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SNOMED CT

# Data Analytics with SNOMED CT

## *SNOMED CT in Germany*

May 10th, 2023

*Anne Højen and Kai Kewley*  
*SNOMED International*

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# Outline

(Friday)  
March 24

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



# Introduction to Data Analytics and Meaning-based Data Retrieval

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# 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?*

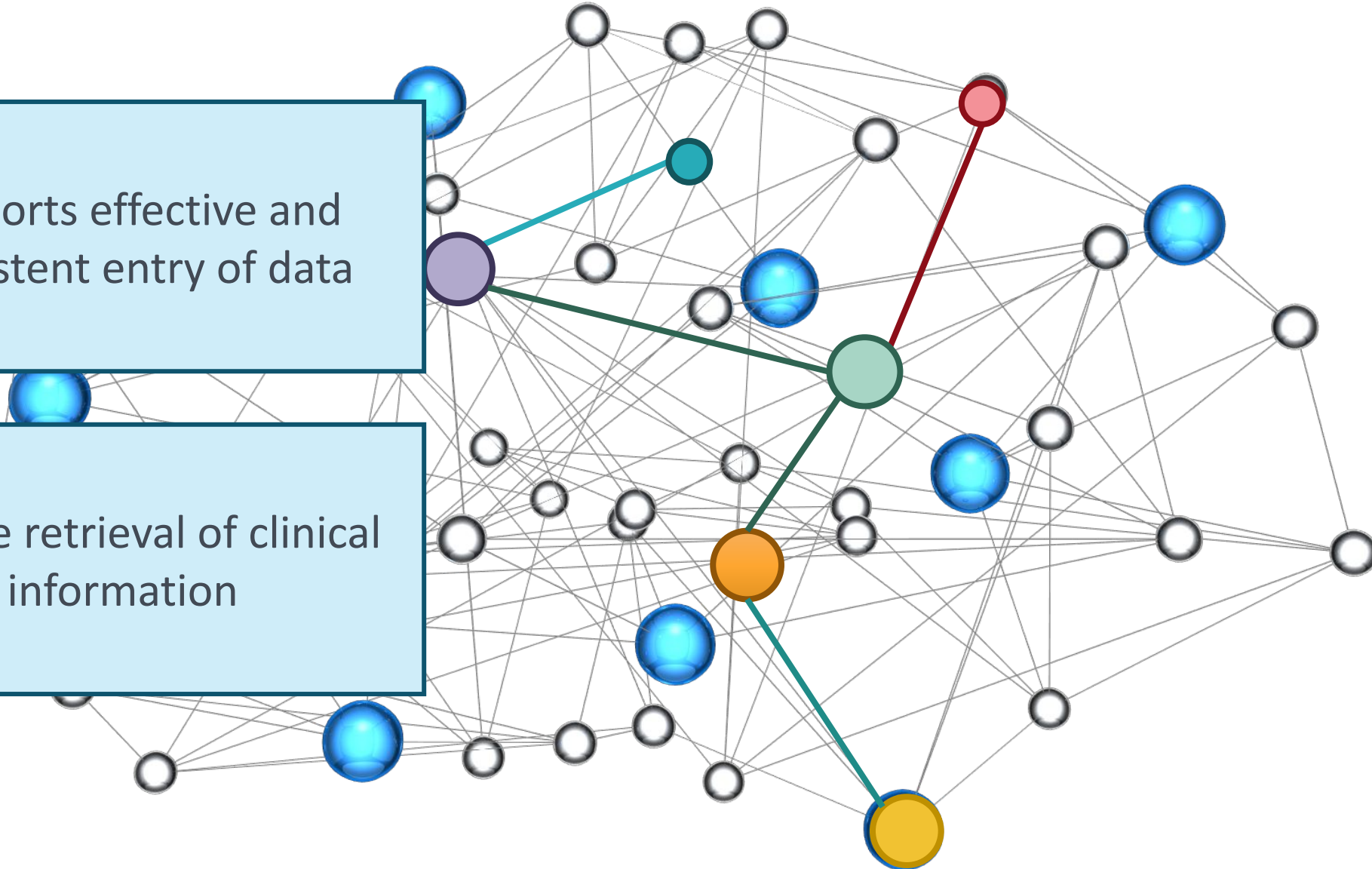


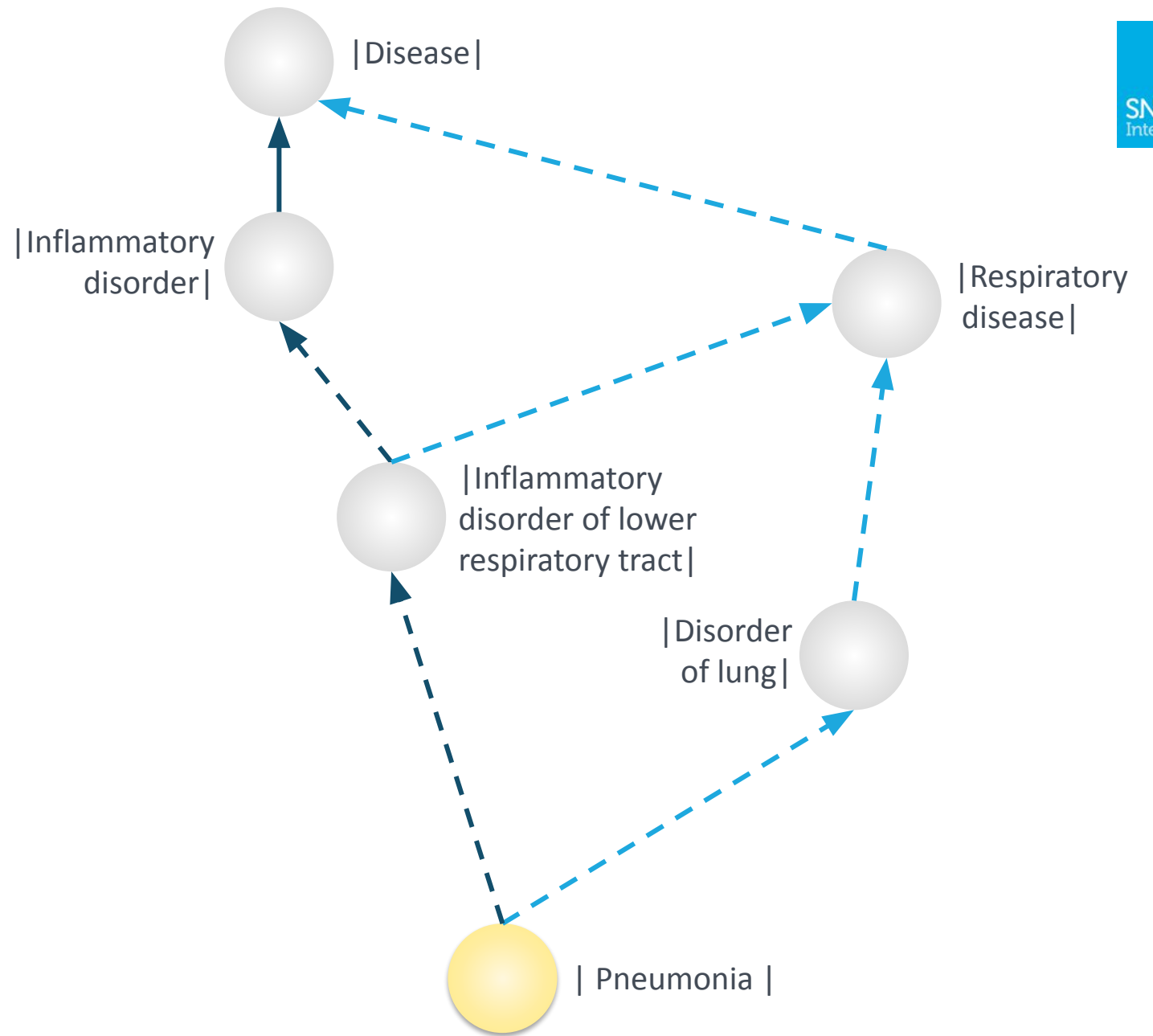
**Improving the quality and efficiency of care**  
*What are the causal effects?*

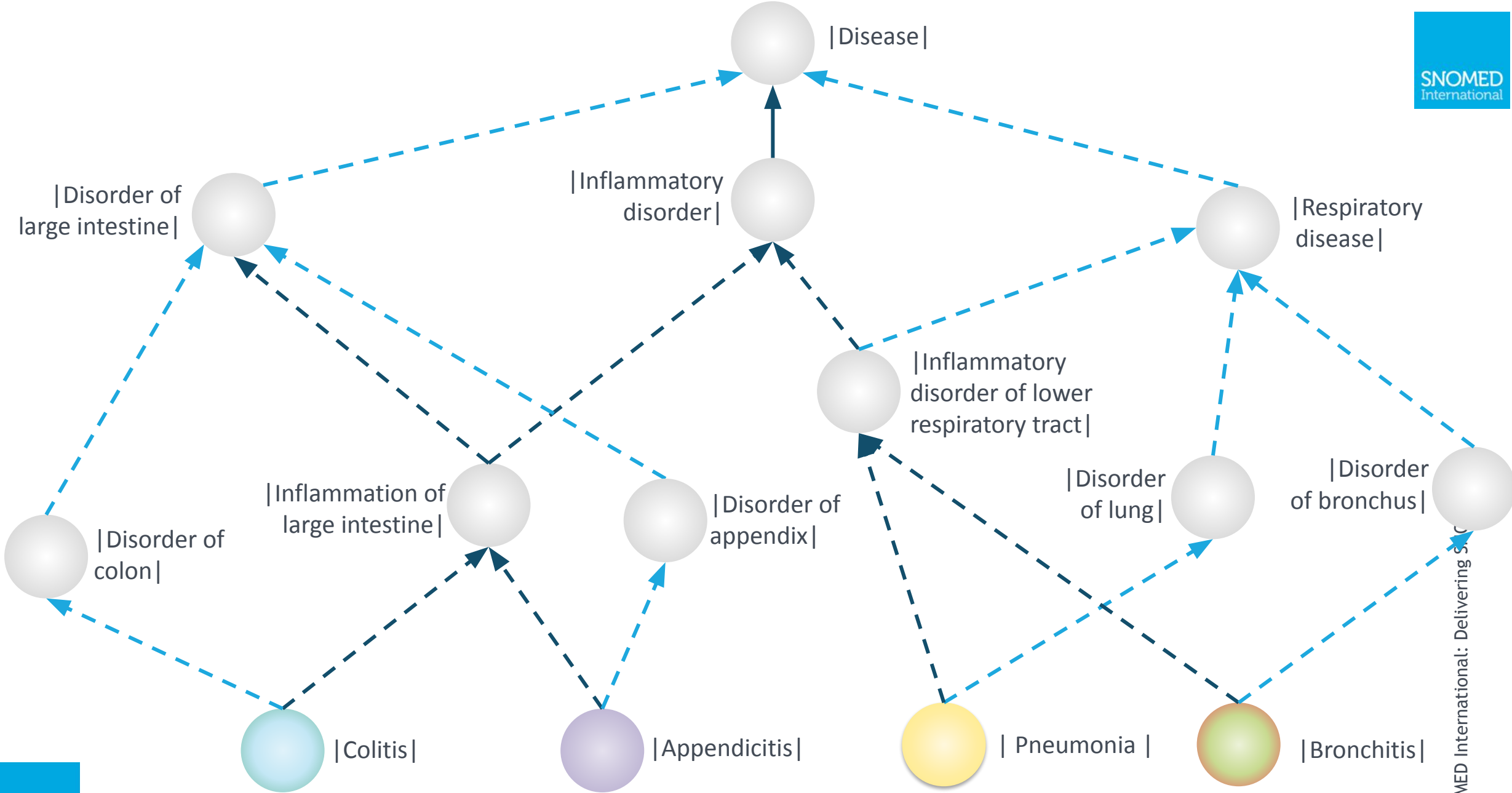
## ... A Semantic Network of Clinical Meanings

Supports effective and  
consistent entry of data

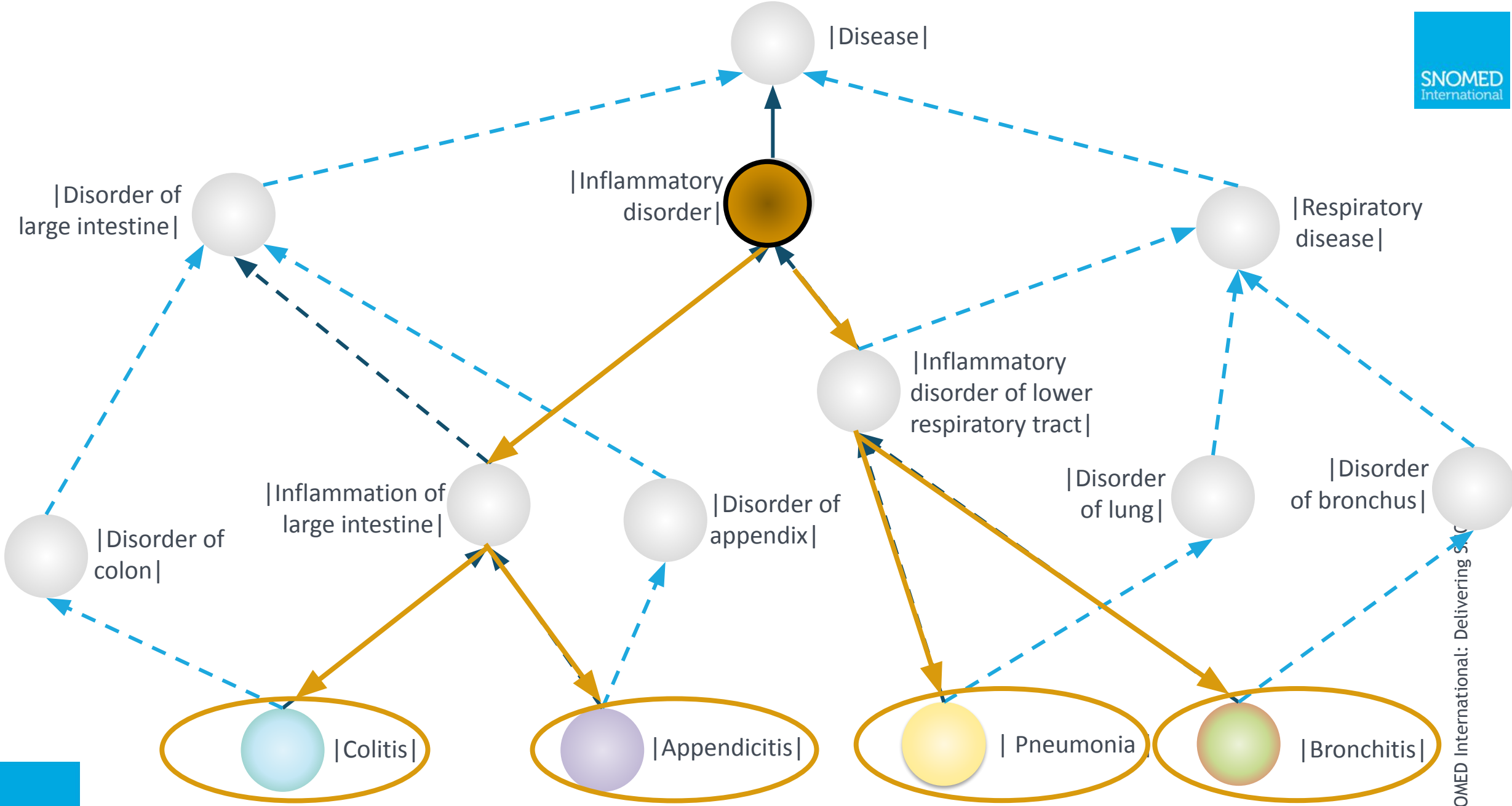
Flexible retrieval of clinical  
information

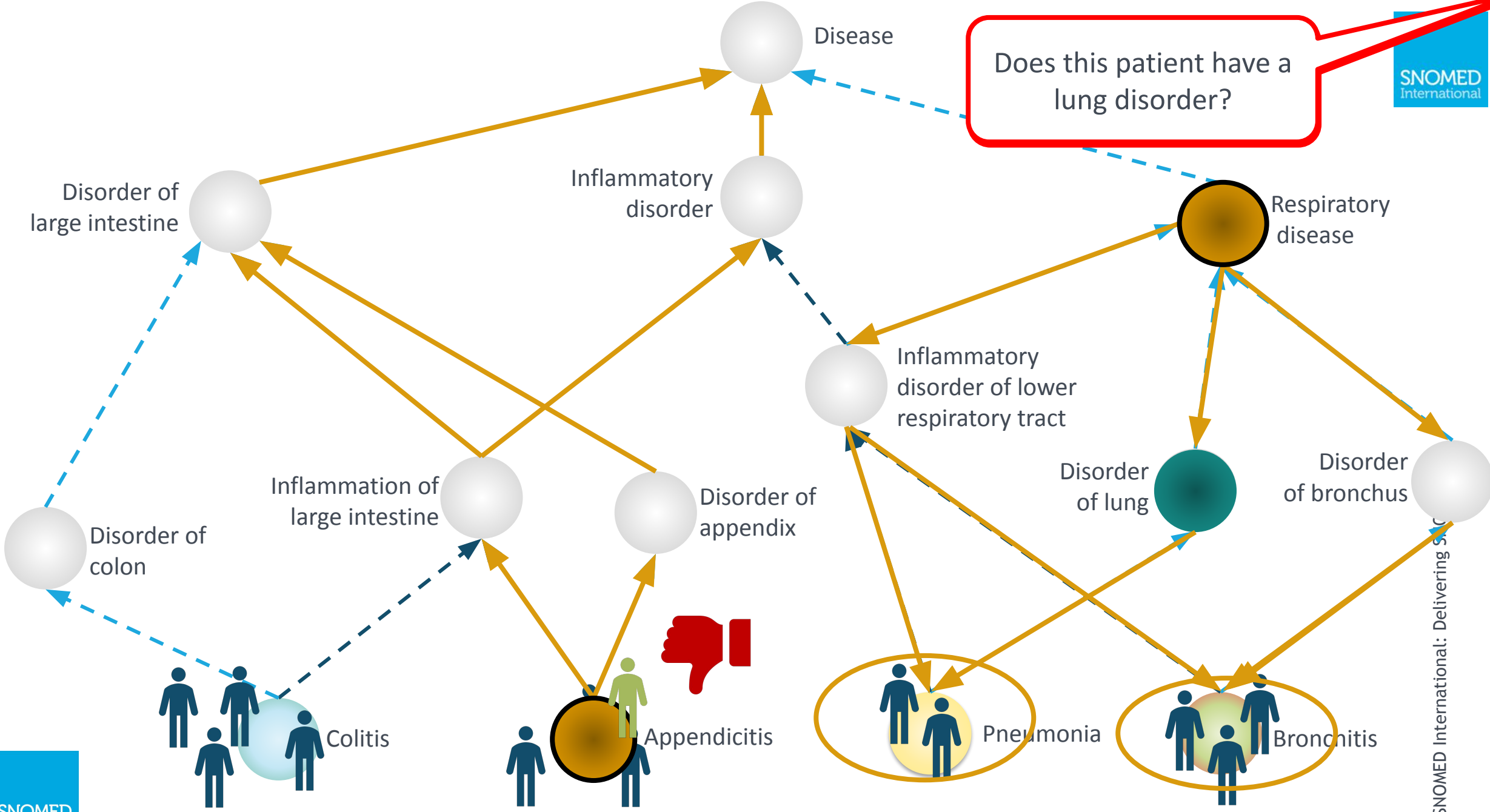










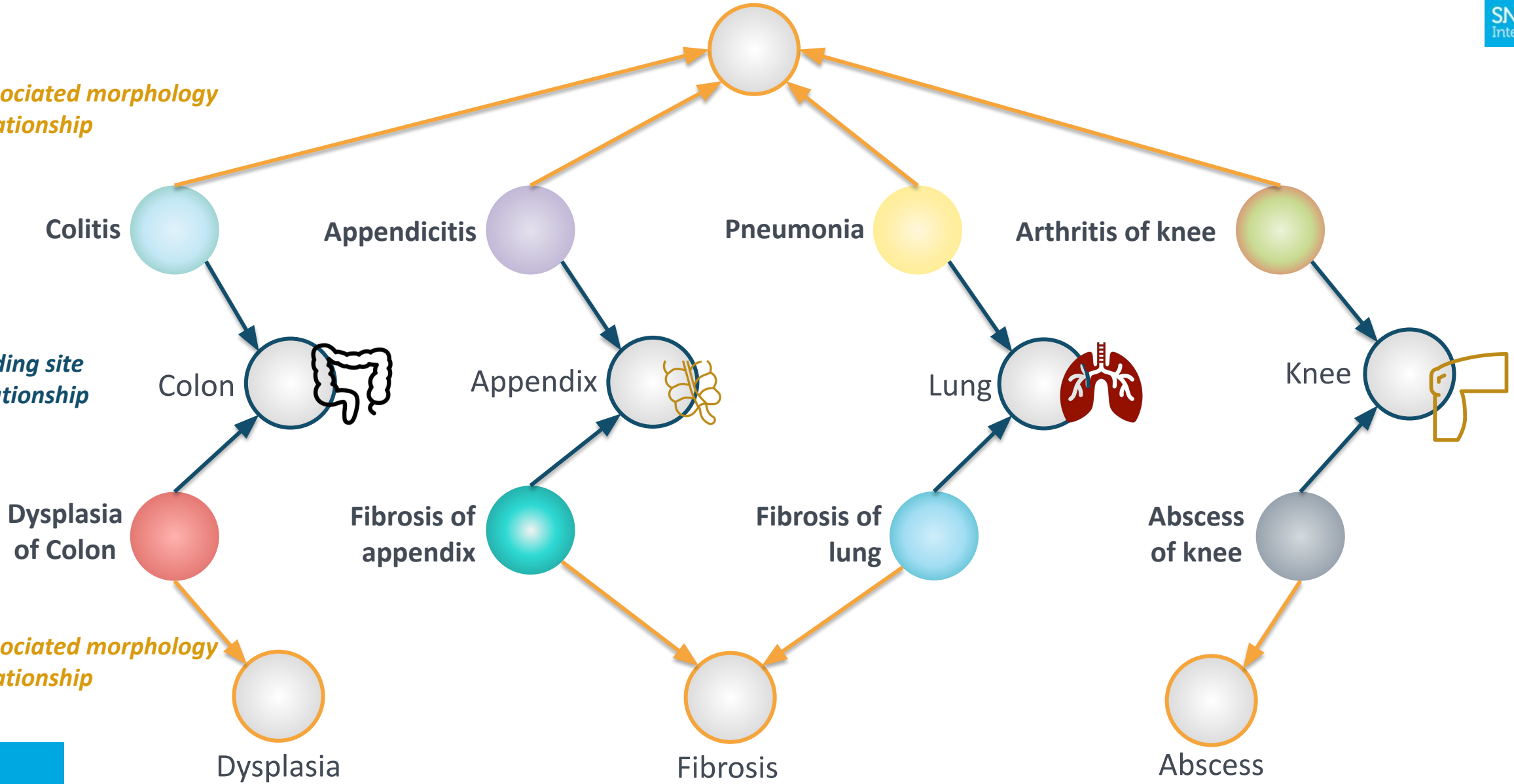


# Inflammatory morphology

*Associated morphology relationship*

*Finding site relationship*

*Associated morphology relationship*



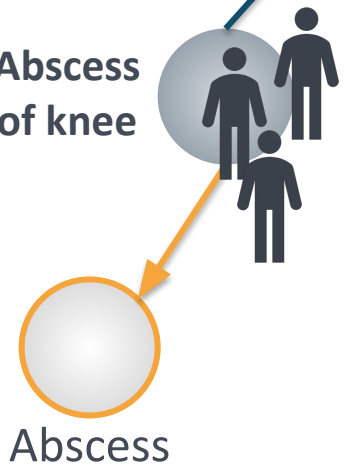
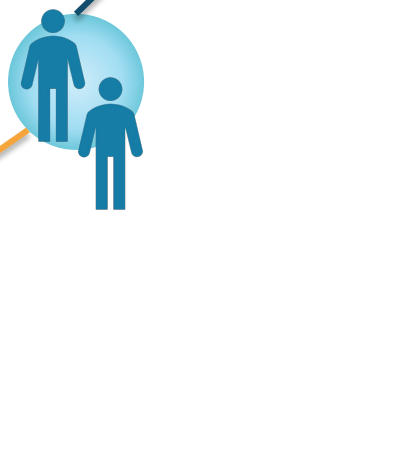
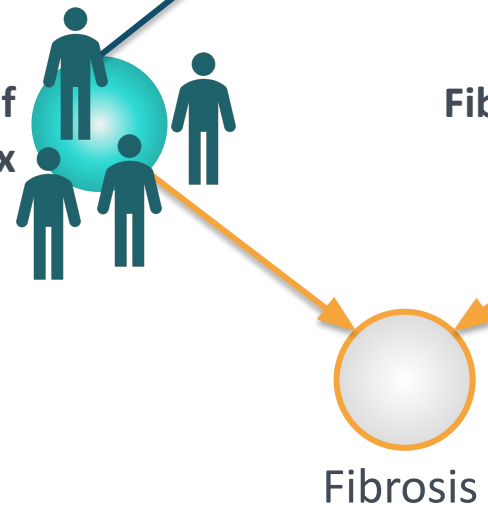
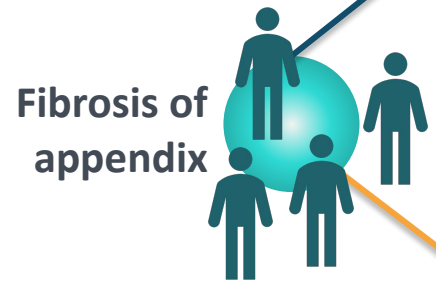
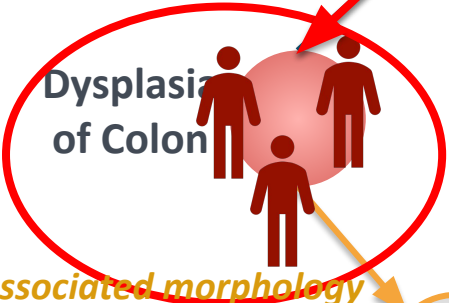
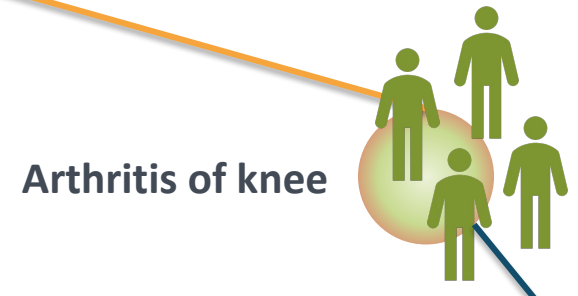
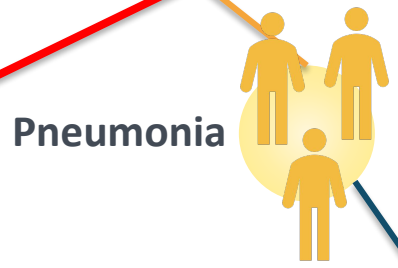
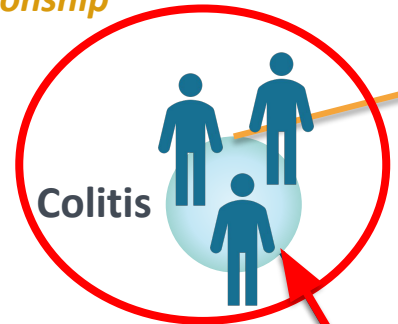


People with a disorder located in the **colon** structure?

*Associated morphology relationship*

*Finding site relationship*

*Associated morphology relationship*

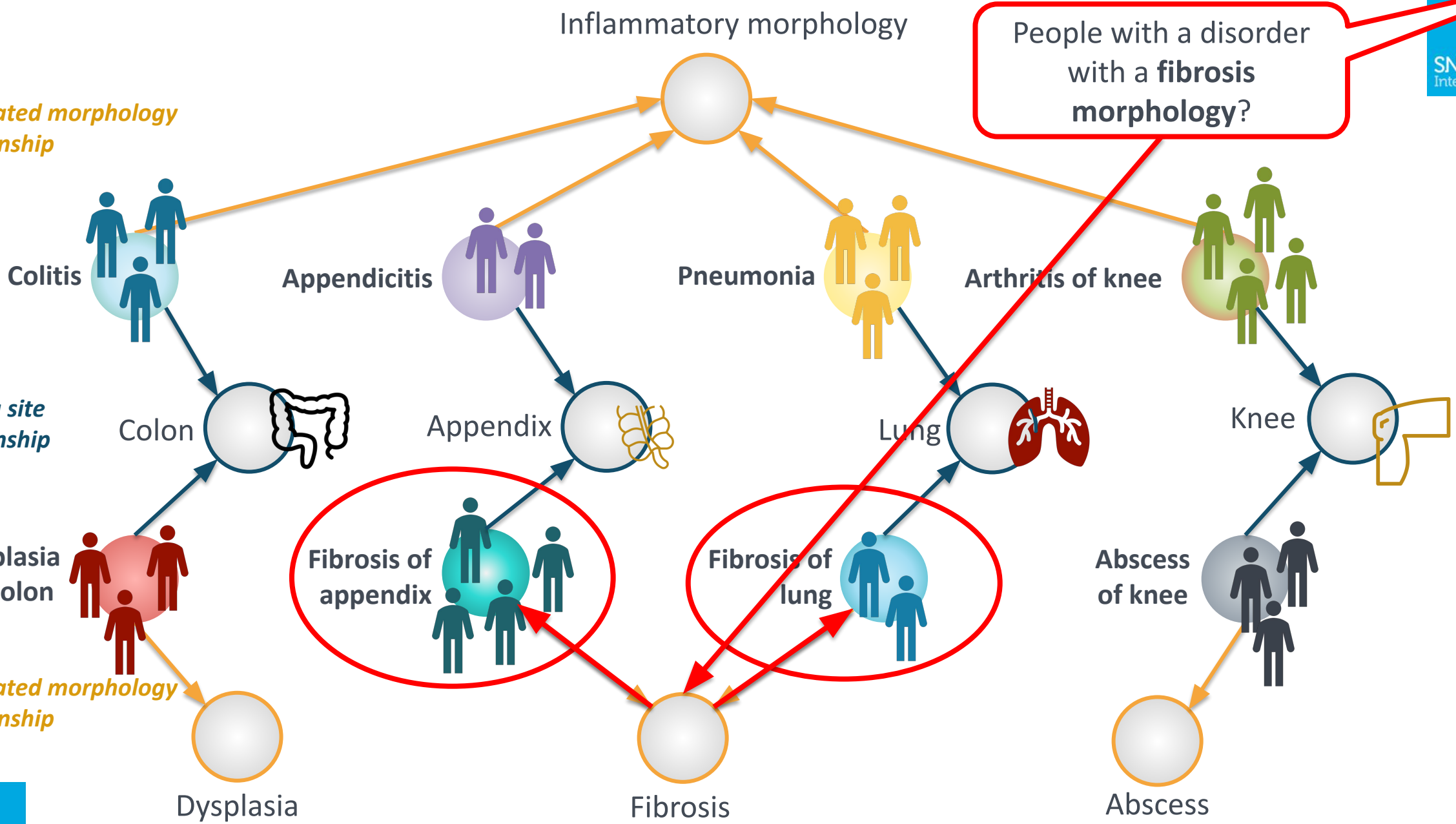


*Associated morphology relationship*

People with a disorder with a **fibrosis morphology**?

*Finding site relationship*

*Associated morphology relationship*



## Question

People with a **respiratory disease**?

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

People with a disorder with a **fibrosis morphology**?

## What concepts

All concepts that are subtypes of the concept 'respiratory disease'

All concepts that represent a disease with a finding site of 'colon structure'

All concepts that represent a disease with a morphology of 'fibrosis'

## Expression constraint language

## Query

```
<< 50043002 |Respiratory disease|
```

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

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



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

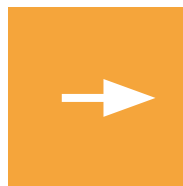
## Expression constraint language

### 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 |Breast structure|,  
 116676008 |Associated morphology| = << 367651003 |Malignant Neoplasm (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 (disorder)	Primary malignant neoplasm of skin of right breast	15950061000119105



# 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

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# Population Health Monitoring

[snomed.org](http://snomed.org)

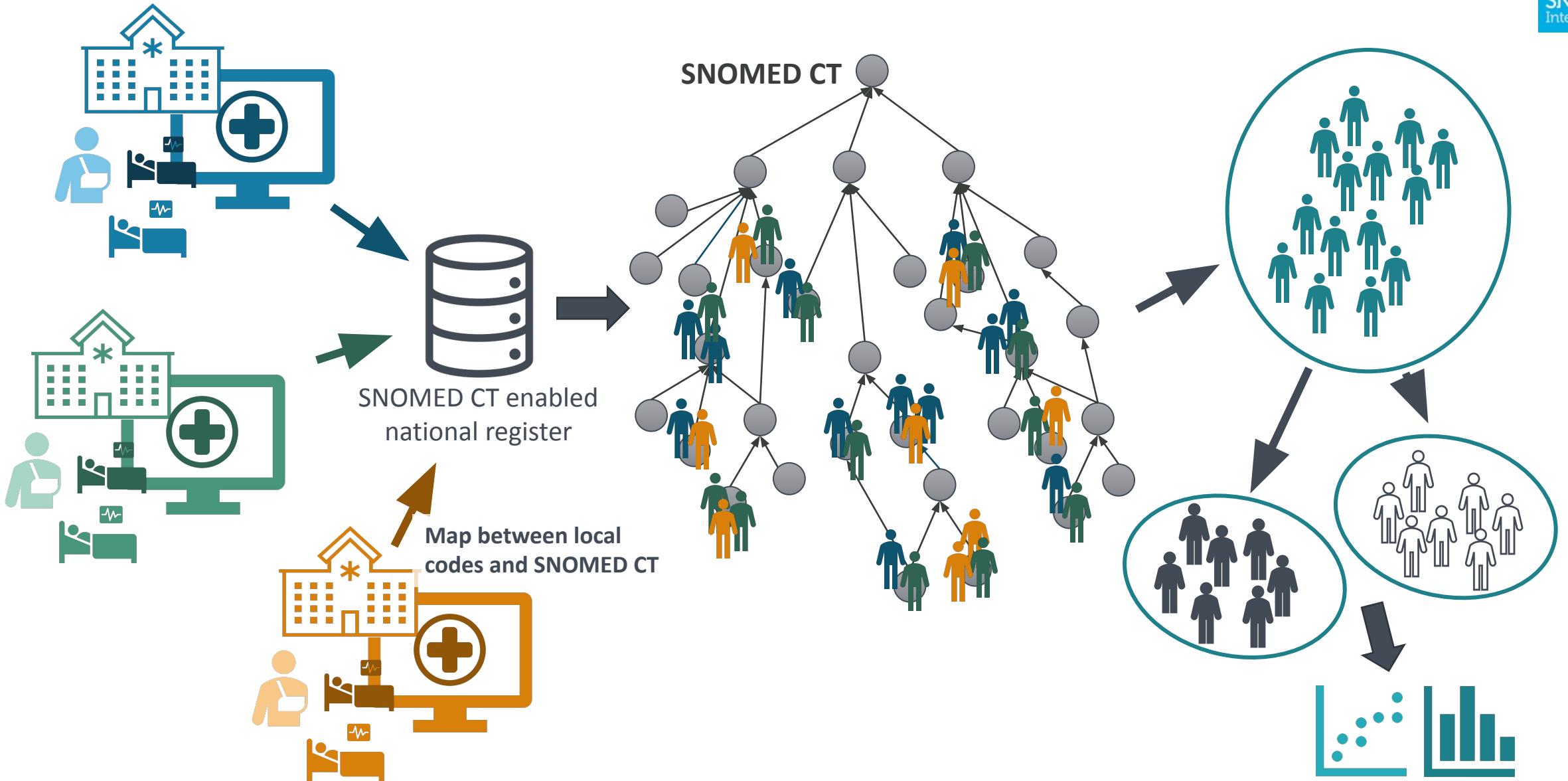


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Point of Care



# 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

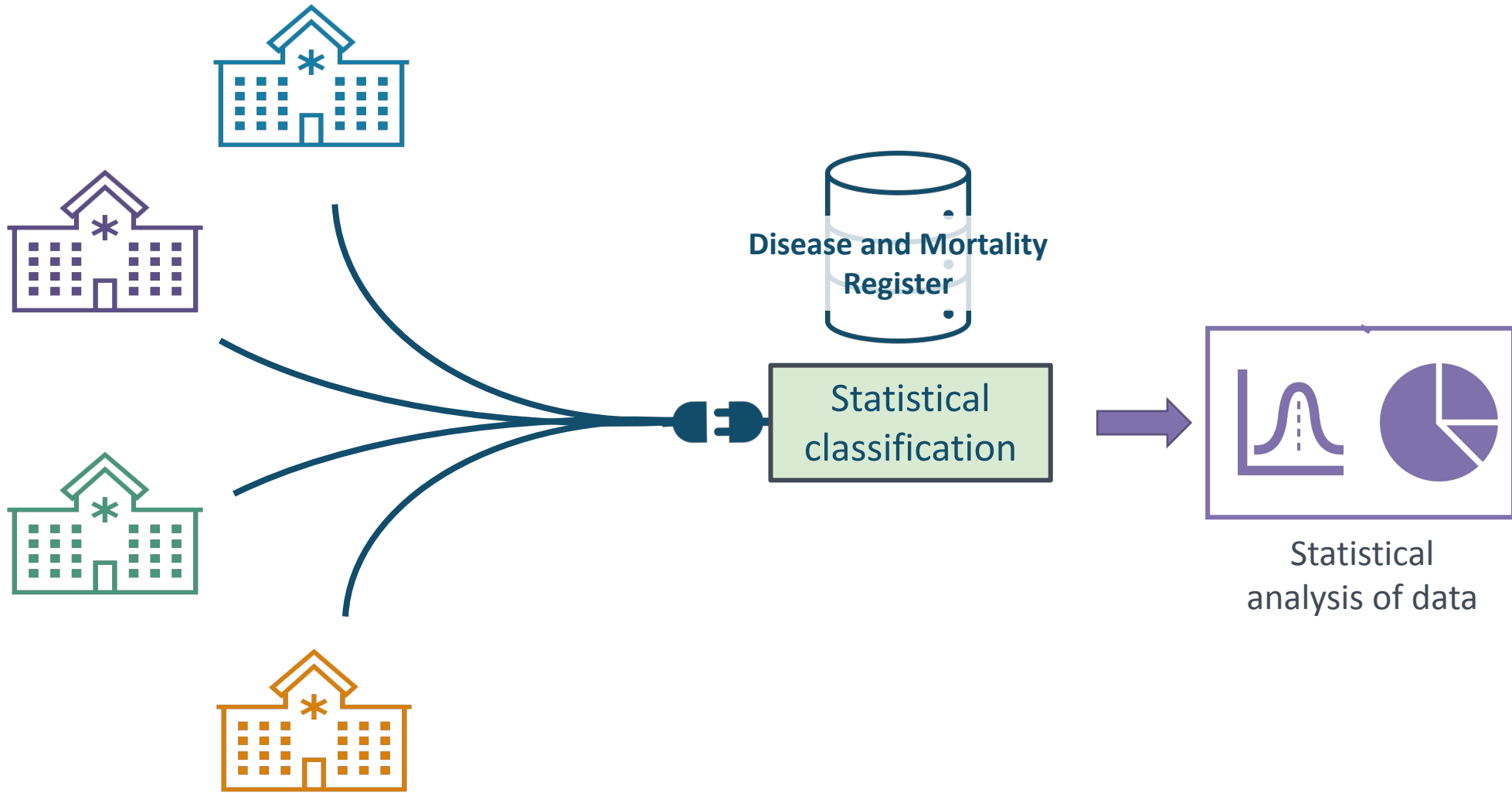
Balance and prioritize  
healthcare related costs

# 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

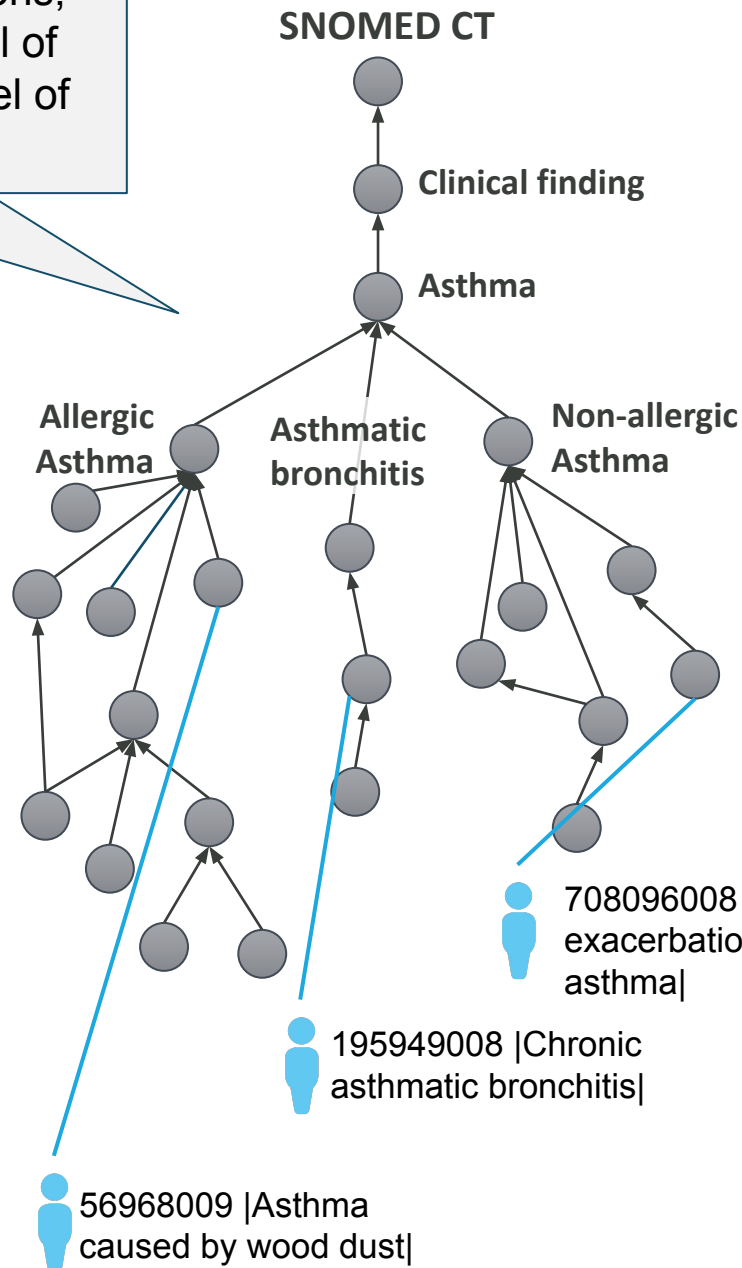




Compared to statistical classifications, SNOMED CT provides a high level of flexibility when determining the level of aggregation



Selective and explorative analysis of data

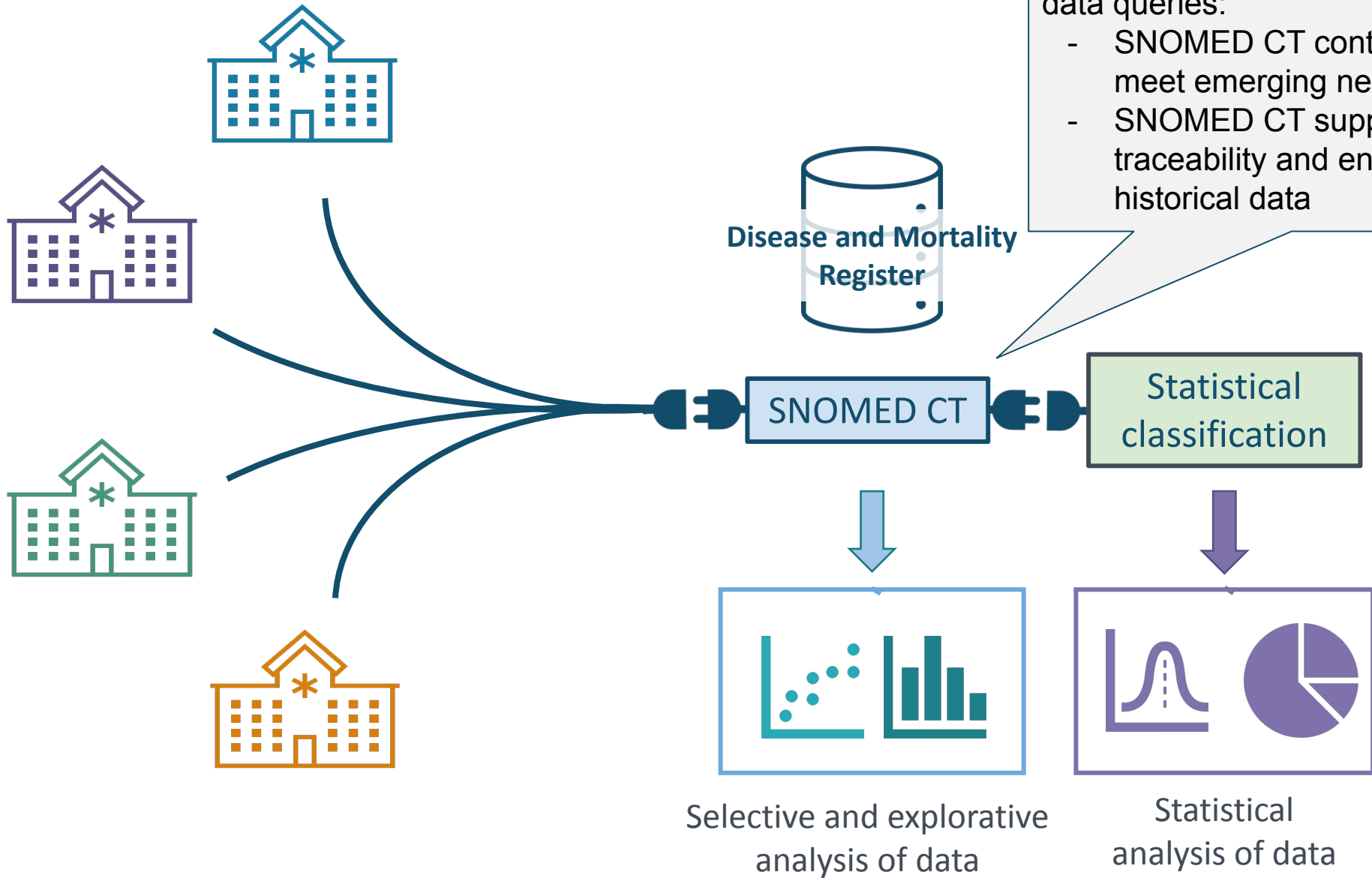


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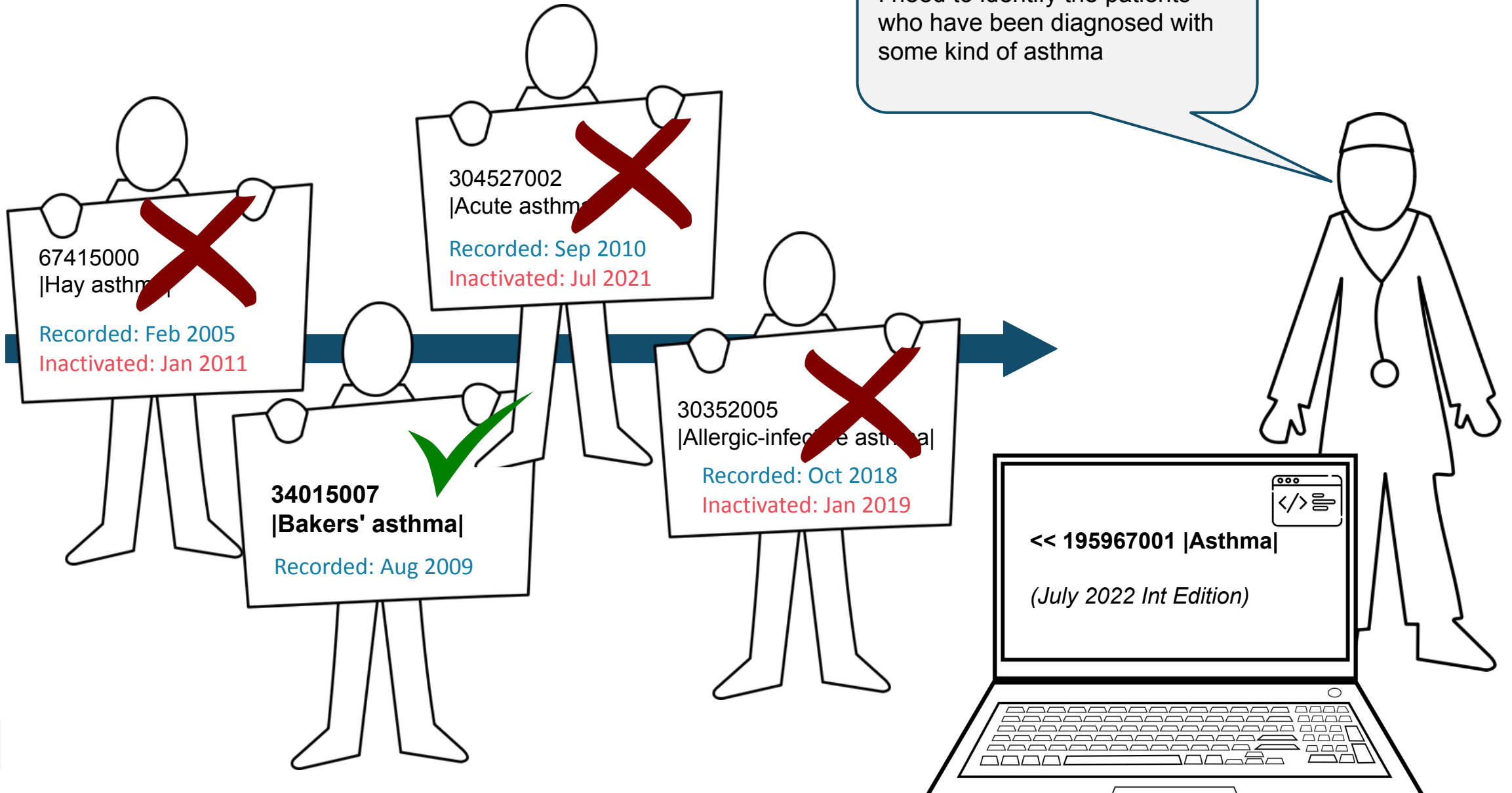
Using SNOMED CT as the core terminology is beneficial for longitudinal data queries:

- SNOMED CT continuously evolve to meet emerging needs
- SNOMED CT supports full traceability and enables queries over historical data



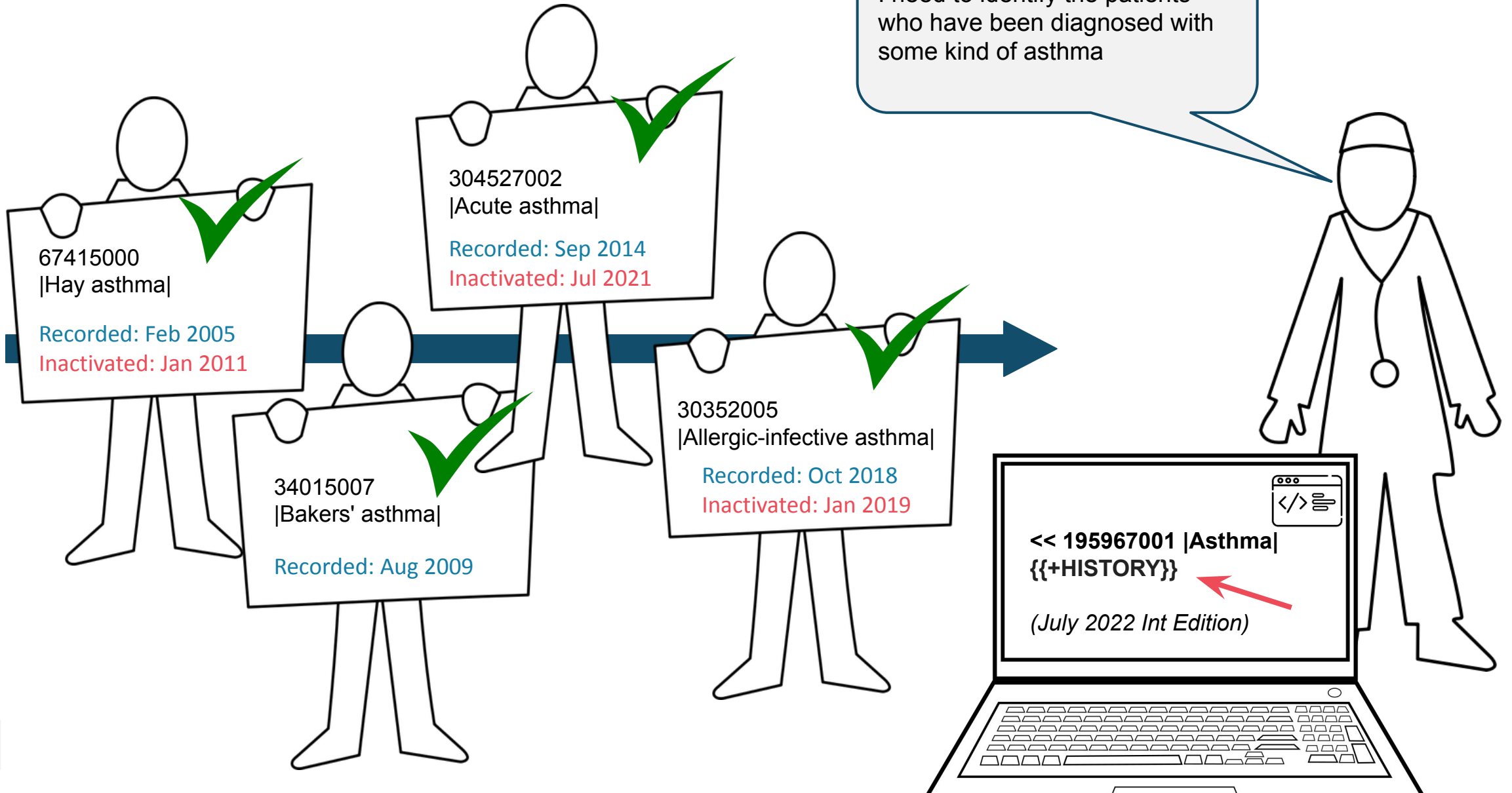
# Querying Historical data (ECL

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

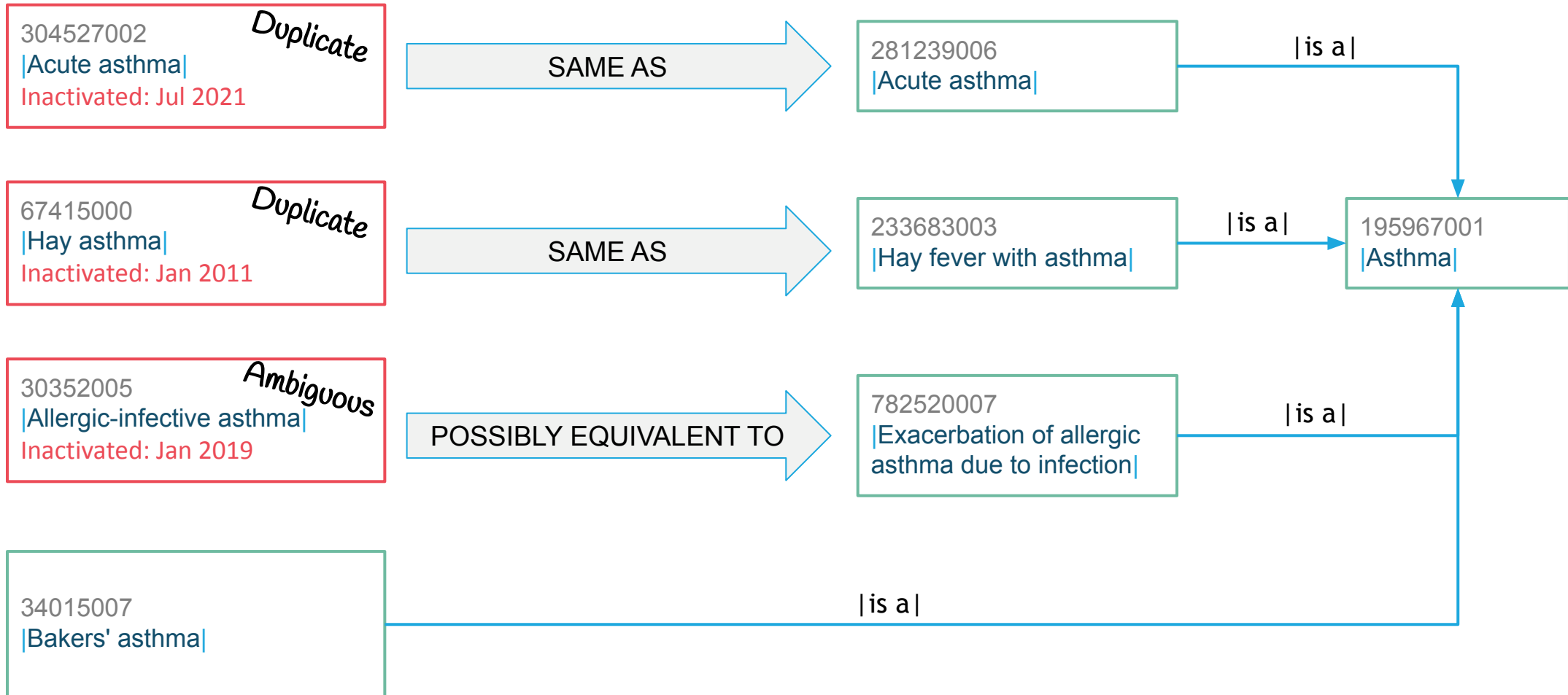
Important to retain access to  
inactivated content to support  
historical records

## Children

No children



# History Supplements (ECL v2.0)

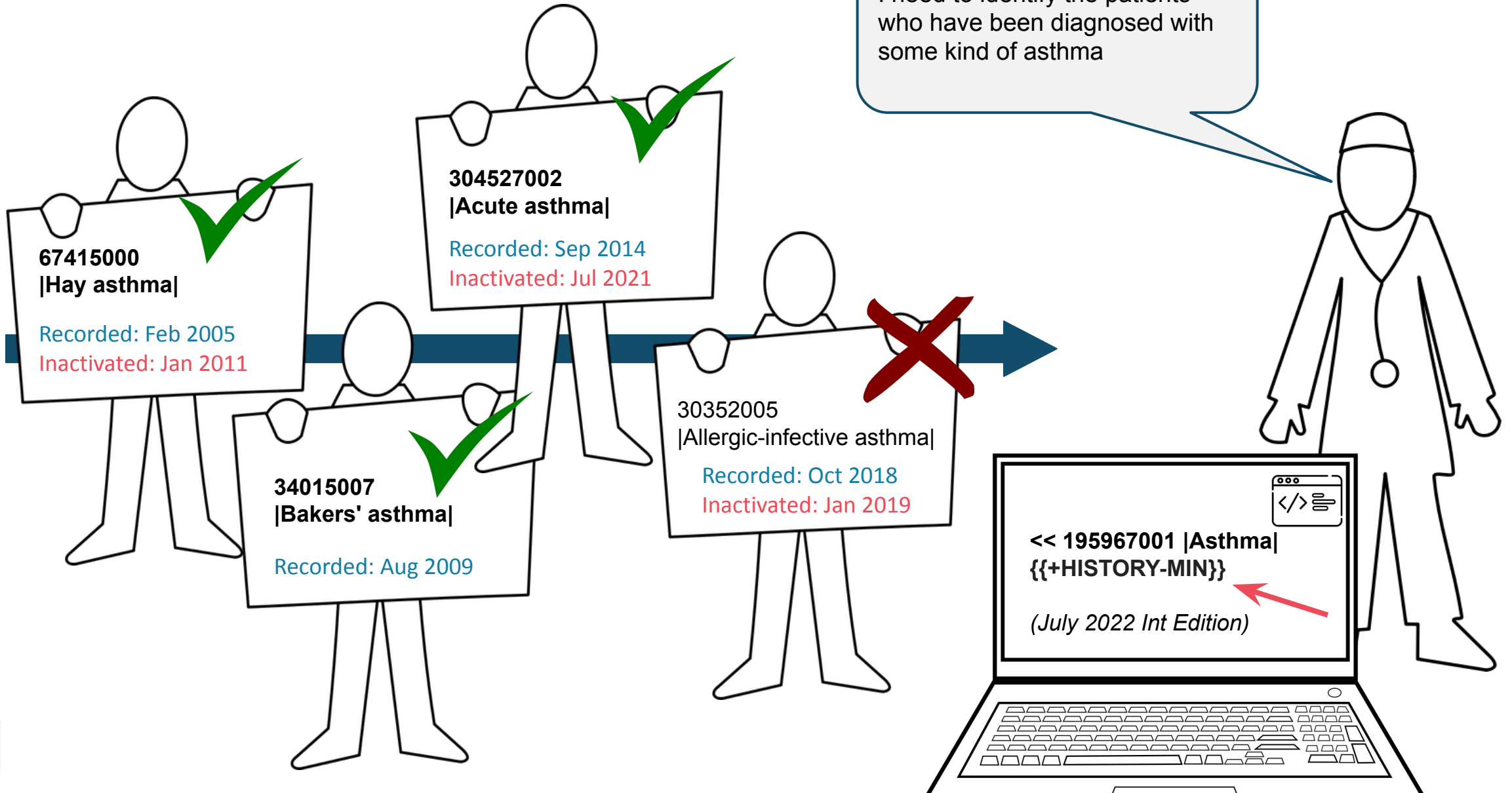


# History Supplements (ECL v2.0)

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

# Querying Historical data (ECL

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



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# Enabling Preventive Care Measures

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[linkedin.com/company/ihtsd/](https://linkedin.com/company/ihtsd/)



# 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

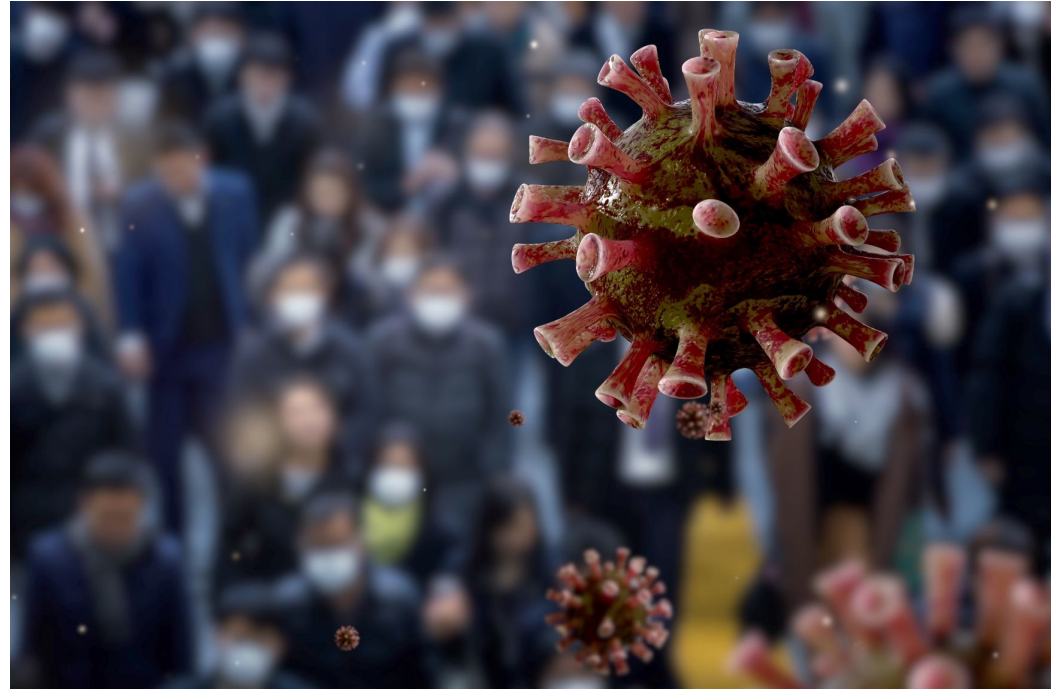
## Patient group

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

Patients with COVID-19

<< 840539006  
| COVID-19 |

<< 882784691000119100  
| Pneumonia caused by  
SARS-CoV-2 |

Patients with  
pneumonia due to COVID-19

<< 419099009  
| Dead |

Diabetes

both

Hypertension

Obesity

Patients  
who died

Obesity

Diabetes

both

Hypertension

<< 414916001  
| Obesity |

<< 73211009  
| Diabetes mellitus |

<< 38341003  
| Hypertensive disorder |



# 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



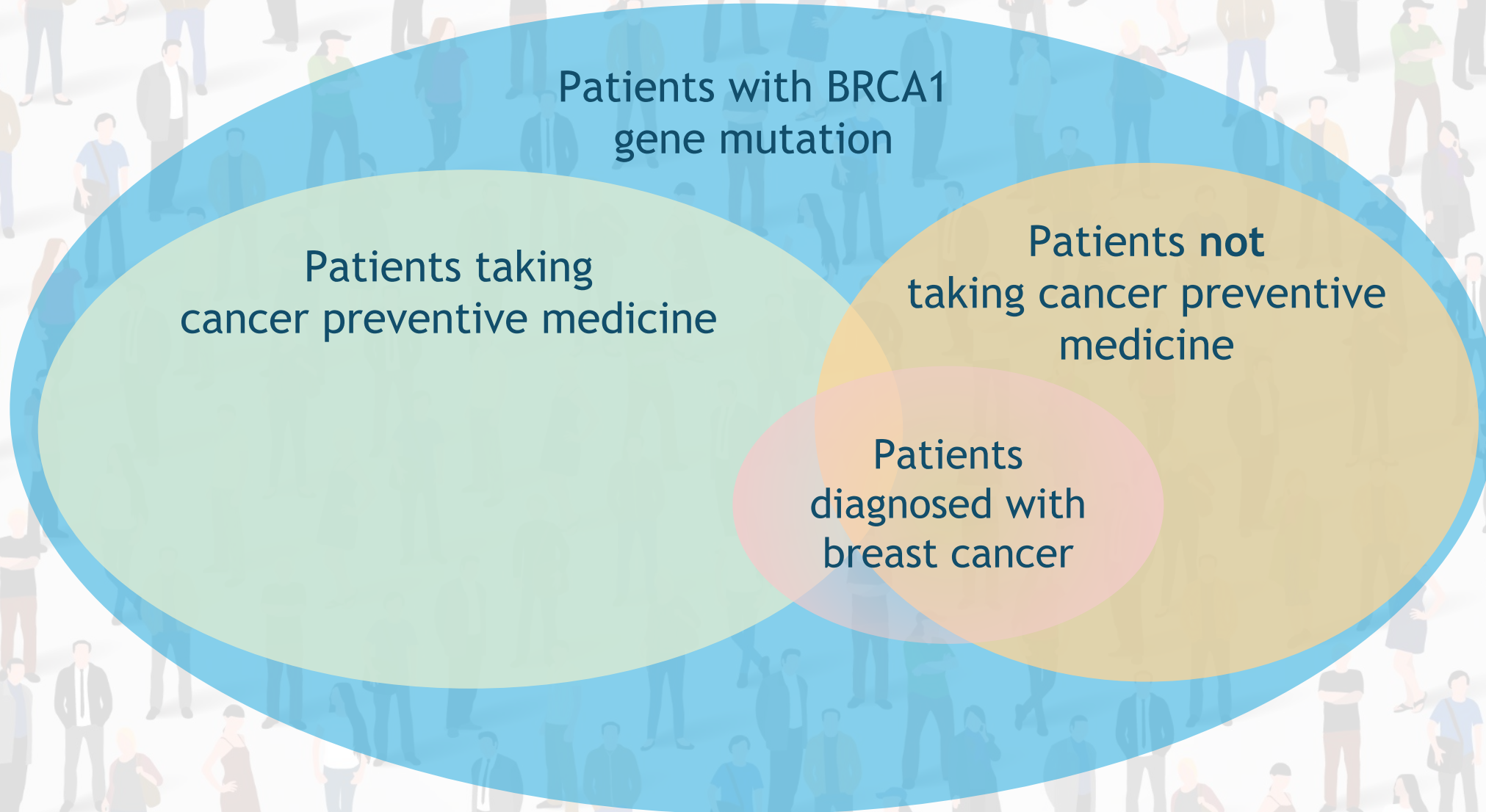
## Question

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|

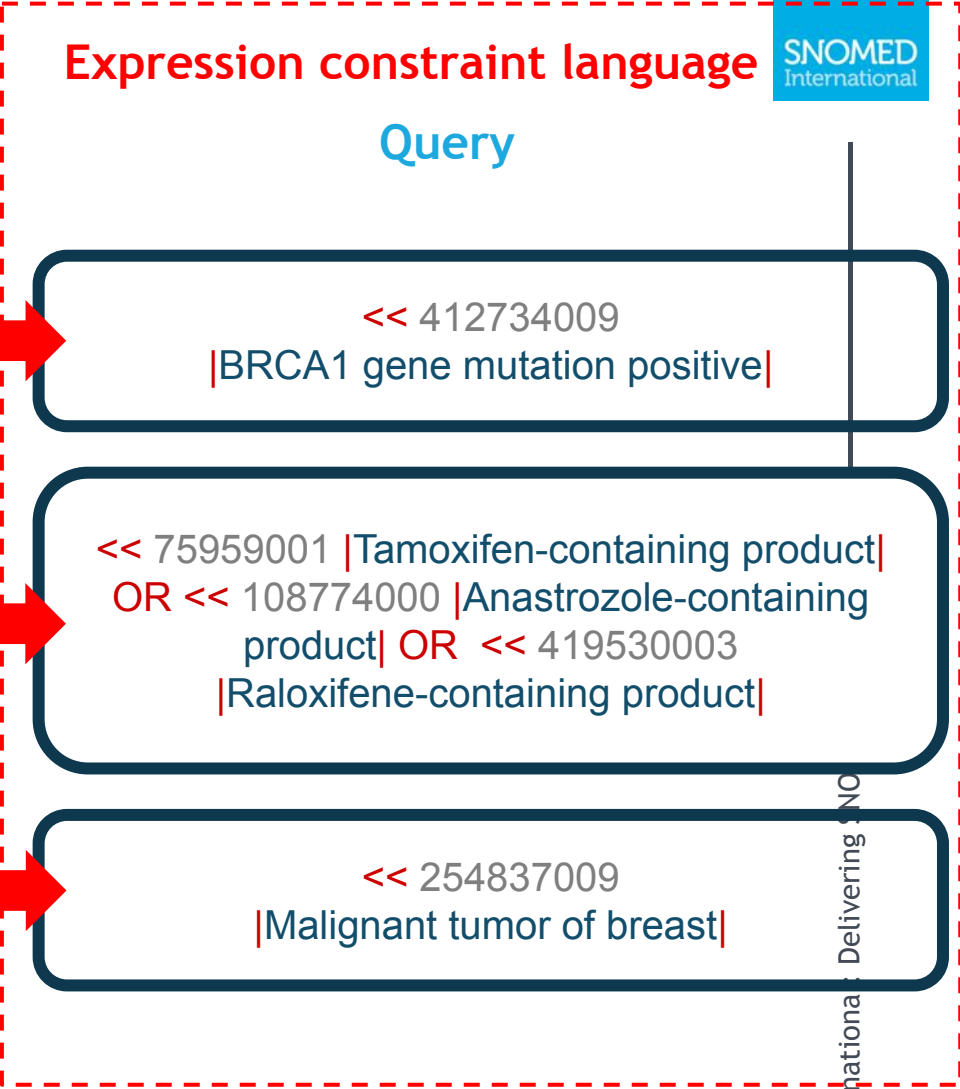
People with breast cancer?



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



<< 254837009  
|Malignant tumor of breast|



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# 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
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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
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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
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# Patient Data Analytics

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SELECT Patient_Id FROM EHR WHERE Diagnosis =
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Electronic data (EHR)

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254841008
188159008
188159008
...



# Demonstration





# Interpreting The Results

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# 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?

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The logo for SNOMED International, featuring the text "SNOMED" in a large, bold, white sans-serif font above the word "International" in a smaller, white sans-serif font, both centered within a solid blue square.

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# THANK YOU

