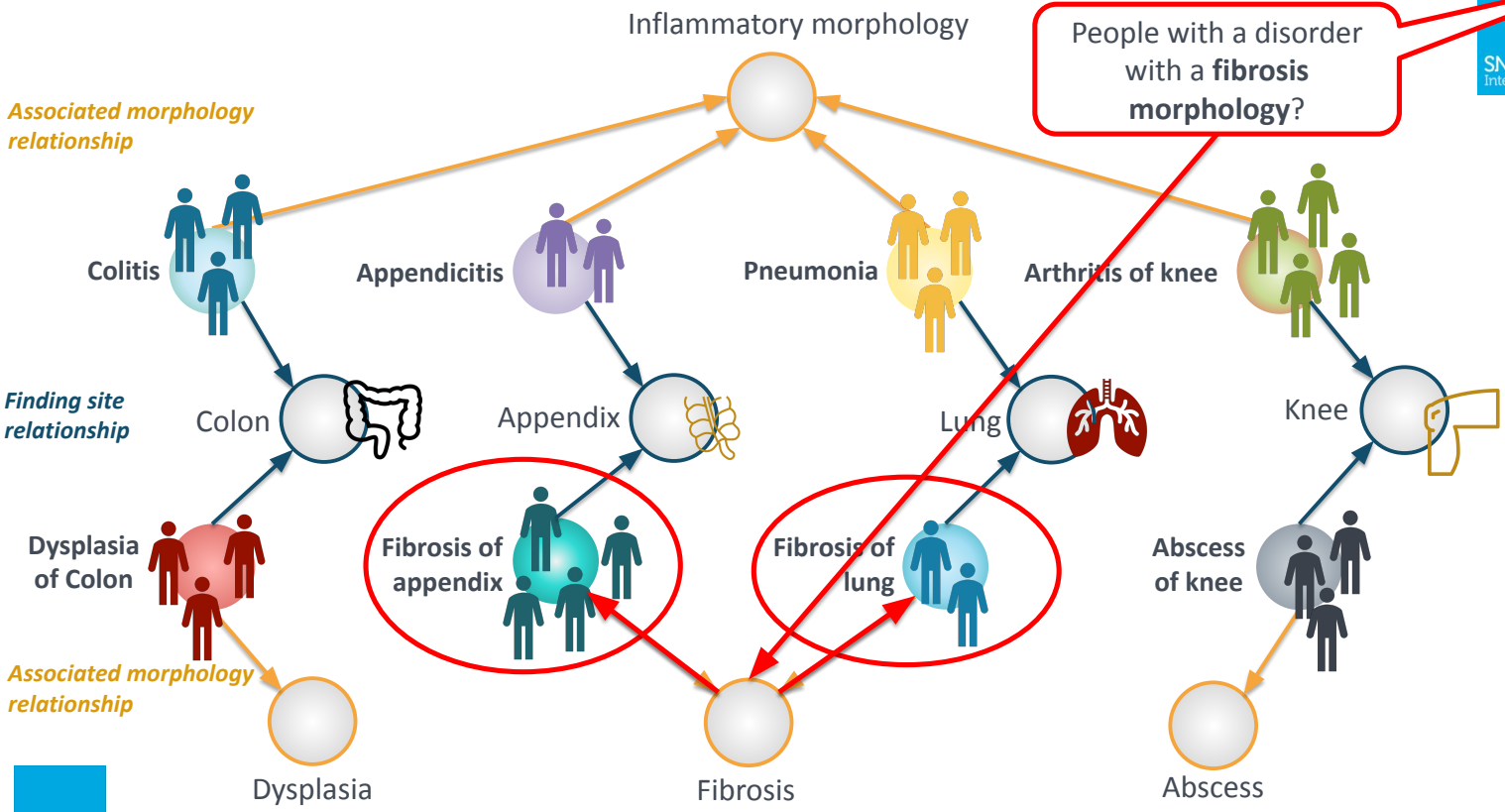
Associated morphology relationship



Inflammatory morphology

People with a disorder located in the **colon** structure?





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	1626063100011910
Primary malignant neoplasm of skin of left breast (disorder)	Primary malignant neoplasm of skin of left breast	1595022100011910
Primary basal cell carcinoma of skin of left breast (disorder)	Primary basal cell carcinoma of skin of left breast	1595014100011910
Primary basal cell carcinoma of skin of right breast (disorder)	Primary basal cell carcinoma of skin of right breast	1595010100011910

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)

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

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	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

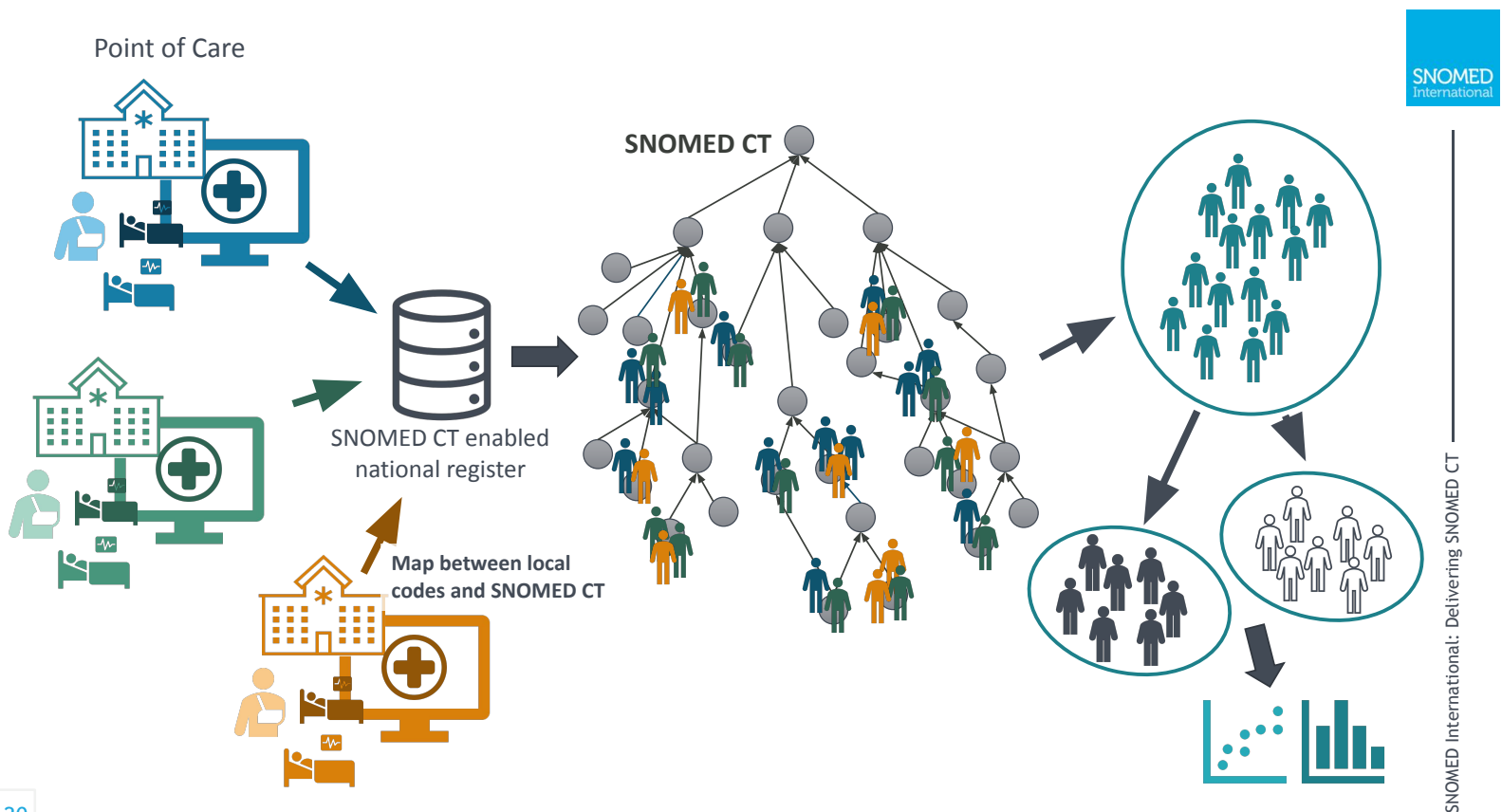
snomed.org



@snomedct



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

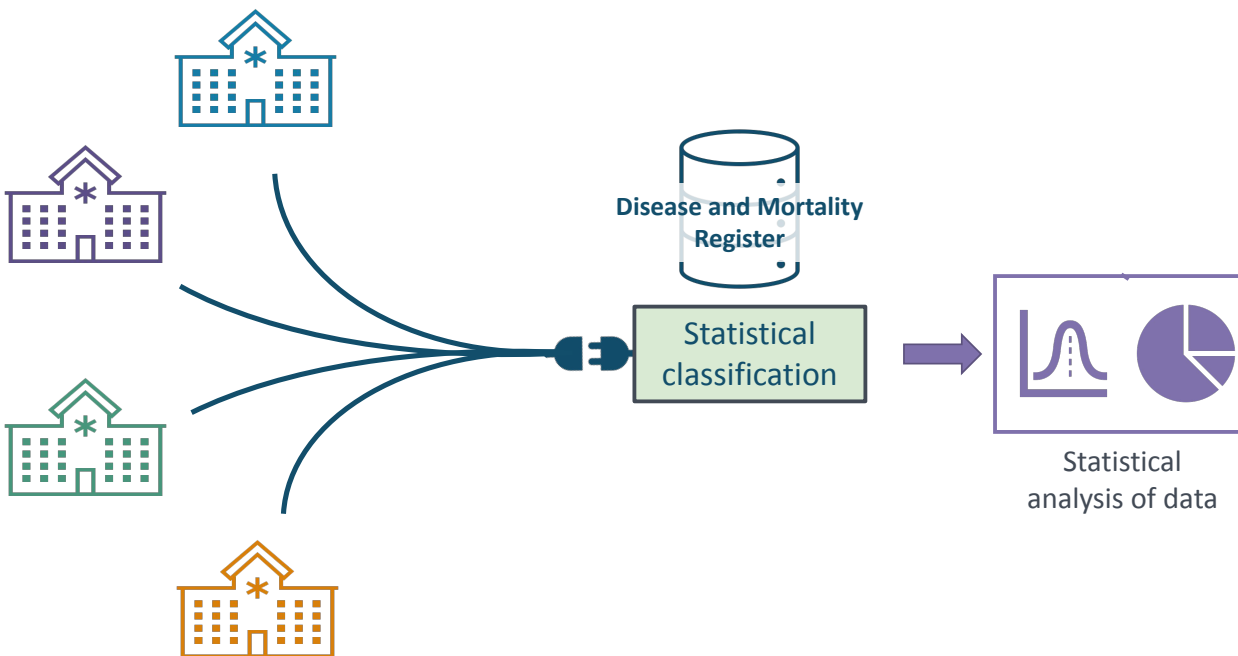
Monitor effect of national programmes and initiatives

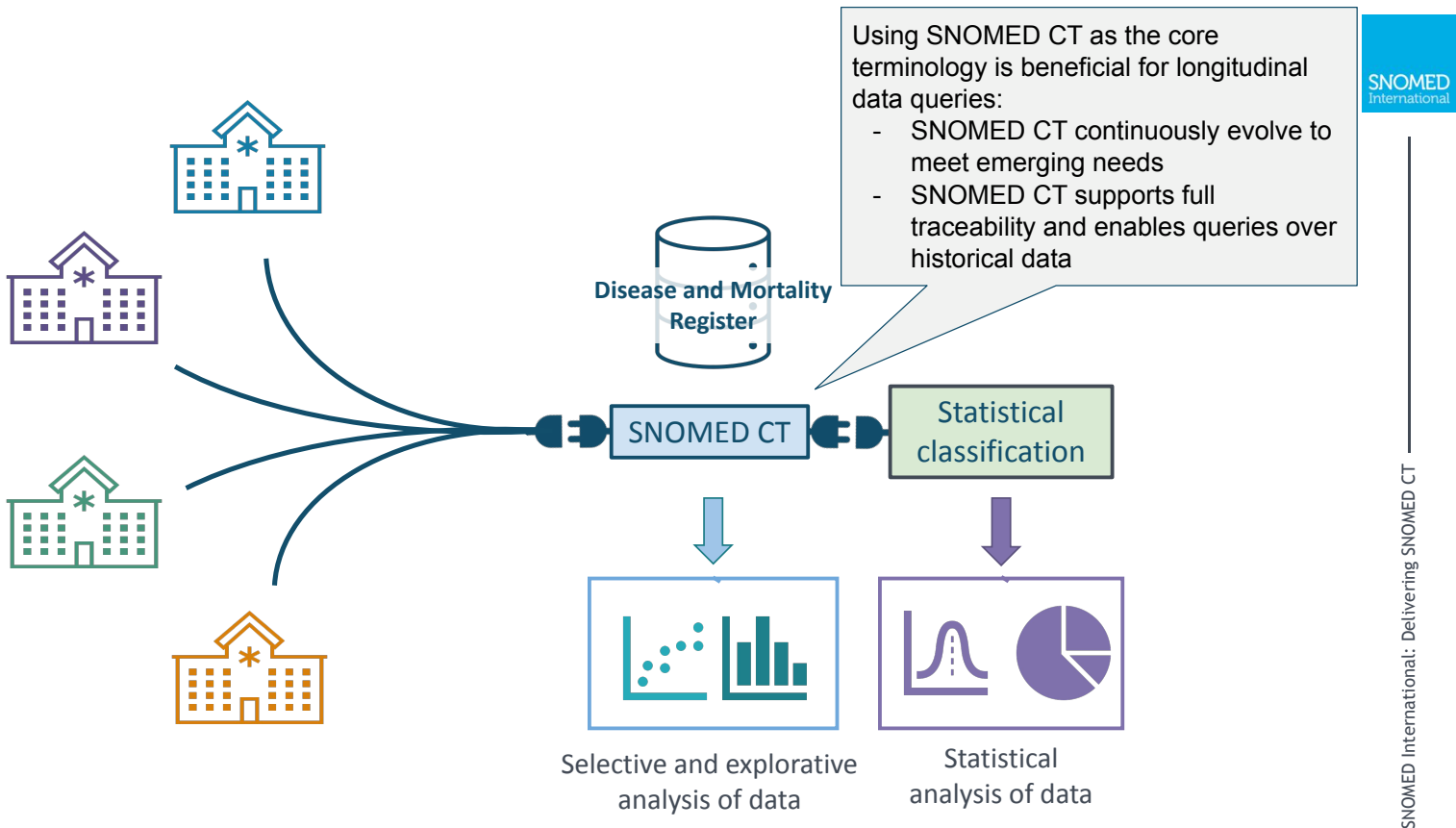
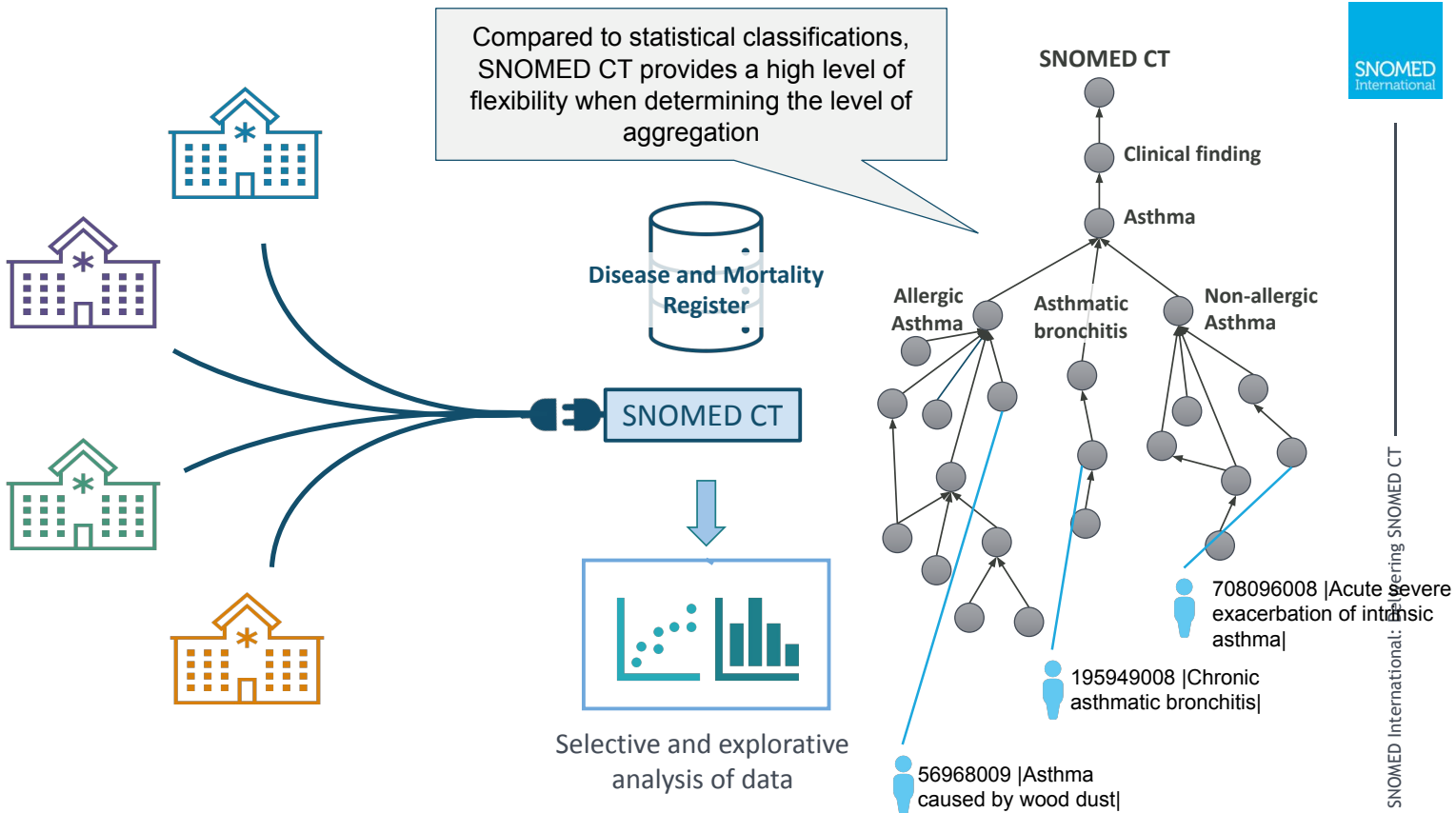
Balance and prioritize healthcare related costs

Demonstration

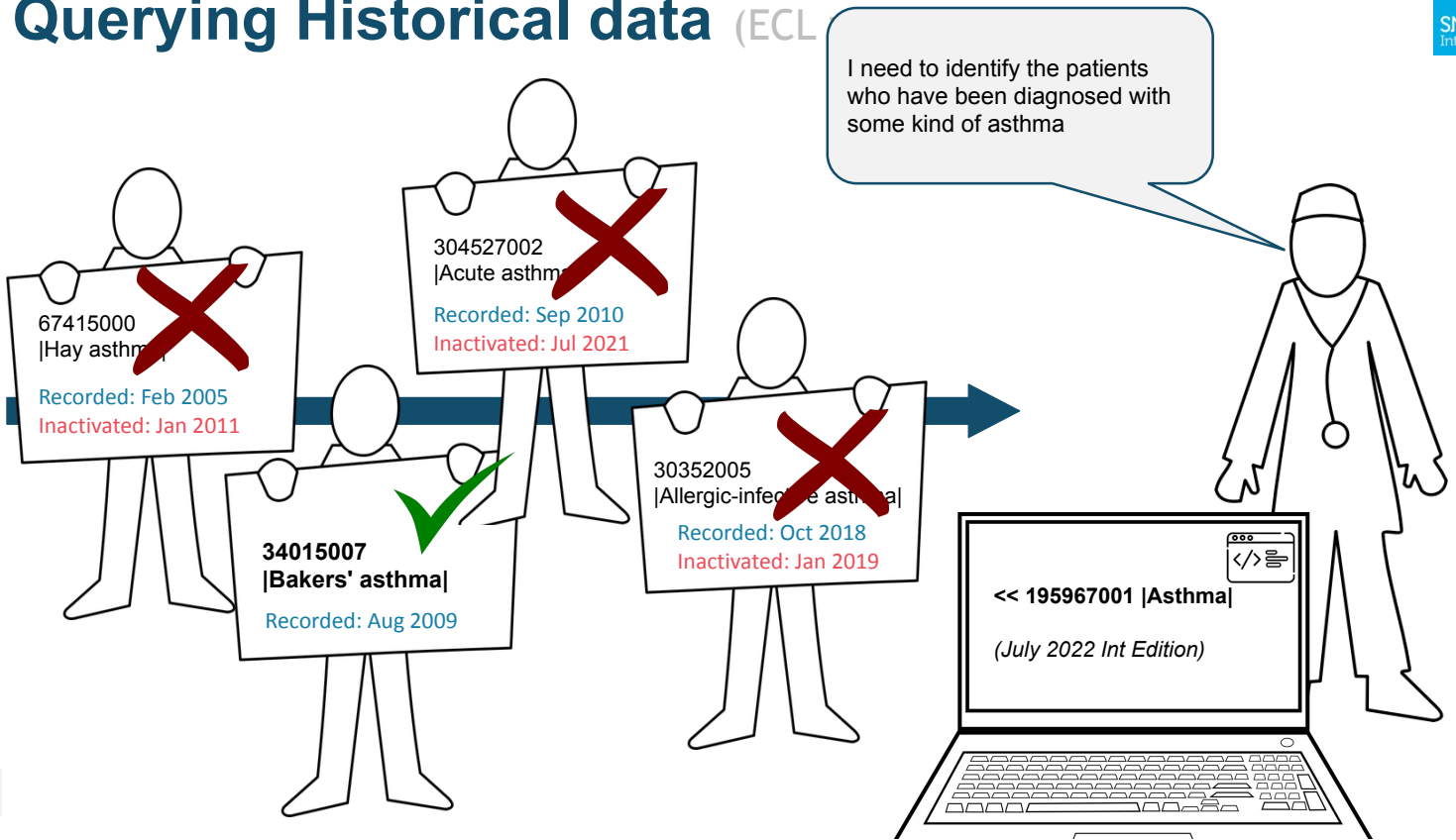
Use a synthetic data set inspired by Danish National Statistics for the **incidence rate** of selected disorders

Small 1 million person population for demo

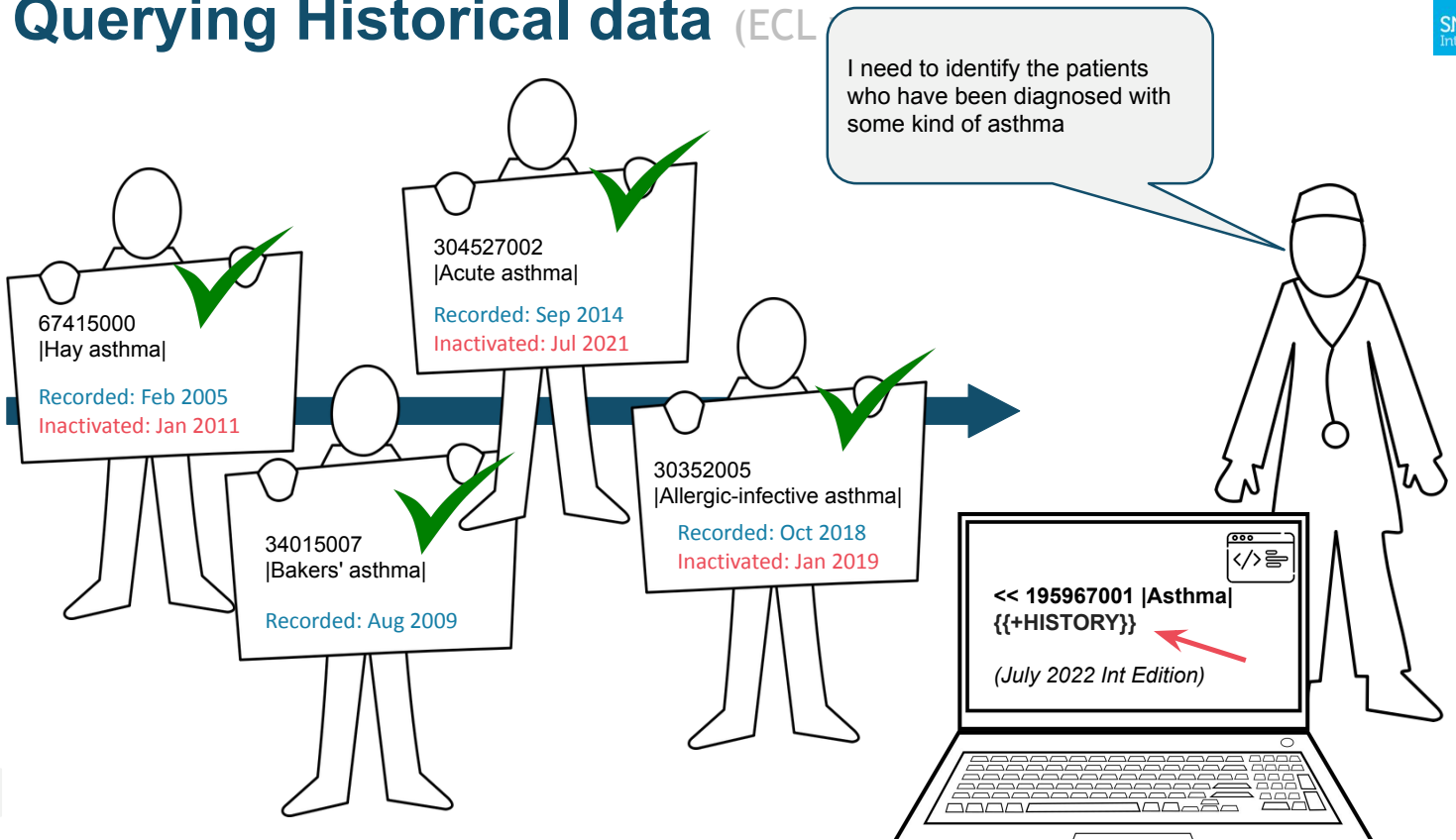




Querying Historical data (ECL)



Querying Historical data (ECL)



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

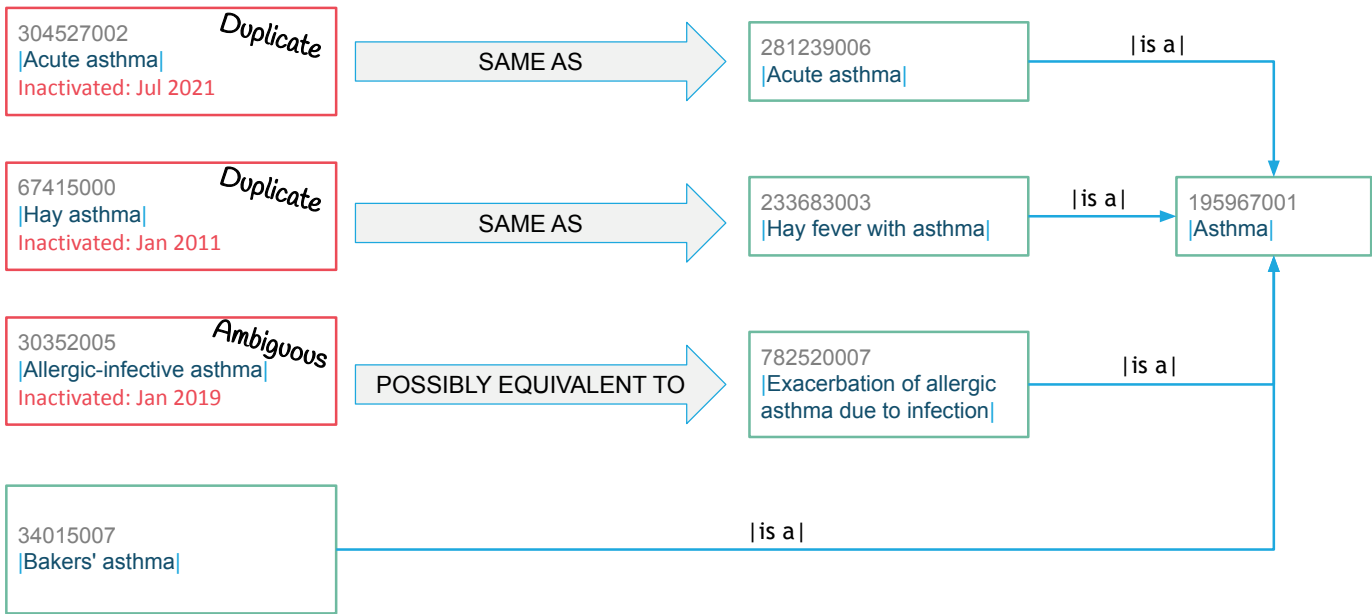
Children
No children

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

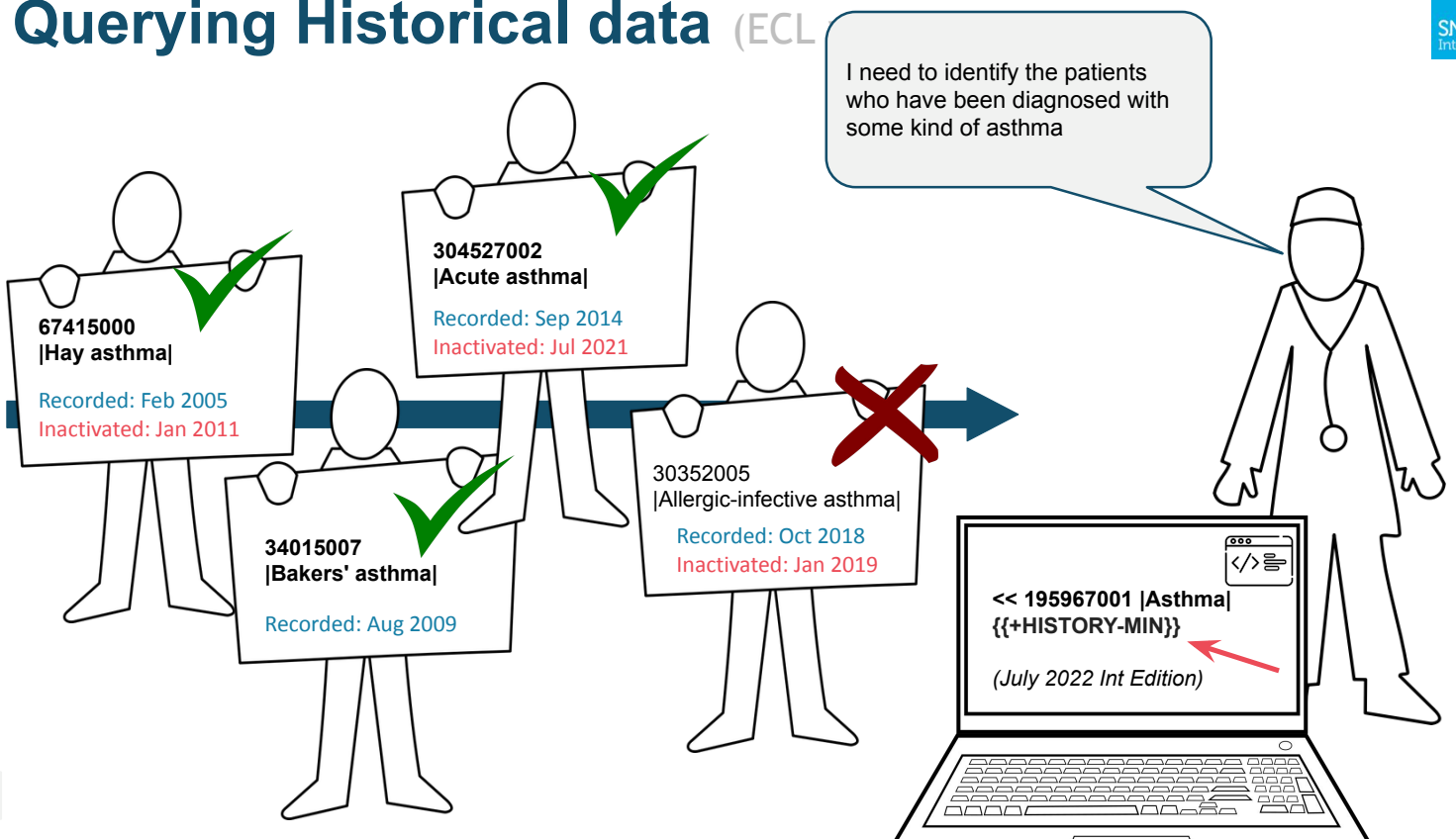
History Supplements (ECL v2.0)



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

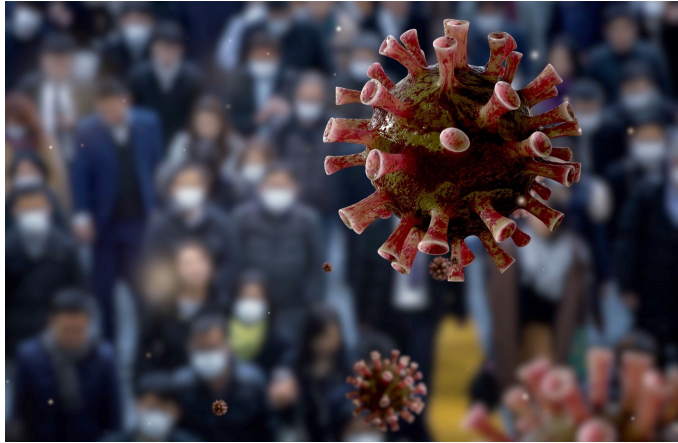
Patient group

People with COVID-19 (any variant)

Outcomes

People with pneumonia due to COVID-19

People died



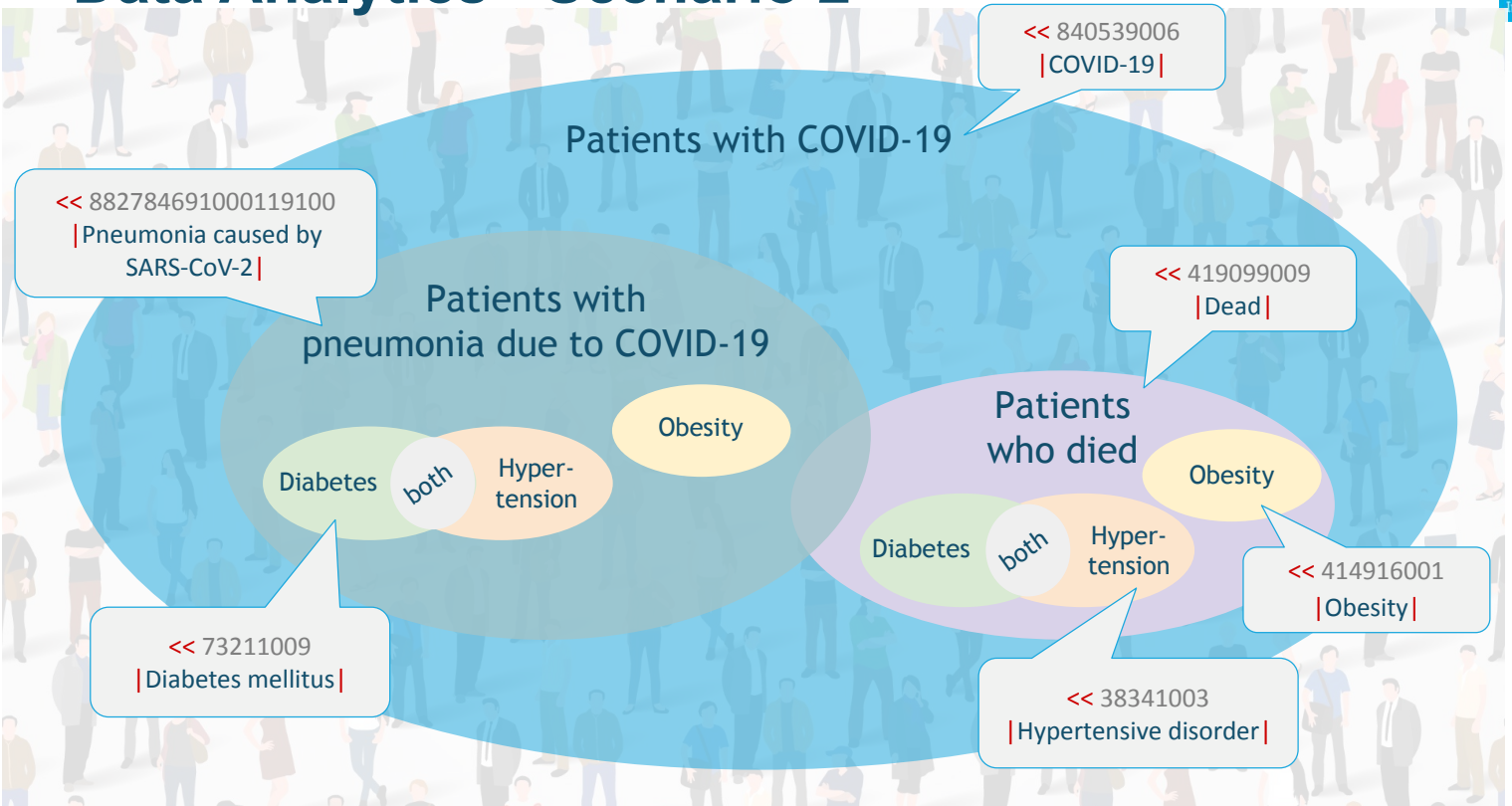
Risk factors

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



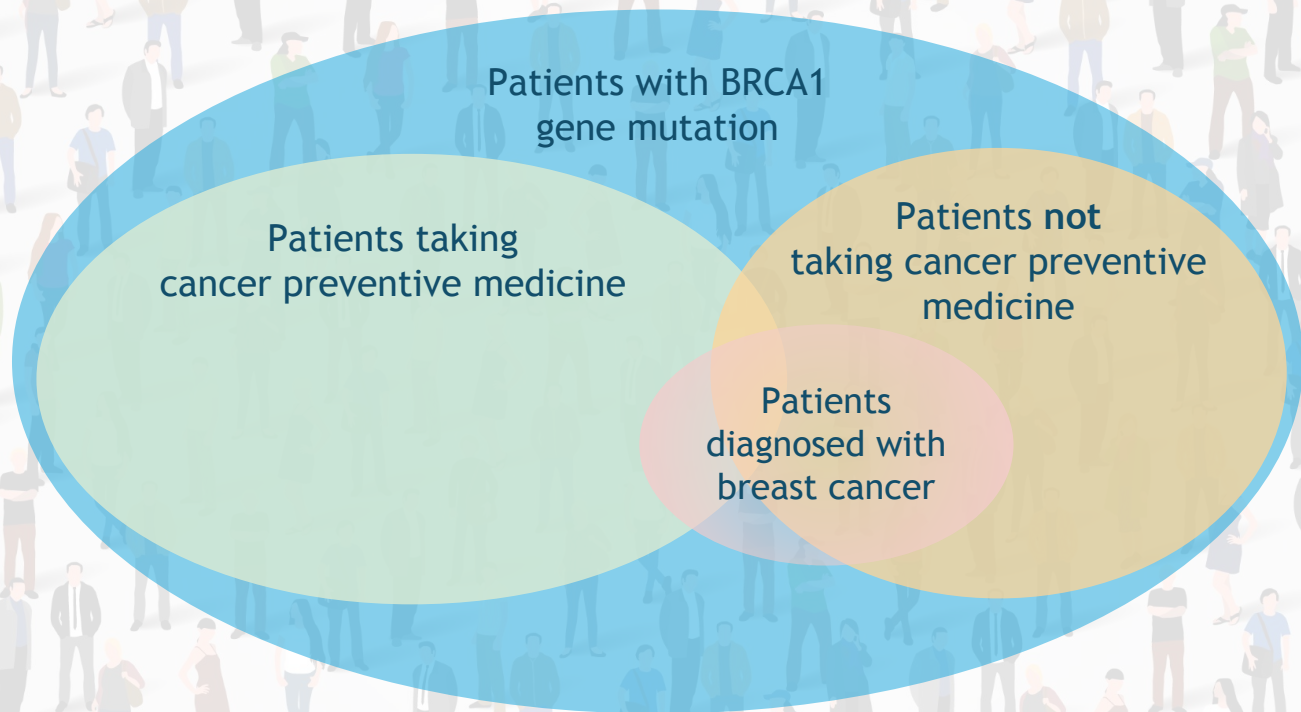
Question

Does the medication significantly reduce the risk of cancer?

Data Analytics - Scenario 3



Data Analytics - Scenario 3



SNOMED CT Queries

Question

What concepts

Query

People with BRCA1 gene mutation

All concepts that are subtypes of the concept 'BRCA1 gene mutation positive'

<< 412734009
|BRCA1 gene mutation positive|

People taking breast cancer preventive medicine?

All concepts that are types of either 'Tamoxifen-containing product', 'Anastrozole-containing product', or 'Raloxifene-containing product'

<< 75959001 |Tamoxifen-containing product|
OR << 108774000 |Anastrozole-containing product| OR << 419530003
|Raloxifene-containing product|

People with breast cancer?

All concepts that represent a disease with a morphology of 'Malignant tumor of breast'

<< 254837009
|Malignant tumor of breast|

Data Analytics - Scenario 3

<< 412734009
|BRCA1 gene mutation positive|

Patients with BRCA1 gene mutation

Patients taking medication containing either tamoxifen, anastrozole or raloxifene

Patients not taking preventive medication

Patients diagnosed with breast cancer

<< 75959001 |Tamoxifen-containing product|
OR << 108774000 |Anastrozole-containing product| OR << 419530003 |Raloxifene-containing product|

<< 254837009
|Malignant tumor of breast|

Patient Data Analytics

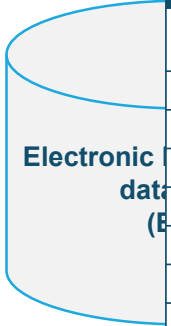
<< 254837009 |Malignant tumor of breast|

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|)
```

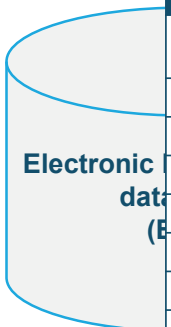


Patient_Id	Diagnosis	Diagnosis term
001	145501000119108	Metastatic malignant neoplasm of breast
002	722223000	Cyst of kidney
003	254840009	Inflammatory carcinoma of breast
004	64226004	Colitis
005	1197732001	Colorectal Crohn disease
006	278050001	Sarcoma of breast
007	1197732001	Colorectal Crohn disease
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
...

Patient Data Analytics

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



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
...

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

Demonstration



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

Questions?



snomed.org



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



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

THANK YOU



snomed.org



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



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