



# SNOMED CT for regional and national chronic diagnosis analysis and reporting

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# Introduction

- Health care data in Australia is not yet currently standardised
  - Different information models
  - Different terminologies
  - Different reporting requirements
- Current models rely on data extraction, mapping and manual processing to compare collections, analyse and report



# SNOMED CT in Australia

- Is the nationally preferred clinical terminology
  - RACGP – Minimum requirements for general practice clinical information systems to improve usability
  - Australian Federal Department of Health – Primary Care Data Quality Foundations work
- An increasing number of clinical and practice management systems across primary and acute care are adopting SNOMED CT for data record, exchange and retrieval
  - including Primary Care, Emergency Departments, Allied Health, Surgery and Genomics



# Making SNOMED CT work for reporting

- Secondary use of health data requires a reduction in the variability in information collected to group information in to meaningful categories.
- SNOMED CT provides valuable and rich language for clinicians to record and exchange for clinical use
- BUT
  - There is no pre-packaged classification like ICPC2 or ICD
  - It is polyhierarchical
  - Large variety of codes can apparently make it difficult to analyse



# Making SNOMED CT work for reporting

- Currently, secondary users of data rely on the collection of classification data such as ICPC2 and ICD-10 to group health data into pre-packaged categories for data analytics.
- Not every clinical service has a coding workforce
- Reuse of pre-classified data can be difficult
  - Driven by non-clinical use cases
  - Classifications are bound by their own use cases and their own rules
- As vendor systems and clinicians transition to using SNOMED CT at the point of care, downstream data users have the opportunity to make SNOMED CT data meaningful for analytics.

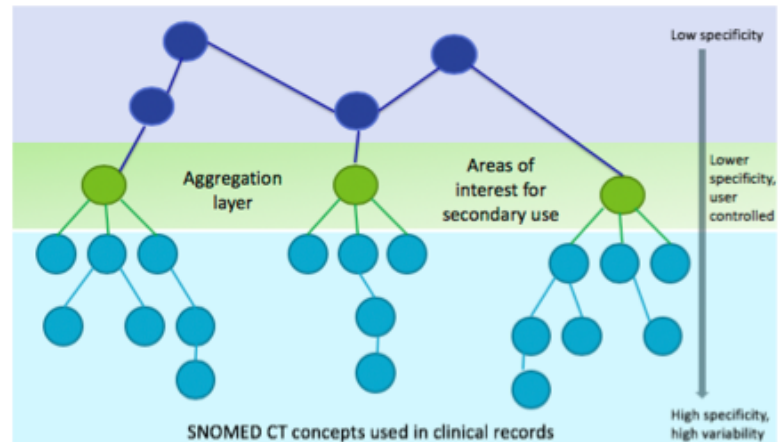


# Making SNOMED CT work for reporting

- Clinical uses demand specificity (precision)
- Most reporting uses demand sensitivity (recall)
- To reduce variability for secondary use and data analytics, techniques for aggregating SNOMED CT need to be used
  - Leverage SNOMED CT hierarchical structure and formal concept definitions
  - Allow selective information retrieval
  - Ability to create
    - standardised, predefined groupings suitable for national use cases,
    - flexible, ad-hoc queries suitable for local, bespoke use cases, and
    - Ensuring data reuse and interoperability for a variety of reporting purposes

# Aggregation for reporting/data analytics

- Reporting or “aggregation layers” can be created within SNOMED CT.
- Use case specific
- Designed to suit business or reporting needs
- May be local to individual users/practices or standardised and shareable across a health sector



**Your report, your rules**



- This aggregation layer must be designed by the user community to suit their needs
- SNOMED CT does not dictate how clinical concepts shall be grouped
- Allows SNOMED CT encoded data analytics to be tailored to suit a variety of downstream data uses





# Chronic disease reporting

- Difficult to define chronic disease
- Lack of standard definitions and inclusions for chronic disease reporting
  - No published national standard
    - Defining chronic disease
    - Commonly agreed reporting categories
  - Difficult to aggregate and analyse data nationally given current variability
  - Leading to a diminished ability to measure the effectiveness of the health system in treating these conditions



Definition	Country
<p>Chronic diseases are <b>long lasting conditions with persistent effects</b>. Their social and economic consequences can impact on peoples' quality of life. Chronic diseases are becoming increasingly common and are a priority for action in the health sector. AIHW commonly reports on 8 major groups: arthritis, asthma, back pain, cancer, cardiovascular disease, chronic obstructive pulmonary disease, diabetes and mental health conditions.</p>	AIHW Australia
<p>A long term condition (LTC) is a condition <b>that cannot, at present, be cured</b> but is controlled by medication and/or other treatment/therapies.</p>	NHS UK
<p>Chronic diseases are defined broadly as conditions that <b>last 1 year or more</b> and require ongoing medical attention or limit activities of daily living or both Alzheimer's Disease, Arthritis, Breast Cancer, Cervical Cancer, Colorectal (Colon) Cancer, Diabetes, Epilepsy, Gynecologic Cancer, Heart Disease, High Blood Pressure, Lupus, Multiple Chronic Conditions, Obesity, Prediabetes, Skin Cancer, Stroke, Tooth Decay, Type 2 Diabetes</p>	Centers for Disease Control and Preventio n – USA
<p>Chronic conditions are no longer viewed conventionally (e.g., limited to heart disease, diabetes, cancer, and asthma), considered in isolation, or thought of as disparate dis-orders. The demands on patients, families, and the health care system are similar, and, in fact, comparable management strategies are effective across all chronic conditions, making them seem much more alike than different. Chronic conditions therefore include: <b>noncommunicable conditions, persistent communicable conditions, long-term mental disorders, and ongoing physical/structural impairments</b></p>	WHO

<https://www.aihw.gov.au/reports-data/health-conditions-disability-deaths/chronic-disease/overview>  
[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/216528/dh\\_134486.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/216528/dh_134486.pdf)  
<https://www.cdc.gov/chronicdisease/about/index.htm>  
[https://www.who.int/chp/knowledge/publications/iccc\\_ch1.pdf](https://www.who.int/chp/knowledge/publications/iccc_ch1.pdf)



# Chronic disease reporting in primary care

- Primary Care Practice management software in Australia
  - Proprietary terminologies
  - Moving to SNOMED CT natively
  - Data collected
    - Local/proprietary code sets
    - Free text
    - Gappy/missing
    - Proxy



# Chronic disease reporting in primary care

- Currently primary care practices rely on data extractors and Primary Health Networks to extract data, process and provide reports
- Practice incentive payments to report chronic diseases
  - Limited
  - Coarse grained
- No national endorsed published primary care chronic disease reporting
- Programme of work with Australian Federal Department of Health to improve data quality in primary care using FHIR and SNOMED CT



# SNOMED CT and Chronic Disease

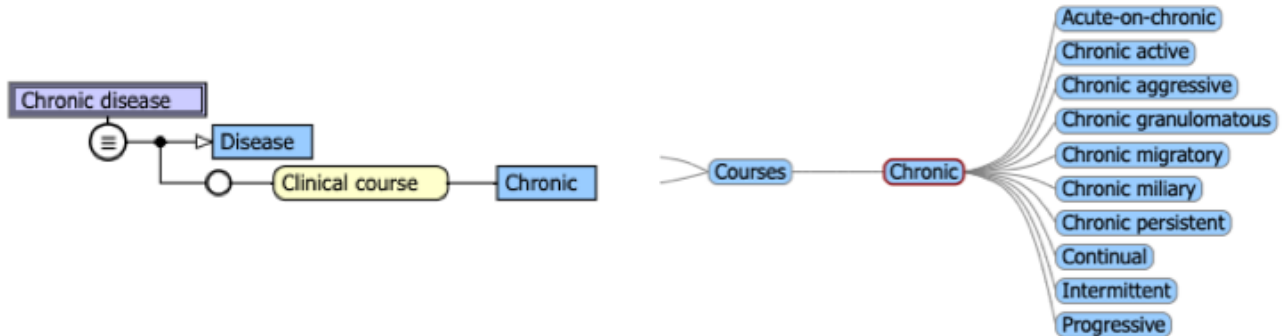
## Selection of chronic disease categories

- AIHW 6 National Priority Areas
- AIHW Chronic Disease Groups
- There are data reporting requirements that extend beyond the minimal national (AIHW) interests in Chronic Disease reporting

AIHW Chronic Disease Groups	Chronic Disease Groups
Arthritis Asthma Back pain Cancer Cardiovascular disease Chronic obstructive pulmonary disease Diabetes Mental health conditions	Alcohol and Other Drugs Cancer Cardiovascular disease Chronic Kidney Disease Dementia and Alzheimer's Diabetes Mental Health Musculoskeletal disorders Oral disease Respiratory disease

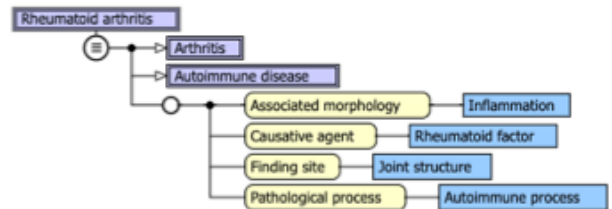
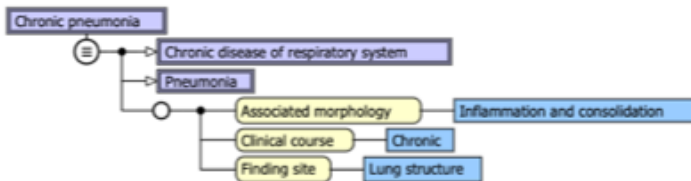
# SNOMED CT and Chronic Disease

- Identification inclusions and exclusion for the groups
  - Ideally use hierarchy and attribute relationships
  - Example: (<< 50043002 | Respiratory disease | AND << 27624003 | Chronic disease |)

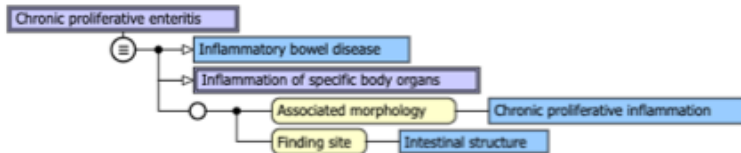


# SNOMED CT and Chronic Disease

- But modelling of clinical course is inconsistent
  - Mainly concepts that have “chronic” in its description
  - Not modelled in other common chronic diseases (defined and primitive)
    - Asthma
    - Diabetes mellitus type 2
    - Rheumatoid arthritis



- Morphological abnormalities that are “chronic”
  - But do not have a clinical course of “chronic”







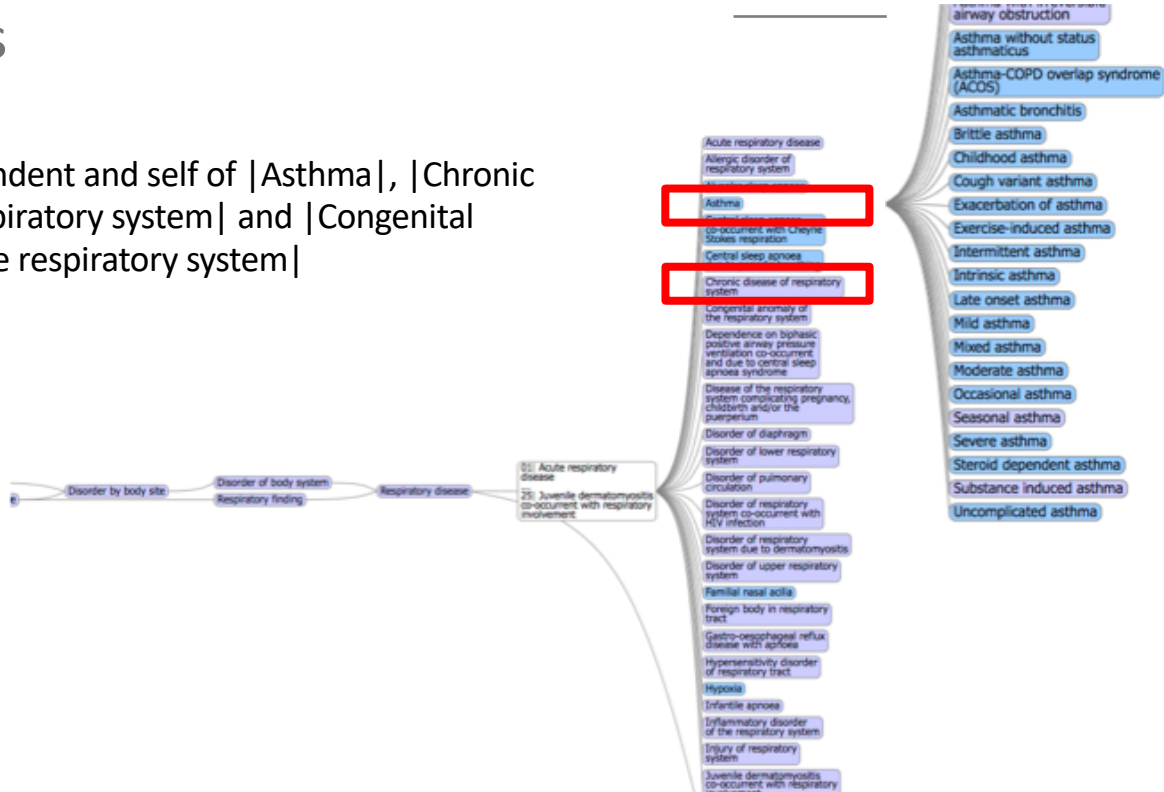
# SNOMED CT and Chronic Disease

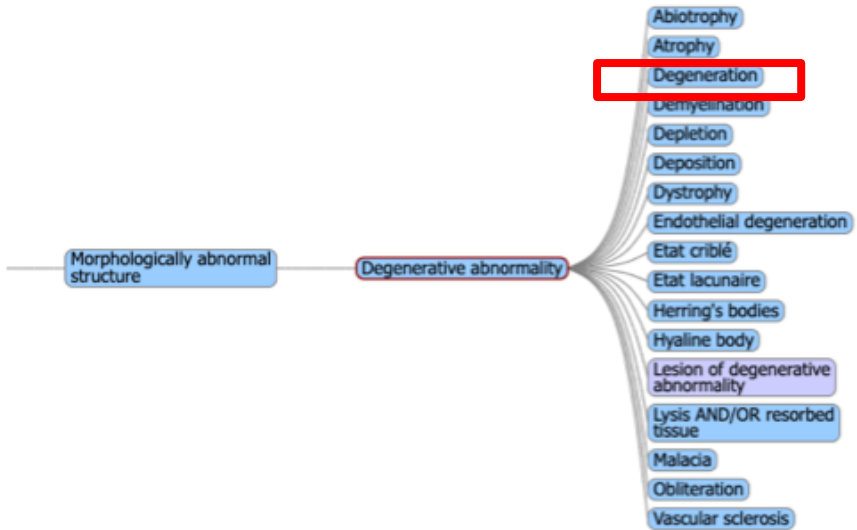
- For each chronic disease group
  - Used SNOMED CT hierarchy and concept definitions as much as possible
    - nodes in the SNOMED CT hierarchy which subsumed multiple concepts of interest (manual identification)
    - attribute relationships
      - Chronicity
      - Identification of morphological abnormalities which indicated chronicity
    - Lexical patterns in descriptions



# Identification of inclusions and exclusions - SNOMED CT nodes

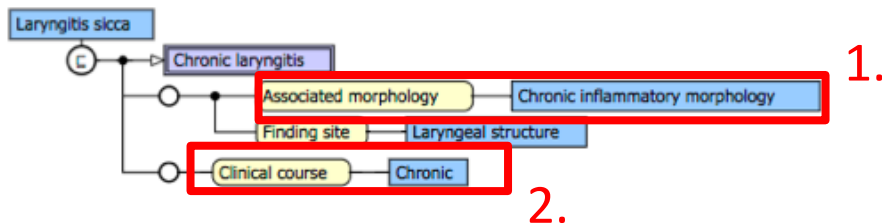
Include descendent and self of |Asthma|, |Chronic disease of respiratory system| and |Congenital anomaly of the respiratory system|





# Identification of inclusions and exclusions - SNOMED CT attributes

- Include all concepts with a |Clinical course| = |Chronic|
- Include all concepts with any other attribute relationship which contains the term “chronic”





# Identification of inclusion and exclusions

## SNOMED CT Descriptions

- Lexical search of descriptions for “chronic” to pick up any missed
- Other terms which were similar or synonymous to “chronic” were also included, for example
  - Recurrent
  - Progressive
  - Continual
  - Remitting



# Inclusions and exclusions

- For all chronic disease groups
  - Only covers concepts that are findings and disorders (diagnoses)
  - Conditions related to gestation and breast-feeding were excluded
  - Acute diseases were excluded



# Documentation of inclusions and exclusions - ECL

- Rules documented in a machine readable manner using Expression Constraint Language (ECL)
  - Run to get SNOMED CT codes
- The SNOMED CT Expression Constraint Language is a formal, computer processable language to allow the searching of concepts using their structure, attributes and terms. They can be used to:
  - Explore and analyse SNOMED CT Content
  - Create subsets of SNOMED CT content
  - Terminology binding
- There are tools that are freely available to help build ECL queries which can then be used to build FHIR® ValueSets



INCLUDES

# Example ECL query

```
(
  (
    (<< 106048009|Respiratory finding| AND (
      (<<
        ({{{term="Recurrent acute"}}} OR {{{term="Chronic"}}} OR {{{term="Recurrent"}}} OR {{{term="Intermittent"}}} OR
        {{{term="Relapsing course"}}} OR {{{term="Congenital"}}}))
      )
    ) OR (
      (<< 106048009|Respiratory finding| : * = (<< ({{{term="Chronic"}}} OR {{{term="Recurrent"}}} OR
        {{{term="Episodic"}}} OR {{{term="Remitting"}}} OR {{{term="Congenital"}}}))
      )) OR (
        (<< 106048009|Respiratory finding| : 263502005|Clinical course| = << 90734009|Chronic|
        )
      ) OR (
        (<< 195967001|Asthma| OR << 13645005|COPD| OR << 409623005|Respiratory insufficiency| OR <<
        51615001|Pulmonary fibrosis| OR << 73430006|Sleep apnoea| OR << 190905008|Cystic fibrosis|)
        )
      )
    ) MINUS
    (
      (<< ({{{ term="acute" }}}))
      ) OR (
        (<< 2704003|Acute disease| OR << 198609003|Complication of pregnancy, childbirth and/or the puerperium|)
        )
    )
  )
)
```

Type of "Respiratory finding" that also contains the **terms** "Recurrent acute", "Chronic", "Recurrent", "Intermittent", "Relapsing course" or "Congenital"

Type of "Respiratory finding" that also has an **attribute** that contains the terms "Chronic", "Recurrent", "Episodic", "Remitting" or "Congenital"

Type of "Respiratory finding" that also has a "Clinical course" of "Chronic"

Any type of Asthm, COPD, Respiratory insufficiency, Pulmonary fibrosis, Sleep apnoea or Cystic Fibrosis

EXCLUDES

Any concepts containing the **term** "acute"

Type of Acute disease or types of complications of pregnancy or childbirth

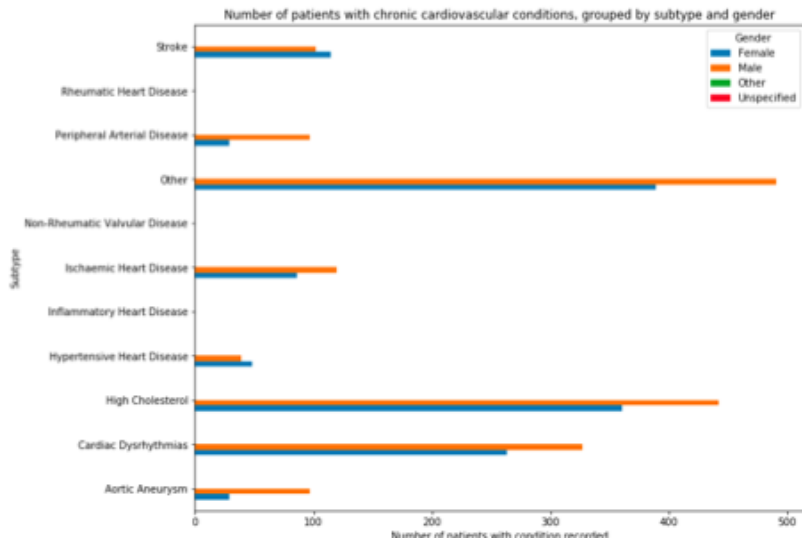




# ECL and FHIR

- Created value sets for each of the chronic disease groups
- Chronic cardiovascular disease example
  - Jupyter notebook
  - Synthetic patient data
    - Used the chronic cardiovascular ECL query to create a value set
    - Created cardiovascular subtype value sets
    - Queried the synthetic patient data to count the patients who have chronic cardiovascular disease and then grouped them by the subtypes and gender

- Rendered the patient data



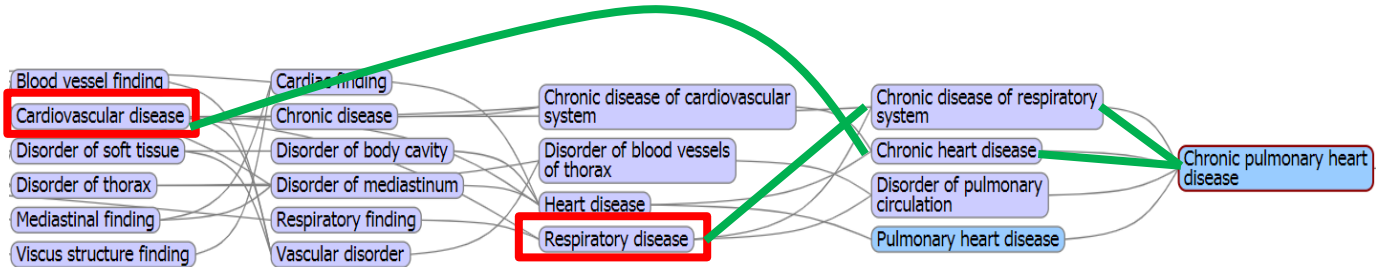


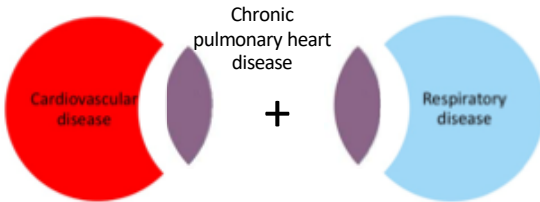
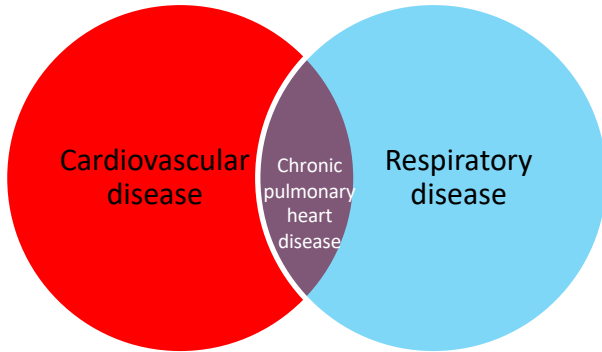
# Mutual exclusivity

- Traditional health analytics practice uses classifications which provide data aggregated to mutually exclusive or disjoint categories, by a pre determined design
- Mutual exclusivity may be desirable in some use cases e.g. counts for funding
- Other situations may require things to be counted in more than one category e.g. identification of patients or co morbidity analyses

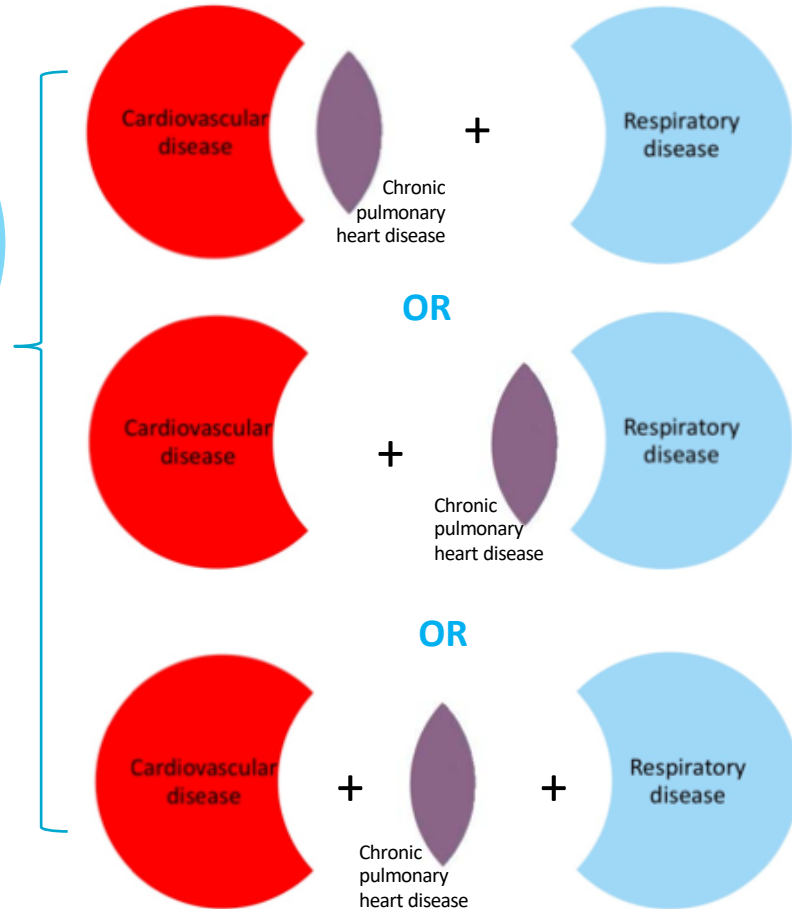
# Mutual exclusivity

- If we use SNOMED CT natively





Based on the required use case, the parameters of how things should be counted can be adjusted





# Mutual exclusivity example for chronic disease

- The value sets as they have been built are not mutually exclusive i.e. SNOMED CT codes may appear in more than one category. Mutual exclusivity can be achieved in SNOMED CT however it requires decisions to be made
- To demonstrate, we made some simple rules
- Course grained rules developed and then applied to the ValueSets to allow mutual exclusivity.
- These rules for mutual exclusivity were documented to be used and re-used to provide comparability between users when required.



# Mutual exclusivity example for chronic disease

If a SNOMED CT concept falls into either category A or category B, it will preferentially be placed into the category specified as “Preferred”

These rules can be refined and specificity for grouper category membership can be increased as required.

Category A	Category B	Preferred
Dementia	MentalHealth	Dementia
Dementia	AoD	Dementia
AoD	MentalHealth	AoD
Cancer	Musculoskeletal	Cancer
Cancer	Cardiovascular	Cancer
Cancer	CKD	Cancer
Cancer	Oral	Cancer
Cancer	Respiratory	Cancer
Dementia	Cardiovascular	Dementia
Cardiovascular	Musculoskeletal	Cardiovascular
Cardiovascular	Respiratory	Cardiovascular
Cardiovascular	MentalHealth	Cardiovascular
Cardiovascular	Diabetes	Cardiovascular
Cardiovascular	CKD	Cardiovascular
Respiratory	Musculoskeletal	Respiratory
Musculoskeletal	Oral	Musculoskeletal
Musculoskeletal	MentalHealth	Musculoskeletal
Musculoskeletal	CKD	Musculoskeletal
Oral	Respiratory	Oral
MentalHealth	Oral	Oral
Diabetes	MentalHealth	Diabetes
Diabetes	Respiratory	Diabetes
CKD	MentalHealth	CKD
AoD	CKD	AoD
Respiratory	MentalHealth	Respiratory
CKD	Respiratory	Respiratory
MentalHealth	Cancer	MentalHealth



# Results

- Using this method we were able to identify 10 mutually exclusive categories for chronic disease

Category	Number of concepts
Alcohol and other drugs	1752
Cancer	7718
Cardiovascular	3296
Chronic kidney disease	405
Dementia	127
Diabetes	342
MentalHealth	1448
Musculoskeletal	3659
Oral	75
Respiratory	671
Total	19493





# National reporting

- Value sets are in the process of being validated by software vendors
- Will be submitted to the Australian Digital Health Agency (National Release Centre of SNOMED CT) for publishing in the national release
- These can be used as exemplar references for chronic disease reporting.
  - National reporting bodies can use these as a reference for vendors to use to help define cohorts
  - Local users can take them and adapt for local use if required



# Summary

- SNOMED CT is a clinical terminology, designed to allow clinicians to record what they need at the specificity they require for clinical uses cases
- Data aggregation and data analytics can be achieved using SNOMED CT data
- Using SNOMED CT as recorded by clinicians allows data to be re-used for different types of reporting
  - Not bound by maps with specific use cases or classifications with specific use cases
- Using SNOMED CT and ECL, we can clearly define data sets that are
  - Standardised and published for national use; and
  - Customised for local bespoke use cases to meet other reporting requirements



# Thank you

**Australian e-Health Research Centre**

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