Introduction to SNOMED CT

Overview

- Part 1
  - Background
    - SNOMED CT
    - SNOMED International
  - Benefits
    - Meaningful records
    - Clinical knowledge linkage

- Part 2
  - Features
  - Customizing SNOMED CT
  - Analytics
  - Learn more
Background

SNOMED Clinical Terms

- Most comprehensive multilingual clinical terminology
  - Designed on experience
  - Logic based design
  - Quality assured clinically relevant content
  - Customisable
    - Extensions, reference sets including subsets and mapping, language preferences
  - Enables analysis, decision support and knowledge linkage
SNOMED Clinical Terms

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SNOMED CT History

- First released in 2002
  - By the College of American Pathologists (CAP)
  - Original Content from
    - Earlier versions of SNOMED (CAP)
    - Read Codes (UK NHS)
- Design based on
  - Identified user requirements
  - Practical experience
  - Scientific principles established in peer reviewed publications
- Acquired by IHTSDO (SNOMED International) for the public good in 2007
The requirements for effective representation of clinical ideas are described in Dr James Cimino’s widely referenced, peer acclaimed 1998 paper “Desiderata for controlled clinical vocabularies in the twenty-first century.”

SNOMED CT was designed to address these requirements.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3415631/

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SNOMED CT - Not Just a Code System

- Logical relationships between concepts supports meaning-based processing

SNOMED Clinical Terms

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  - Customisable
    - Extensions, reference sets including subsets and mapping, language preferences
    - Enables analysis, decision support and knowledge linkage
Broad Scope of Content

- Updated to changes in medical knowledge

SNOMED Clinical Terms

- Various levels of detail
  - Myocardial infarction (disorder)
  - Acute ischemic heart disease (disorder)
  - Acute myocardial infarction (disorder)
  - Acute myocardial infarction due to right coronary artery occlusion (disorder)
  - Acute ST segment elevation myocardial infarction due to right coronary artery occlusion (disorder)

- Quality approach to content
  - Expert SNOMED International personnel
  - Transparency through guidance
  - Automated rules validation, pattern evaluation
  - Collaboration
SNOMED Clinical Terms

- Most comprehensive multilingual clinical terminology
  - Designed on experience
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SNOMED International

- An international not-for-profit organisation
  - Owned by Members
  - Governed by General Assembly of its Members
  - Funded by members based on national wealth
- Maintains and delivers SNOMED CT
  - Free use in Member territories
  - Low cost licenses for institutions in other countries

Global Patient Set (GPS) released
- Managed collection of existing SNOMED CT subsets
- Free for all users to support cross-border interoperability
- Includes
  - Unique identifiers
  - Fully specified names
  - Preferred terms in international English
  - Active/inactive status flags

SNOMED International Support

- Website, communications and document library
- Business meetings and Expo
- Collaboration environment
- Advisory and project groups
- SNOMED CT education
- Content request service (CRS)
- Customer support management
- Vendor and clinical engagement
- Standards collaboration
SNOMED International Tooling Support

- SNOMED CT tooling
  - SNOMED CT browser, mapping tool, refset management and translation tool, authoring platform, CRS
- Open source software development
  - e.g. Snowstorm - scalable SNOMED CT terminology server
- SNOMED International managed service

GitHub
https://github.com/IHTSDO

SNOMED International Membership Growth
2007 - 2019

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SNOMED International Membership Benefits

- Free use of SNOMED CT and related products
- Membership of General Assembly
- Ability to create national extension and translation
- Access to global community of member countries
- Free new member induction
- Member education benefits
  - FREE Foundation Course for all students
  - Membership discount (50%) for all education courses
  - NRC access to 1 FREE enrolment in each course per year
  - NRC access to 1 FREE enrolment in each certification per year

Our Vision

By 2025 clinical terminologies will be used globally, which will result in better health and patient outcomes, supported by one language of health.
Benefits

Meaning View of Health Records

- SNOMED CT provides information about
  - Significant facts in oceans of data
  - The immediate problems and risks for a patient
  - Outcomes of different types of clinical treatment
  - Enhances decision making
- Computation of the current situation requires
  - Consistent processable representation of clinical information

SNOMED CT is designed to support meaning-based processing of clinical information in health records
Clinical Knowledge Linkage

SNOMED CT provides a reference terminology for EHR knowledge linkage

Benefits to Individual Care

- Retrieval of relevant information to better support care
- Meaning-based sharing of clinical information
- Identification of patients requiring follow-up or treatment changes
- Reduction in duplication of investigations and interventions
- Integration with decision support, guidelines and care pathways

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Benefits to **Population Care**

- 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

Benefits to **Clinical Research**

- Identification of clinical trial candidates
- Clinical care delivery planning
- Planning for future service delivery provision
- Research into the effectiveness of different approaches to disease management
Benefits of SNOMED CT Implementation

- A solid foundation for clinical records
- Improved access to guidelines and decision support
- Interoperable information and knowledge resources
- Improved Clinical and Business Intelligence

SNOMED CT Features
Concept

A clinical idea with a unique identifier

Description

Human-readable term linked to a concept
|Is a| Relationship

- 57809008 myocardial disease
- 25106100 myocardial necrosis
- 41454008 ischemic heart disease
- 22298006 myocardial infarction
- 60941002 necrosis of anatomical site

|Is a| relationships form a subtype ‘polyhierarchy’

Subtype Relationships

SNOMED CT concept | ROOT CONCEPT
---|---
clinical finding | TOP LEVEL HIERARCHY
finding by site
cardiovascular finding
cardiac finding
heart disease
myocardial disease
myocardial infarction
acute myocardial infarction
Acute myocardial infarction of anterior wall
Acute myocardial infarction of anterior wall involving right ventricle

LEAF CONCEPT

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Subtype Relationships

SNOMED CT concept
- clinical finding
  - finding by site
    - cardiovascular finding
      - cardiac finding
        - heart disease
          - myocardial disease

myocardial infarction

Acute myocardial infarction of anterior wall involving right ventricle

SNOMED CT Content Hierarchies

- SNOMED CT Concept
  - Body structure (body structure)
  - Clinical finding (finding)
  - Environment or geographical location
  - Event (event)
  - Observable entity (observable entity)
  - Organism (organism)
  - Pharmaceutical / biologic product (product)
  - Physical force (physical force)
  - Physical object (physical object)
  - Procedure (procedure)
  - Qualifier value (qualifier value)
  - Record artifact (record artifact)
  - Situation with explicit context (situation)
  - SNOMED CT Model Component (metadata)
  - Social context (social concept)
  - Special concept (special concept)
  - Specimen (specimen)
  - Stages and scales (staging scale)
  - Substance (substance)
SNOMED CT Concept Model

- Rules for how SNOMED CT concepts are defined
  - Constrains the domain and range of each attribute
  - Defines some additional constraints (e.g. cardinality)

- Machine Readable Concept Model
  - Defines concept model rules is a computer processable way
  - Distributed with the international release of SNOMED CT

SNOMED CT Languages

1. Compositional Grammar ([http://snomed.org/scg](http://snomed.org/scg))
   To define a SNOMED CT expression
   
   182201002 [Hip joint]: 272741003 [Laterality] = 24028007 [Right]

2. Expression Constraint Language ([http://snomed.org/ecl](http://snomed.org/ecl))
   To constrain the set of possible concepts or expressions
   
   < 19829001 [Disorder of lung]: 116676008 [Associated morphology] = << 79654002 [Edema]

3. Expression Template Language ([http://snomed.org/etl](http://snomed.org/etl))
   To define incomplete expressions with slots that are filled later
   
   < 404684003 [Clinical finding]:
   363698007 [Finding site] = [[+id]]

4. Expression Query Language
   To query over SNOMED CT RF2 content
Using SNOMED CT for Analytics

Analytics with SNOMED CT

Clinical assessment and treatment

Population monitoring

Research
PATIENT: 1961-06-21 Harry Smith

Diagnosis (SNOMED CT)

75570004 | Viral pneumonia (disorder) |

Parents

- Infective pneumonia (disorder)
- Viral lower respiratory infection (disorder)

Pathological process → Infectious process
Associated morphology → Inflammation and consolidation
Finding site → Lung structure
Causative agent → Virus
SNOMED CT Supports Meaningful Health Records

PATIENT: 1961-06-21 Harry Smith
Diagnosis (SNOMED CT)
75570004 | Viral pneumonia (disorder) |

Does patient have respiratory disorder?
Yes: subtype of respiratory disorder

Does patient have an infection?
Yes: subtype of infectious disease

Does the disorder affect the liver?
No: finding site value is not a subtype of liver structure

Does the disorder affect the lung?
Yes: finding site is lung structure

Is the disorder caused by a virus?
Yes: causative agent is virus

Analytics with SNOMED CT

Clinical assessment and treatment
Population monitoring
Research
Viral pneumonia
Bacterial pneumonia

Disease
Disorder of respiratory system
Infectious disease

Bacterial infectious disease

Viral disease
Bacterial respiratory infection

Bacterial otitis media

Pneumonia

Viral pneumonia
Bacterial pneumonia

Tuberculosis of respiratory system
Suppurative otitis media

Identify people with respiratory diseases

Copyright 2019 SNOMED International
Identify people with bacterial infections

Note: When using SNOMED CT for querying, strategies exist to prevent double counting

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient count</td>
<td>10</td>
</tr>
<tr>
<td>Bacterial infectious diseases</td>
<td>8</td>
</tr>
<tr>
<td>Disorder of respiratory system</td>
<td>7</td>
</tr>
<tr>
<td>Double counts</td>
<td>5</td>
</tr>
</tbody>
</table>
Identify people with disease in ear

Identify people with disease in Lung

Customizing SNOMED CT

Viral pneumonia

Bacterial pneumonia

Tuberculosis of respiratory system

Suppurative otitis media

Bacterial infectious disease

Bacterial otitis media

Bacterial infectious disease

Viral disease

Disorder of respiratory system

Tuberculosis of respiratory system

Finding site

Finding site

Finding site

Finding site

Upper body part structure

Lung structure

Global finding site

Finding site

Finding site

Finding site

Finding site

Structure of respiratory system

Middle ear structure

Lung structure

Lower respiratory system structure

Body structure

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Extensions

- Additional content for local use
  - To meet the needs of countries, specialties and realms
  - To meet vendor needs
  - To meet local business needs
- May include local
  - Concepts, relationships, descriptions
  - Subsets, Language, Maps
- Must have one or more authorized namespaces
  - Ensures global uniqueness of identifiers

Reference Sets

- Include and exclude content
- List and prioritize content
- Manage terminology changes
- Maps to/from other code systems
- Specify language preferences
Subset

A collection of components for a particular purpose

<table>
<thead>
<tr>
<th>id</th>
<th>effective Time</th>
<th>active</th>
<th>moduleId</th>
<th>refsetId</th>
<th>referenced ComponentId</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000d6608041-005b-5108-b608-07891b210365</td>
<td>20140731 1</td>
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<td>82272006</td>
<td></td>
<td></td>
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<td>6142004</td>
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<td></td>
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<td>00006ac9-2f97-5ed4-b37e-84cb158c388d</td>
<td>20140731 1</td>
<td>49999999102</td>
<td>55604004</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reference Set

<table>
<thead>
<tr>
<th>id</th>
<th>id</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>82272006</td>
<td>Common cold</td>
<td></td>
</tr>
<tr>
<td>6142004</td>
<td>Influenza</td>
<td></td>
</tr>
<tr>
<td>55604004</td>
<td>Avian influenza</td>
<td></td>
</tr>
</tbody>
</table>

Subset Development

- **Membership is defined by enumeration**
  - Identifying each of the members individually
Development Methods

- **Extensional Definition**
  - Example:
    - 80670004 | Bizarre personal appearance (finding) |
    - 398168006 | Generally clean appearance (finding) |
    - 102892007 | Neglected appearance (finding) |
    - 386549008 | Normal appearance (finding) |
    - 78158007 | Personal appearance dirty (finding) |
    - 397749000 | Well cared for appearance (finding) |

- **Membership is defined by a set of rules**
  - The rules are expressed as a query that computes the reference set members

- **SNOMED CT Expression Constraint**
  - A computable rule that can be used to define a bounded set of clinical meanings
  - [http://snomed.org/ecl](http://snomed.org/ecl)

**Examples:**

- << 387714009 | Operation on lung (procedure))
- < 19829001 | Disorder of lung (disorder) : 116676008 | associated morphology = 79654002 | edema |
Subset Development

SUBSTRATE
Snomed CT International Edition
2016-07-31

INTENSIONAL DEFINITION
< 19829001 | Disorder of lung (disorder) | :
116676008 | Associated morphology | =
79654002 | Edema |

EXPANSION
- Neurogenic pulmonary edema (disorder) 233705000
- Adult respiratory distress syndrome (disorder) 67782005
- Hemorrhagic pulmonary edema (disorder) 276637009
- Postimmersion-submersion syndrome (disorder) 89687005
- Fluid overload pulmonary edema (disorder) 233712009
- Pulmonary edema (disorder) 19242006

Language Preferences

F
22298006 Myocardial infarction (disorder)

S
37443015 Heart attack

F
5861000077119 infarctus du myocarde (trouble)

S
37442013 Cardiac infarction

S
564021000146116 myocardinfarct

S
564041000146110 myocardinfarct (aandoening)
Language Preferences - US

22298006

F 22298006 | Myocardial infarction (disorder) |

S 37443015 | Heart attack |

S 37442013 | Cardiac infarction |

F 5861000077119 | infarctus du myocarde (trouble) |

F 5861000077119 | infarctus du myocarde |

F 564041000146110 | myocardinfarct |

Language Preferences – NL

22298006

F 22298006 | Myocardial infarction (disorder) |

S 37443015 | Heart attack |

S 37442013 | Cardiac infarction |

F 5861000077119 | infarctus du myocarde (trouble) |

F 5861000077119 | infarctus du myocarde |

F 564041000146110 | myocardinfarct |

F 564021000146116 | myocardinfarct (aandoening) |
Language Preferences
Canadian French

SNOMED CT description
22298006 | Myocardial infarction (disorder) |
37443015 | Heart attack |
37442013 | Cardiac infarction |
564041000146110 | myocardinfarct (aandoening) |
5861000077119 | infarctus du myocarde (trouble) |
5861000077119 | infarctus du myocarde |

Canadian French Language Reference Set

<table>
<thead>
<tr>
<th>FR-CA language reference set</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SNO MED CT description</td>
<td>Acceptability</td>
</tr>
<tr>
<td>6802110000077116</td>
<td>900000000000548007 Preferred</td>
</tr>
<tr>
<td>5861000077119</td>
<td>900000000000548007 Preferred</td>
</tr>
</tbody>
</table>
Canadian French Language Reference Set

<table>
<thead>
<tr>
<th>EN-CAN language reference set</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNoMED CT description</td>
<td></td>
</tr>
<tr>
<td>751689013 myocardial infarction (disorder)</td>
<td>9000000000000548007 preferred</td>
</tr>
<tr>
<td>37436014 myocardial infarction</td>
<td>9000000000000548007 preferred</td>
</tr>
<tr>
<td>37442013 cardiac infarction</td>
<td>9000000000000549004 acceptable</td>
</tr>
<tr>
<td>37443015 heart attack</td>
<td>9000000000000549004 acceptable</td>
</tr>
<tr>
<td>37441018 infarction of heart</td>
<td>9000000000000549004 acceptable</td>
</tr>
<tr>
<td>1784872019 MI - Myocardial infarction</td>
<td>9000000000000549004 acceptable</td>
</tr>
<tr>
<td>1784873012 myocardial infarct</td>
<td>9000000000000549004 acceptable</td>
</tr>
</tbody>
</table>

SNOMED CT and Other Coding Systems

SNOMED CT acts as bridge between other code systems

ICD-10
LOINC
Free Text
Local Codes
ICNP2
SNOMED CT
ICD-9
ICD-11
ICD-O3
ICD-11

Enables cross-domain queries and analysis
### Map Example

**Between SNOMED CT and an external code system**

<table>
<thead>
<tr>
<th>SNOMED CT concept</th>
<th>ICD-O code</th>
</tr>
</thead>
<tbody>
<tr>
<td>243930007 entire spine</td>
<td>C41.2 Vertebral column</td>
</tr>
<tr>
<td>372177002 entire nail plate</td>
<td>C44.9 Skin, NOS</td>
</tr>
<tr>
<td>616850007 lower limb structure</td>
<td>C76.5 lower limb, NOS</td>
</tr>
<tr>
<td>447643008 vipoma</td>
<td>8155/1 vipoma, NOS</td>
</tr>
<tr>
<td>127573000 neuroendocrine</td>
<td>8249/3 Neuroendocrine tumor, grade 2</td>
</tr>
<tr>
<td>carcinosa, grade 2</td>
<td></td>
</tr>
<tr>
<td>447644002 benign stromal</td>
<td>8935/0 stromal tumor, benign</td>
</tr>
<tr>
<td>tumour</td>
<td></td>
</tr>
</tbody>
</table>
SNOMED CT Implementation

- Continuous increase in the number and maturity of implementations around the world
- SNOMED CT implementation experiences

SNOMED CT Course Catalogue

[https://courses.ihtsdotools.org](https://courses.ihtsdotools.org)

- Foundation Course*
- Curso de Fundamentos*
- SNOMED for Developers
- SNOMED for Data Analysts
- Implementation Course**
- Authoring L1 Course**
- Authoring L1 Certification**

*Free to residents of Member territories
**Discounts for residents of Member territories
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Submit your answer at snomed.org/win

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All entrants will receive a 20% discount voucher - first 50 enrolments only
All vouchers must be used before December 2019

SNOMED CT Document Library

- Introductory Guides
  - Starter Guide http://snomed.org/sg
  - Vendor Introduction http://snomed.org/vendorintro
  - Member (NRC) Guide http://snomed.org/nrguide
- Specifications and Technical Guidance
  - Release file specifications
  - Computable language specifications
  - Terminology and record services
- Practical Guides
  - Search, Data entry, Decision support, Analytics, Reference sets, Extensions

http://snomed.org/doc
Learning More About SNOMED CT

Expo 2019 tutorials

**Thursday**
- 13:30 Intelligent search and data entry (90 min)
- 15:30 Data analytics and clinical decision support (90 min)
- 15:30 An introduction to authoring (90 min)

**Friday**
- 11:00 Developing subsets and reference sets (90 min)
- 13:30 Understanding SNOMED CT’s description logic enhancements (90 min)

Presentation streams
- A – Demonstrating implementation excellence
- B – Enhancing clinical practice
- C – Terminology leading practices

Additional Information

- SNOMED International website
  [http://snomed.org](http://snomed.org)
- SNOMED CT Browser
  [http://snomed.org/browser](http://snomed.org/browser)
- SNOMED CT Document Library
  [http://snomed.org/doc](http://snomed.org/doc)
- SNOMED CT Starter Guide
  [http://snomed.org/sg](http://snomed.org/sg)
- SNOMED CT E-Learning server
  [http://snomed.org/elearning](http://snomed.org/elearning)
- SNOMED CT Tools
  [http://snomed.org/tools](http://snomed.org/tools)