SNOMED International

Leading healthcare terminology, worldwide

Vendor Introduction to SNOMED CT

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1. Introduction

Background

SNOMED Clinical Terms (SNOMED CT) is the leading global healthcare terminology. Designed for use within Electronic Health Record (EHR) systems, SNOMED CT is a key component in effective solutions to enable meaning-based retrieval from growing volumes of clinical information and to support interoperable information exchange. First released in 2002, SNOMED CT has grown in maturity and since 2007 has been owned and maintained by a not-for-profit organization IHTSDO, that in 2017 formally adopted the trading name SNOMED International. SNOMED International has many Members and thousands of licensees - https://www.snomed.org/members.

SNOMED CT is used to represent clinical information in a coded form, with the level of expressivity appropriate for clinical documentation, and also with extensive support for meaning-based retrieval, analysis and reporting.

SNOMED CT is a valuable resource. However, its value is only realized when integrated within well-designed systems that take advantage of its key features. This guide introduces those features and outlines different options for implementing and utilizing SNOMED CT in software applications to deliver tangible benefits.

Objective

This "Vendor Introduction to SNOMED CT" provides an informative practical introduction to SNOMED CT focused primarily on the needs of vendors and developers of EHRs and other related applications in healthcare information technology.

This Vendor Introduction provides an authoritative basis on which to build more detailed knowledge. Basic information about SNOMED CT including its benefits can be found in the SNOMED CT Starter Guide. In-depth technical information can be found in technical guides available from the SNOMED CT Documentation Library. The SNOMED CT Implementation Support Portal is also a good reference source and has a particular section on Implementing SNOMED CT as well as other useful information. SNOMED International works with vendors to ease adoption, integration and implementation of SNOMED CT into vendor solutions to enhance offerings for the global market, see https://www.snomed.org/vendors for more details. Further information about other available resources is provided in Section 8.

Target Audience

This "Vendor Introduction to SNOMED CT" is targeted at people engaged in the development of EHR systems and related services. The document will also be of interest to a broader audience including anyone engaged in designing, developing, procuring, deploying, configuring or managing EHR systems and services.

2. Benefits to Vendors

This section identifies key benefits for vendors arising from implementing SNOMED CT. It summarizes general benefits that encourage adoption, procurement and deployment of SNOMED CT enabled systems. It also notes direct benefits to vendors arising from use of a common global terminology that enables effective meaning-based retrieval, facilitates mapping to ICD-10 and other classifications, and supports localization and customization to meet specific national, regional or specialty requirements. Figure 1. illustrates the benefits to hospitals and clinics who procure SNOMED CT enabled systems; it is also possible to sell SNOMED CT enabled systems to others in the figure such as governments, clinical research establishments, and health funders & providers who too can derive similar benefits.
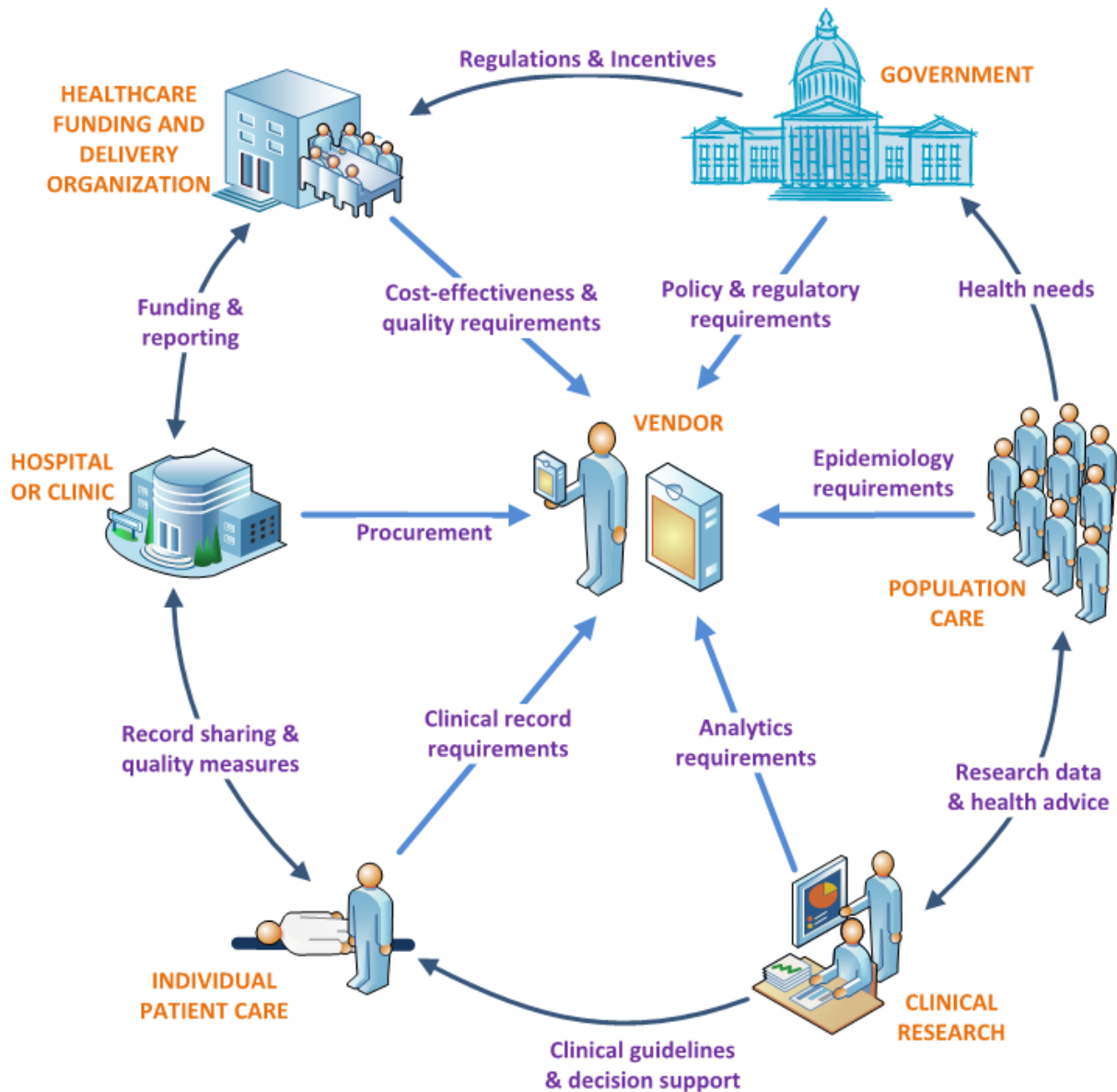
Figure 1. Vendors benefit from the value of SNOMED CT in meeting requirements of a range of stakeholders

General Benefits of SNOMED CT

SNOMED CT supports the consistent representation of comprehensive high-quality clinical content in health records. The value of SNOMED CT is strengthened by its solid clinical validation and a design that facilitates evolutionary growth to meet emerging requirements such as data analytics.

The use of an EHR improves communication and increases the availability of relevant information. If clinical information is stored in ways that allow meaning-based retrieval, the benefits are greatly increased. The added benefits range from increased opportunities for real-time decision support to more accurate retrospective reporting for research and management, as well as enhanced data quality and consistency at the point of data collection. As a result, use of SNOMED CT benefits individual patients and clinicians as well as populations and supports evidence-based care.

SNOMED CT Enabled Health Records Benefit Individuals

SNOMED CT enabled clinical health records benefit clinicians care for individual patients by:

- Enabling relevant clinical information to be recorded using consistent, common representations during a consultation.
- Enabling guideline and decision support systems to check the record and provide real-time advice, for example, through clinical alerts.
- Supporting the sharing of appropriate information with others involved in delivering care to a patient through data capture that allows understanding and interpretation of the information in a common way by all providers.
- Allowing accurate and comprehensive searches that identify cohorts of patients for follow-up or changes of treatment based on revised guidelines.
- Removing language barriers (SNOMED CT is multilingual).

SNOMED CT Enabled Health Records Benefit Populations

SNOMED CT enabled clinical health records benefit policy makers interested in population health by:

- Facilitating early identification of emerging health issues, monitoring of population health and responses to changing clinical practices.
- Enabling accurate and targeted access to relevant information, reducing costly duplications and errors.
- Enabling the delivery of relevant data to support clinical research and contribute evidence for future improvements in treatment.
- Enhancing audits of care delivery by providing capability for detailed analysis of clinical records (e.g. to investigate outliers and exceptions).

SNOMED CT Enabled Health Records Support Evidence-Based Healthcare

SNOMED CT enabled health records inform evidence-based healthcare decisions by:

- Enabling links between clinical records and existing clinical guidelines or protocols.
- Supporting the development of adequate evidence used in the development of clinical guidelines.

Consequently there can be:

- Enhanced quality of care experienced by individuals.
- Reduced costs from inappropriate and duplicative testing and treatment.
- Reduced frequency and impact from adverse healthcare events.
- Increased cost-effectiveness and quality of care delivered to populations.

These general benefits lead to SNOMED CT being increasingly included as part of clinical system procurements in Member countries and elsewhere. Population benefits arising from use of SNOMED CT may also motivate bodies responsible for governance, funding and management of healthcare provision to include it in their strategic plans. As a result, use of SNOMED CT is being increasingly recommended, incentivized or mandated to enable Members to gain the benefits of their investment in and ownership of SNOMED CT.

Strategic Benefits to Vendors

Staying Competitive and Relevant to the Market

- SNOMED CT is increasingly a stated requirement in EHR system procurements
- Even when not explicitly mentioned, SNOMED CT can contribute to meeting procurement requirements related to:
  - Clinical records
  - Decision support
  - Reporting
  - Care quality measures
  - Mapping to ICD-10 and other classifications
  - Standard reference data e.g. allergen list

Selling Into International Markets

- SNOMED CT is designed as global terminology for healthcare
- Products built to use SNOMED CT can be deployed in many different countries
- SNOMED CT is available for free use in Member territories see https://www.snomed.org/members
- Member countries welcome systems that make effective use of SNOMED CT
- Several countries specify SNOMED CT as a required or preferred clinical terminology
- SNOMED CT is used in more than eighty countries

Meeting Clinician Expectations

- SNOMED CT makes data collection by busy doctors easy, safe and reusable
- SNOMED CT supports recording at a level of detail appropriate to clinical record keeping
  - Greater detail than commonly available from classifications such as ICD
  - Maps to classifications to support allocation of classification codes and avoiding double entry for clinical and classification/reporting purposes
  - Level of clinical detail is aligned to the needs of clinical decision making and clinical decision support systems
- SNOMED CT covers a broad range of clinical concepts required by different clinical specialties
- Enhanced features enabled by SNOMED CT lead to better clinician acceptance which influences procurement decisions and is essential for deployment
- Proven examples of effective clinical systems with innovative features which are enabled by SNOMED CT are key to winning new business

Supporting Standards

- SNOMED CT is a terminology standard for unambiguous representation of clinical information
- Standardization creates bridges for effective communication and reuse of EHR data
- SNOMED CT forms a configurable foundation for national and local standards
- SNOMED International is working with other standards bodies to meet the requirements for interoperability

Retaining Existing Customers

- SNOMED CT can be introduced in a staged manner minimizing disruption to existing customers
- SNOMED CT readiness avoids loss of customers when SNOMED CT requirements are adopted

Practical Benefits to Vendors

Common Terminology

- A single internationally-maintained clinically-validated terminology minimizes the need to support local code systems that duplicate effort and create incompatible solutions
- SNOMED CT covers the broad scope of clinical information represented in health records which can be used to meet the needs of most specialties
- SNOMED CT is regularly updated to keep pace with changing patterns of health and emerging clinical knowledge
- A managed request submission process supports quality-assured additions to SNOMED CT
- The SNOMED CT extension mechanism enables the addition of concepts to meet national or local requirements within the framework of a common terminology

Ease of Adoption

- While Section 4 covers the different ways in which SNOMED CT can be used in an EHR system, the simplest of those can be done quite with minimal effort
- Vendors can choose to implement SNOMED CT natively or choose to integrate with offerings from among the many specialists in terminology services

Enhanced User Interfaces

- SNOMED CT provides navigation hierarchies, and effective techniques to constrain searches
- SNOMED CT provides interface designers with concepts that have an unambiguous meaning and synonyms which they can employ directly
- SNOMED CT also allows searches to be performed over any synonym of a concept, thereby increasing the chances of finding the concept needed

Enhanced Analytics

- SNOMED CT concept definitions enable flexible and powerful querying of clinical information
- Analysis can be further enhanced by tools that exploit description logic inferencing i.e. computation which utilizes the defining relationships of concepts

Using Clinical Data to Meet External Reporting Requirements

- SNOMED CT maps enable clinical data to be reused to report statistical and management data using other code systems and classifications

Integration of Third Party Products

- Use of SNOMED CT enables systems to use common services that add functionality to an EHR system. For example:
  - Integration with guideline and decision support services based on knowledge encoded using SNOMED CT
    - A common example of this is the providers of medication knowledge bases to support prescribing decision support
  - Integration with add-on products and services to facilitate the management of specific diseases or participation in clinical research projects

Adapting to Meet Requirements

- SNOMED CT enables configuration to meet the various requirements of:
  - Multi-lingual environments
  - Different clinical specialties
  - Different clinical settings
  - Support for different types of implementation
- Vendors can use the configurability of SNOMED CT to meet diverse user requirements, but from a common platform
- Elements of a configuration can be reused to meet similar use cases

3. Introduction to SNOMED CT

This section provides a brief description of the key characteristics of SNOMED CT, how to access SNOMED CT, some of the other services offered by SNOMED International, and how SNOMED CT can be used with other terminology and related health informatics standards. For a detailed introduction to SNOMED CT, the reader should refer to the SNOMED CT Starter Guide available from http://snomed.org/sg. Also see https://www.snomed.org/what-is-snomed-ct.

Key Characteristics

SNOMED CT:

- Is the most comprehensive, multilingual clinical healthcare terminology in the world
- Includes diagnoses, signs, symptoms, procedures, body structures, organisms and substances
- Is a resource with comprehensive, scientifically validated clinical content
- Ensures quality clinical content in electronic health records
- Is mapped to other international standards

SNOMED CT components include:

- Concepts representing clinical thoughts and phrases that are organized into hierarchies
- Descriptions which link appropriate human readable terms to concepts
- Relationships which link each concept to other related concepts

When implemented in software applications, SNOMED CT can represent clinically relevant information consistently, reliably and comprehensively as an integral part of producing and using electronic health information.

SNOMED CT Components

SNOMED CT is a core clinical healthcare terminology that contains concepts with unique meanings and formal logic based definitions organized into hierarchies.

Concepts

SNOMED CT concepts represent clinical thoughts, ranging from abscess to zygote. Every concept has a unique numeric concept identifier using up to 18 digits. Within each hierarchy, concepts are organized from the general to the more detailed. This allows detailed clinical data to be recorded and later accessed or aggregated at a more general level.

Descriptions

SNOMED CT descriptions link appropriate human readable terms to concepts. There are several different types of Description of which the two most important are "fully-specified name" (FSN) and "synonym". The FSN is an unambiguous formally structured phrase that specifies the meaning of the concept. Synonyms are other terms that are used to refer to the same meaning. Each translation of SNOMED CT includes an additional set of descriptions, which link terms in another language to the same SNOMED CT concepts. Figure 2. shows a concept with the identifier (128601007), a fully specified name and three English language synonyms.

Concept Id

128601007

Descriptions

FSN: |Infectious disease of lung (disorder)|
SYN: |Infectious disease of lung|
SYN: |Pulmonary infection|
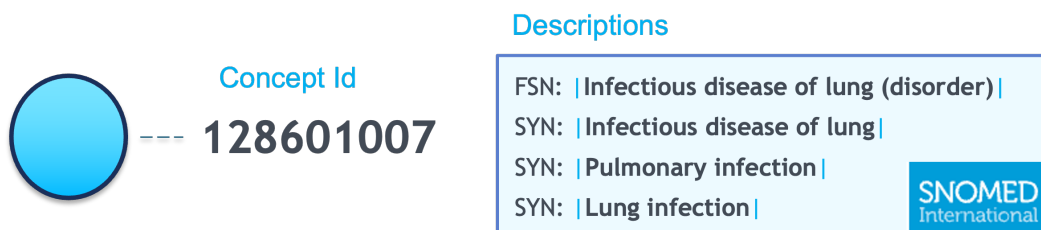SYN: |Lung infection|

Figure 2. SNOMED CT synonyms enable users to choose which terms they want to represent a concept

Relationships

SNOMED CT relationships link each concept to other concepts that have a related meaning. These relationships provide formal definitions and other characteristics of the concept. A common type of link is the hierarchical relationship which relates a concept to more general concepts. For example, the concept *viral pneumonia* is a child of the more general concept *pneumonia*. Such relationships which define the hierarchy of SNOMED CT concepts are represented as |is a| relationships.

Other types of relationships represent other aspects of the definition of a concept. For example, the concept *viral pneumonia* has a *causative agent* relationship to the concept *virus* and a *finding site* relationship to the concept *lung*.

Comprehensive, Scalable and Flexible

SNOMED CT has a broad coverage of health related topics. It can be used to describe a patient's medical history, the details of an orthopedic procedure, the spread of epidemics, and much more. At the same time, the terminology has an unmatched depth, which enables clinicians to record data at the appropriate level of granularity.

Specific applications tend to focus on a restricted set of SNOMED CT, such as concepts related to ophthalmology. These subsets can be used to present relevant parts of the terminology, depending on the clinical context and local requirements.

When individual jurisdictions have needs beyond those that can be reflected in a global terminology, perhaps due to requirements in local legislation, they can develop local or national extensions. Thus, even though SNOMED CT is global in scope, it can be adapted to each country's or area's requirements. Vendors can also create extensions for concepts specific to their own systems, or for subsets to support implementation.

SNOMED CT maps work to provide explicit links to health related classifications and coding schemes in use around the world. These maps facilitate reuse of SNOMED CT based clinical data for other purposes, such as reimbursement or statistical reporting.

Maps included in the SNOMED CT International Edition include:

- SNOMED CT to ICD-10
- SNOMED CT to ICD-O (linking SNOMED CT morphologies with ICD-O codes)
- SNOMED CT to MedDRA and MedDRA to SNOMED CT
- SNOMED CT to Orphanet
- SNOMED CT to GMDN

More information on maps can be found at https://www.snomed.org/maps.

Supporting Different Languages

SNOMED CT is a multinational, multilingual terminology. It has a built-in framework to manage different languages and dialects. The International Release includes a set of language independent concepts and relationships. Today, SNOMED CT is available in US English, UK English and Spanish as well as other languages, see https://www.implementation.snomed.org/member-translations.

SNOMED CT Expressions

A single concept identifier can be used to represent any of the 360,000+ concepts in SNOMED CT e.g. pneumonia. In some cases, even finer granularity of meaning may be required to capture the true intent of a clinician's statement e.g. pneumonia caused by streptobacillus. In these cases, SNOMED CT provides a formal mechanism of using two or more concept identifiers linked together in a logical way to represent refinements of the meaning of a concept. These are known as postcoordinated expressions. For example 'pneumonia caused by streptobacillus' can be expressed by:

53084003| bacterial pneumonia |:246075003| causative agent |=29295005| Streptobacillus |

It is not essential for vendors to implement postcoordination unless there are requirements for representing meanings that cannot be captured using a single concept identifier. Even in cases where more specific information is needed, there are other options that can be used. These include using specific fields in the user interface or message to capture specific refinement patterns such as laterality. However, postcoordinated expressions provide a flexible way to represent additional detail, where this is required.

- Expressions which identify a concept using only a single concept identifier are referred to as 'precoordinated'
- Expressions which rely on the composition of multiple concept identifiers, as illustrated above, are referred to as 'postcoordinated'.

Logical Representation of Meaning

In addition to the human-readable representation of meaning (provided by descriptions), SNOMED CT includes relationships between concepts which provide a machine-processable representation of the meaning of each concept. These defining relationships provide the foundation for meaning-based retrieval.

Each SNOMED CT Concept (except the root concept) has a relationship to one or more parent concepts. Each of these parent concepts represents a more general clinical meaning (known as a supertype). The resultant network of relationships is more than a simple tree and forms a logical structure known as a polyhierarchy[1] . This structure makes it possible to represent meaning in a more complete way than is possible in a simple hierarchy.

For example, a simple hierarchy could only represent |cellulitis of foot| as either a type of |disorder of foot| or a type of |cellulitis|. As shown in in Figure 3, the SNOMED CT subtype polyhierarchy captures both of these supertype relationships.
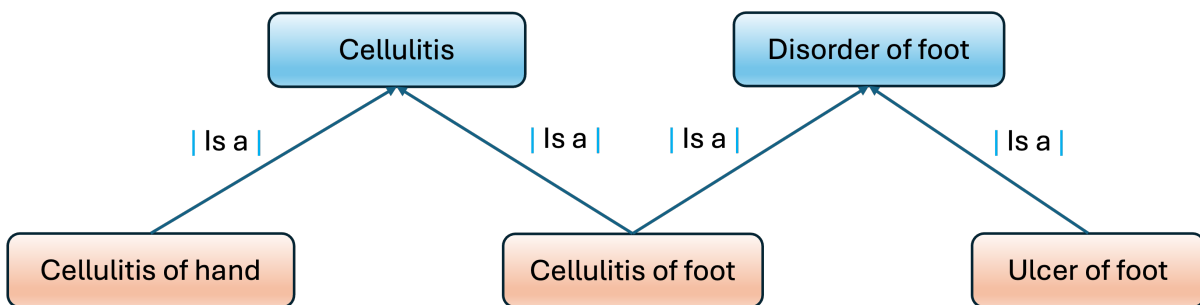
Figure 3. Fragment of the SNOMED CT subtype polyhierarchy showing a concept with two supertype parents

In addition to the relationships that form the subtype polyhierarchy, SNOMED CT also includes other relationships which represent features of a concept that distinguish it from its supertypes. For example, as shown in Figure 4, the defining relationships of |cellulitis of foot| also include values for |associated morphology| and |finding site|.
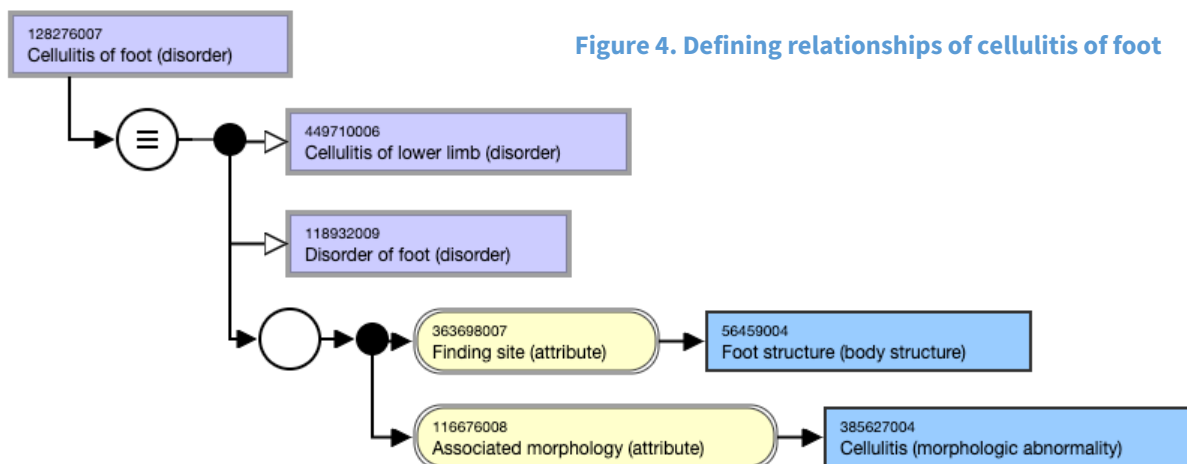
Figure 4. Defining relationships of cellulitis of foot

Concepts, their descriptions and relationships can be explored using the SNOMED International Browser (http://browser.ihtsdotools.org).

Standard Release Format with Built in Versioning

SNOMED CT has standardized methods for packaging and distribution of content and derivatives. Files in the distribution follow a formal naming convention and have a standardized tab-delimited release format that includes full version tracking for every version of each component since the launch of SNOMED CT in 2002. The release files include files for Concepts, Descriptions, Relationships and an extensible Reference set file structure used to represent maps, subsets and language preferences.

The versioning mechanism supports the distribution of distinct representations of the release data.

With every SNOMED CT release two different release file types are made available:

- Full Release: containing the complete history of every component
- Snapshot Release: containing the current state of every component

Note on Delta Release (includes changes made between one version and the next): Delta files have been removed from the SNOMED International release package, Managed Service Extensions and Derivative packages. However a Delta Generation Tool is available for those who need it. The Delta Generation Tool allows users to create their own Delta between two fixed release dates - you can find it here: https://github.com/IHTSDO/delta-generator-tool/releases.

The International Edition is provided in both release types. However, as the Snapshot can be generated from the Full Release, the specification only requires that organizations that maintain Extensions provide a Full Release of their extension.

Continuous Improvement

SNOMED CT is the subject of continuous improvement such as the addition of new concepts where needed or refinement of concept definitions. The quality assured content is released in discrete releases. SNOMED CT has robust version control of all components based on an 'effective date' mechanism. The data includes a full and explicit history of all versions of all components whether or not they are currently active.

Accessing SNOMED CT

Reviewing SNOMED CT Content

SNOMED International provides a Terminology Browser to enable online review of the SNOMED CT International Edition (http://browser.ihtsdotools.org). This browser also provides access to several National Editions of SNOMED CT. Other SNOMED CT browsers are listed at http://snomed.org/browsers.

Obtaining SNOMED CT Release Files

Licensing and Access to Release Files

All vendors, developers and providers of SNOMED CT enabled products and services are required to register acceptance of the SNOMED CT Affiliate License Agreement. By doing this they become SNOMED International Affiliates and gain access to downloads of the SNOMED CT International Edition and derivatives. Some Member countries require use of their National Edition of SNOMED CT and access to this may be subject to an additional license agreement. More information on licensing, including end-user sublicensing and fees for use in Non-Member Territories, is provided in Section 7.

Downloading the International Edition

National Release Centers in some Member countries host their own distribution sites that allow SNOMED International Affiliates that are registered with them to download the International Edition of SNOMED CT. SNOMED International provides a central service for SNOMED International Affiliates to download the International Edition. This service is also used by some Member countries.[2]

Downloading National Extensions or Editions

National Release Centers (NRCs) in Member countries that maintain National Extensions provide these Extensions to SNOMED International Affiliates registered with them. In some cases, the National Extension and International Edition may be distributed in a pre-merged form representing the complete National Edition. For details see the links to SNOMED International Members from http://snomed.org/members.

Release Dates

SNOMED International provides regular updates to the SNOMED CT International Edition. SNOMED CT is released monthly on the first day of each month. Further details can be found in https://www.snomed.org/releases.

Similarly, Members and Affiliates that maintain Extensions release updated versions of their Extensions to align with the SNOMED CT International Edition but after the relevant international release.

Other SNOMED Products

SNOMED International maintains and distributes a range of other products to its Members, licensees and other users.

These products include extensions and derivative SNOMED CT products, while others are global products available outside of the traditional SNOMED CT licensing model. For example, the International Patient Summary Terminology and the Global Patient Set, please see https://www.snomed.org/other-snomed-products for more details.

Other SNOMED International Services

Documentation

The SNOMED CT Document Library at http://snomed.org/doc provides access to detailed specifications of SNOMED CT design and release file formats. The library also provides access to related standards and guidelines. These documents are available as online web browsable pages and/or as downloadable PDF files.

Education

Where to start?

- The SNOMED CT Starter Tutorial provides an overview of the basics of SNOMED CT.
- The Education Resource Guide provides details of educational material that cover a range of topics related to SNOMED CT.

SNOMED International provides a range of Education offerings. The set of courses, learning pathways, and certification exams are shown below.

> ⓘ **Course Catalogue and E-Learning Platform**
>
> To enrol in all SNOMED CT courses and certification exams, please visit our SNOMED CT course catalogue at https://courses.ihtsdotools.org/ and select the relevant education product.
> Our E-Learning Platform, which hosts the majority of our education offerings can be accessed at https://elearning.ihtsdotools.org/.

Courses

[Foundation course](), [Implementation course](), [Authoring Level 1 course](), [Authoring Level 2 course](), [Terminology Services course]().

Learning Pathways

[SNOMED CT for Developers](), [SNOMED CT for Data Analysts](), **[SNOMED CT for Clinicians]()**, [SNOMED CT for Translators]().

Certification Exams

[SNOMED CT Authoring Level 1 Certification](), [SNOMED CT Authoring Level 2 Certification](), [Terminology Services Certification]().

Some National Release Centers also provide a range of materials and services in support of implementation and several host local implementation communities. For more information, please refer to the relevant Member by following links http://snomed.org/members.

Tools and Services

SNOMED International is developing a range of tools mostly targeted at supporting terminology development and distribution centrally by SNOMED International and nationally by NRCs in Member countries. These tools are developed following open source principles and therefore may be of practical or illustrative value to vendors. See details at https://www.snomed.org/software-tools.

There are also other providers of tools and services that support implementation of SNOMED CT - https://www.implementation.snomed.org/implementation-tooling. These include commercial providers as well as some development by SNOMED International Members and SNOMED International following an open source model.

Requests for Changes and Additions

SNOMED International provides a request submission service to gather and process requests for additions and changes to the content of the SNOMED CT International Edition. This service is directly accessible by National Release Centers (NRC) in Member countries and recognized Terminology Authorities representing standards organizations with whom SNOMED International is collaborating.

Vendors in Member countries should submit their requests initially to the NRC in the country in which they are based or the country in which the requirement for the addition or change has been noted. Requests with particular local relevance may be added to a National Extension, but those that the NRC considers have international relevance will be forwarded to SNOMED International for a decision. If a request is deemed to have high priority, it should result in action in the next release cycle. However, requests that require significant changes that would impact on other content may take longer.

Using SNOMED CT with Other Standards

SNOMED CT is only one part of the solution to the challenges of making effective use of clinical information. Therefore, SNOMED International cooperates with many organizations to optimize practical benefits and minimize duplication of effort. This section outlines some key areas where this collaborative approach is driving developments that address the needs of healthcare provides, EHR vendors and users and other stakeholders with an interest in consistent representation of health related information.

SNOMED International has an active program of partnering with international standards development organizations, professional clinical bodies and commercial organizations. The goal is to facilitate the use of SNOMED CT with other international standards and profiles please see https://www.snomed.org/our-partnerships.

World Health Organization Classifications

SNOMED International has a formal working arrangement with the World Health Organization (WHO) to develop and assure maps and links between SNOMED CT and WHO Classifications, see https://www.snomed.org/standards-partnerships/world-health-organization.

SNOMED CT to ICD-10 maps and SNOMED CT to ICD-O maps are distributed by SNOMED International, see https://www.snomed.org/maps.

LOINC (Logical Observation Identifiers Names and Codes)

In July 2013 SNOMED International signed a long-term agreement with the Regenstrief Institute Inc. (RII) owners of LOINC (Logical Observation Identifiers Names and Codes). This agreement marked the beginning of cooperative work which will link LOINC and SNOMED CT.

The collaborative work produced a LOINC®/SNOMED CT Expression Association and Map Sets file based on SNOMED CT International Release, July 2017 and version 2.58 of LOINC, released in December 2016.

In 2022, the two organizations signed a new collaboration agreement facilitating the adoption of standardized terminology to support broadened interoperability of health data exchange around the globe with the goal of enhancing and improving the delivery of healthcare.

The new agreement lays the foundation for development of a LOINC® extension that aligns with the SNOMED CT model, enabling SNOMED International and Regenstrief to distribute LOINC® and SNOMED CT content together to their respective users. The extension will create both SNOMED CT and LOINC® codes for all concepts that are shared between the terminologies, making it easy for implementers to have a unified approach to implementing both standards and to meet clinical and regulatory requirements globally.

In October 2023, and under the scope of the 2022 agreement, the teams produced The LOINC Ontology: A LOINC and SNOMED CT interoperability solution. The LOINC Ontology supports providers and users who implement different combinations of SNOMED CT and LOINC in health information systems and allows them to meet clinical and regulatory requirements in a single solution. Linked together in a complementary way, SNOMED CT provides the computable framework and LOINC provides laboratory and pathology content in an understood format to countries who do not currently use LOINC.

HL7

In July 2019, HL7 and SNOMED International announced another 2 year collaboration agreement, building on previous agreements in 2009, 2014 and 2016. The agreement again is aimed at improving interoperability, thus focusing on the adoption of working practices that facilitate the use of SNOMED CT with HL7 standards globally. As previously, both organisations are working towards avoiding duplication of effort and resolving issues related to gaps and overlaps. For more details see https://www.snomed.org/standards-partnerships/hl7-international.

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[1] More precisely the |is-a| relationship polyhierarchy is a Directed Acyclic Graph [DAG]
[2] The SNOMED International licensing and download service (https://mlds.ihtsdotools.org) is targeted at Affiliates in Non-Member Territories and those in Member countries (note some countries have their own download sites).

4. Choosing an Approach to Implementation

- What is the target configuration for the particular EHR where SNOMED CT will be used?
- Should the target configuration be achieved in just one stage or in a sequence of stages, and if so what are the stages?
- Should SNOMED CT content be held alongside other system reference data or separately?
- Should SNOMED CT implementation be done natively within the EHR system or through integration with a third-party provider of terminology services?

The diverse nature of EHR systems, as well as the wide scope of SNOMED CT, means that there can be no universal approach. There are different ways to achieve similar outcomes and variation between the development sequences taken to reach the same outcome.

Implementation strategy and planning is discussed here by addressing:

- The different locations for use of SNOMED CT within EHR systems and subsystems
- What is commonly done for each
- Some common implementation stages: moving to more extensive or more integrated use

Introduction to Target Configurations

The simplified depiction of an EHR system shown in Figure 5 is used to illustrate a variety of alternative configurations in which SNOMED CT is implemented in one of more of the component parts of an EHR.
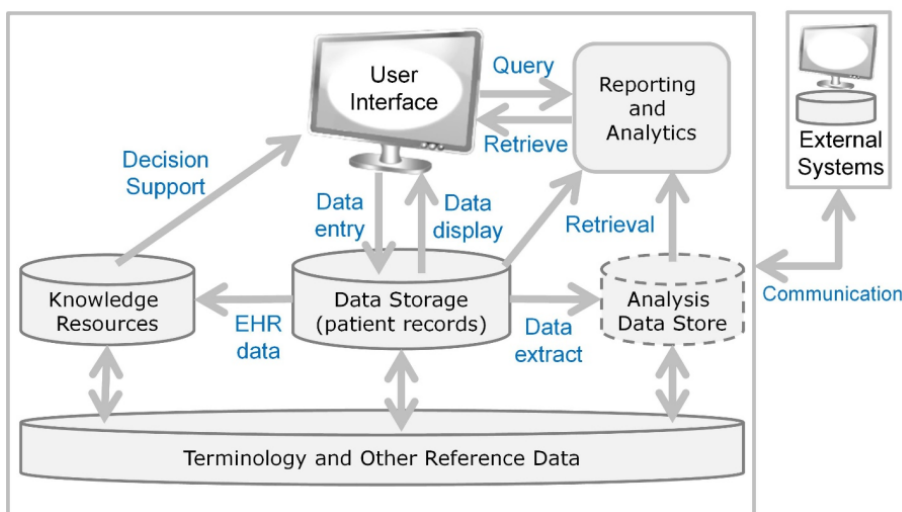
Figure 5. Schematic illustration of an EHR system

The illustration above shows as separate components the user interface, data storage and external data communication, for systems interoperation. In the SNOMED CT documentation these are considered collectively to be part of a Clinical Records implementation. Other types of implementation include linking to Knowledge Resources and Aggregation and Analysis. These are illustrated above by the Knowledge Resources and Reporting and Analytics components. In the diagram, a distinction is made between Reference Data such as SNOMED CT or ICD-10, and the clinical data records held in the clinical data store. Separate from both of these is the Analysis Data Store in which copies of parts of the collection of clinical data records are held separately in support of data analysis and reporting.

One way of categorizing the components illustrated above is:

- Used by clinicians caring for individual patients – entry, display, use of decision support
- Used by those interested in management, statistical or other population/cohort data – retrieval, analysis, research, epidemiology

The diagrammatic conventions used in this section are shown in Figure 6 below
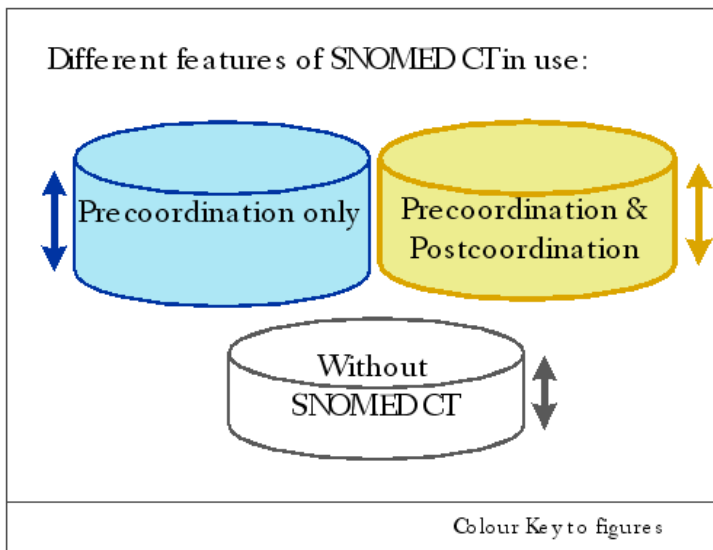
Figure 6. Color key for Figure 7 to Figure 16 inclusive

The rest of the section introduces ten ways in which SNOMED CT can be used in EHR systems. As mentioned earlier, these are not exhaustive or even fully mutually exclusive, but just illustrative. Ten approaches of using SNOMED CT are:

1. As a reference terminology for communication
2. As a reference terminology for data integration
3. As an indexing system for data retrieval
4. As a code system for clinical data storage
5. As an interface terminology for data entry
6. For simple aggregation and analysis
7. For complex analytics using description logic
8. For knowledge linkage
9. As an extensible foundation for representing clinical data
10. Full use of all SNOMED CT features

Based on the categorization introduced earlier about clinician use or use by others, approaches 1, 2, 4, 5, 8, 9 and 10 are primarily aimed at clinician use, whereas approaches 3, 6 and 7 are primarily aimed at use by others. However approaches 6 and 7 include elements of interest to clinicians, and approaches 9 and 10 include elements of interest to others.

1. SNOMED CT as a Reference Terminology for Communication
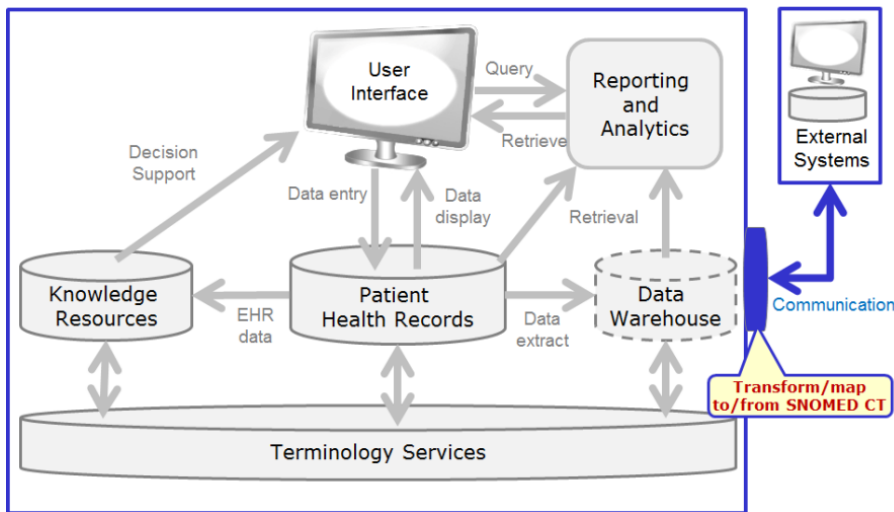
Figure 7. SNOMED CT as a Reference Terminology for Communication

This approach uses SNOMED CT as a 'Reference Terminology', mapping clinical record data to SNOMED CT for inbound and outbound communications with other systems. Where there is a need to exchange SNOMED CT encoded clinical data with other systems, this approach has merit. For an EHR system without any pre-existing SNOMED CT implementation, this approach is likely to have lower costs for re-engineering than other options; however it does not offer any benefits apart from enhanced data exchange. The transformation to and from SNOMED CT will need to be maintained over time and the mapping may result in some information loss.

Benefits

- Communication using shared meaning based on SNOMED CT Concept identifiers
- No changes required to core clinical system
- Supports research and analysis in external systems

Considerations

- The benefits derived from a more extensive use of SNOMED CT are not realized
- This approach allows continuity of systems interoperation despite limited use of SNOMED CT, in an environment which requires some use of SNOMED CT
- This requires that a sufficient proportion of existing coded clinical items can be successfully mapped to and from SNOMED CT
- Mapping between the terminology scheme used in the EHR and SNOMED CT needs to be kept up-to-date
- Exceptions will need to be gracefully handled

2. SNOMED CT as a Reference Terminology for Data Integration
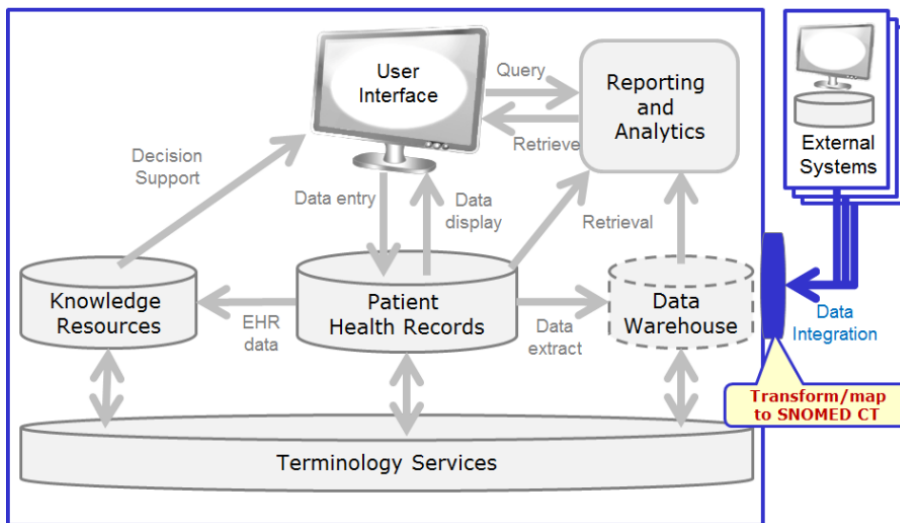
Figure 8. SNOMED CT as a Reference Terminology for Data Integration

This approach uses SNOMED CT as a 'Reference Terminology' for data integration, by transforming the various codes and free text received from external systems into SNOMED CT. This approach will usually be combined with one of the following approaches that uses the integrated data for reporting, querying, decision support, or displaying to the user in a consistent way.
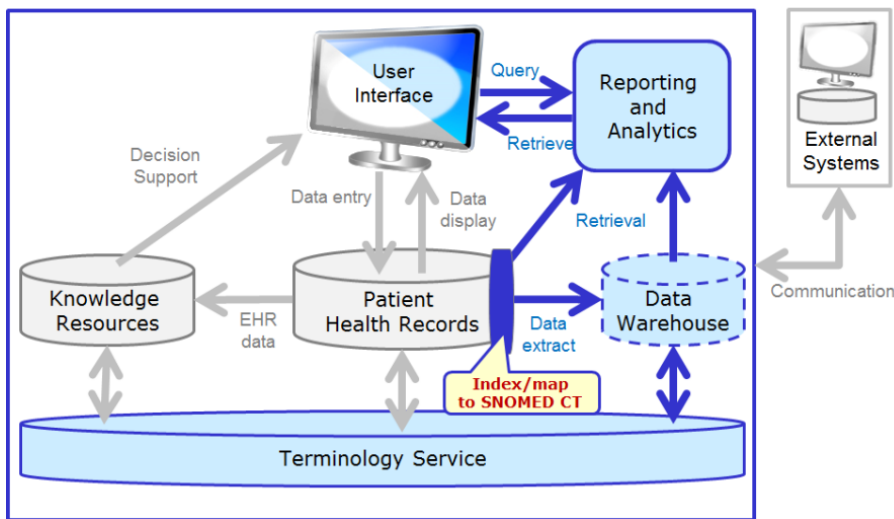
Benefits

- Patient data may be integrated from a variety of structured and unstructured sources, including hospital health record systems and mobile devices
- Patient data coded in a consistent way can be used for analytics, querying, decision support or displaying to the user
- Correlations between data from disparate sources can be made using SNOMED CT's defining relationships

Considerations

- Mapping between the source code systems and SNOMED CT needs to be kept up-to-date
- Natural Language Processing to encode unstructured records may need manual validation to ensure high quality coding
- Exceptions will need to be handled gracefully

3. SNOMED CT as an Indexing System for Data Retrieval

Figure 9. SNOMED CT as an Indexing System for Data Retrieval

This approach has benefits for those who perform data analysis as well as for front-line clinical users. It features no change to data entry or the principal clinical data storage. Records stored as narrative text or using other code systems are processed by a routine that matches the stored codes (and/or narrative text) to appropriate precoordinated SNOMED CT concepts. The end result is a representation of relevant parts of the record information tagged and indexed using SNOMED CT. The resulting index is then used by the Reporting and Analytics subsystem to support querying, retrieval and analysis using terminology based on SNOMED CT.

Benefits

- Supports research and analysis in a local system or shared data warehouse
- Supports use of SNOMED CT for analysis and reporting
  - For identification of cohorts of patients for research studies
  - For exploration of data in support of clinical process review
  - To improve the user experience of longitudinal record review
- Zero or minimal disruption to run-time processes

Considerations

- The benefits derived from a more extensive use of SNOMED CT are not realized
- This requires that a sufficient proportion of existing coded clinical items can be successfully mapped to and from SNOMED CT
- Individual coded items may map to more than one target in SNOMED CT; in some computations, this will require the selection of just one target from the set of candidates, in others it will be unproblematic
- Quality of the clinical data itself may be the dominant factor in the value of this approach, more than the existence of exceptions e.g. where no single map exists for a coded item
- Exceptions will need to be gracefully handled

4. SNOMED CT as a Code System for Clinical Data in the EHR
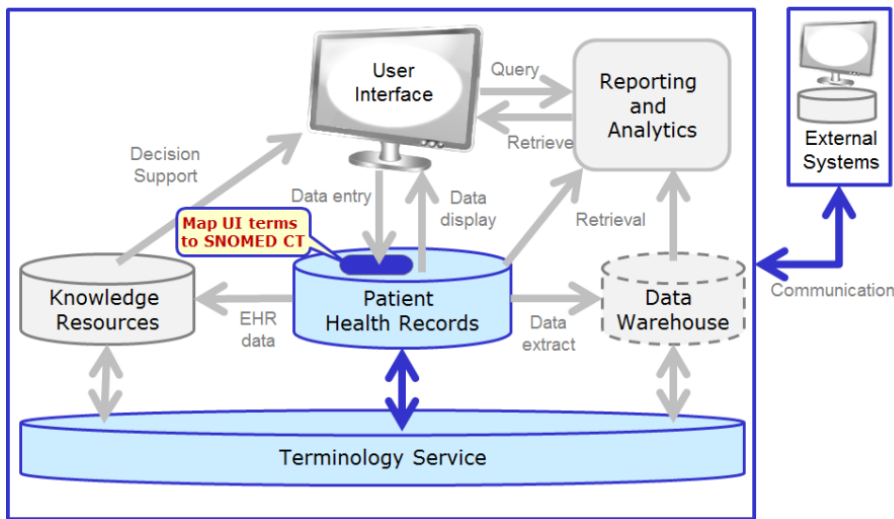
Figure 10. SNOMED CT as a Code System for Clinical Data in the EHR

An implementer who is motivated to introduce SNOMED CT records, but who is also keen to keep changes to the clinical user experience to an absolute minimum, may choose this approach. It can be a low risk step towards a more extensive use of SNOMED CT. The quality of the map between the 'retained interface terminology' and precoordinated SNOMED CT concepts will need to meet a variety clinical governance requirements, as set locally. As the data store content uses SNOMED CT, SNOMED CT concept codes are available for communicating with external systems. An approach of this type is likely to be recognized as 'storing and exchanging records using SNOMED CT'.

Benefits

- No change to terms that clinicians are used to seeing in the user interface
- Patient data stored using SNOMED CT concepts
- Communication using shared meaning
- Can utilize internationally developed mappings such as the mappings to ICD-9 and ICD-10
- SNOMED CT is available for direct use in electronic communications
- Standardized integration with decision support rules

Considerations

- This requires that a sufficient proportion of existing interface terminology can be successfully mapped to SNOMED CT
- An ideal map between the interface terminology and SNOMED CT is a one-to-one map.
  - Exceptions will need to be handled gracefully where no map exists between an existing interface item and SNOMED CT.
  - It may be appropriate to adjust the interface item to remove any ambiguity.
- Mapping between the interface terminology and SNOMED CT needs to be kept up-to-date

5. SNOMED CT as an Interface Terminology for EHR Data Entry
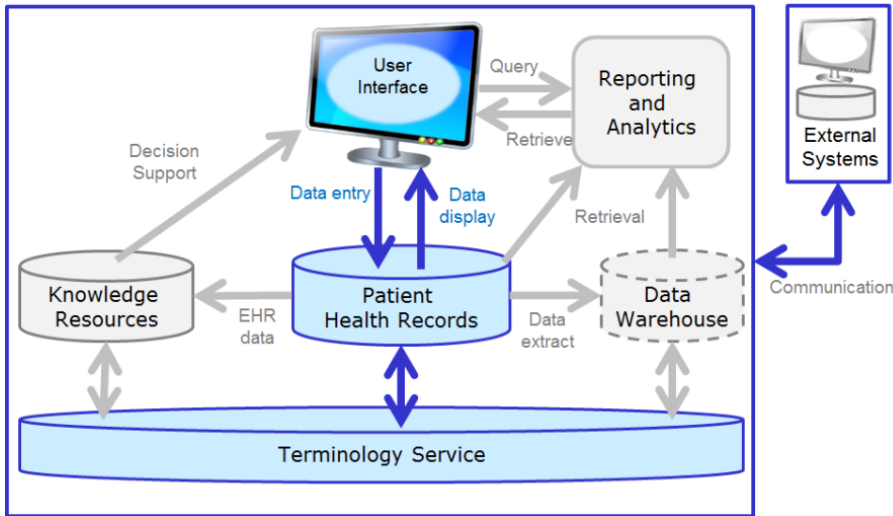
Figure 11. SNOMED CT as an Interface Terminology for EHR data entry

Employing SNOMED CT at the user interface is the distinction of this approach from the preceding one. It removes the complexity of creating and maintaining a map from the interface terminology to SNOMED CT. Given the large number of terms available in SNOMED CT, this approach may be supported by the use of SNOMED CT subsets to constrain the search for the appropriate SNOMED CT concept. As the data store content uses SNOMED CT, concept codes are available for communicating with external systems. Furthermore SNOMED CT can act as a readily available source of master reference data e.g. allergen list.

Benefits

- Standardized descriptions in the user interface
- No mapping required between interface terms and codes stored in patient record
- Supports enhanced techniques for data entry, search and display e.g. searching over synonyms of the same concept
- Patient data stored using SNOMED CT concepts
- Readily available master reference data e.g. allergen list

Considerations

- This approach may require a transition of the user experience. However, it should be noted that new descriptions may be added to SNOMED CT to meet the expectations of the users.
- Subsets need to be created and maintained to support users in searching for and recording the appropriate SNOMED CT concepts

6. SNOMED CT for Simple Aggregation and Analysis of Data
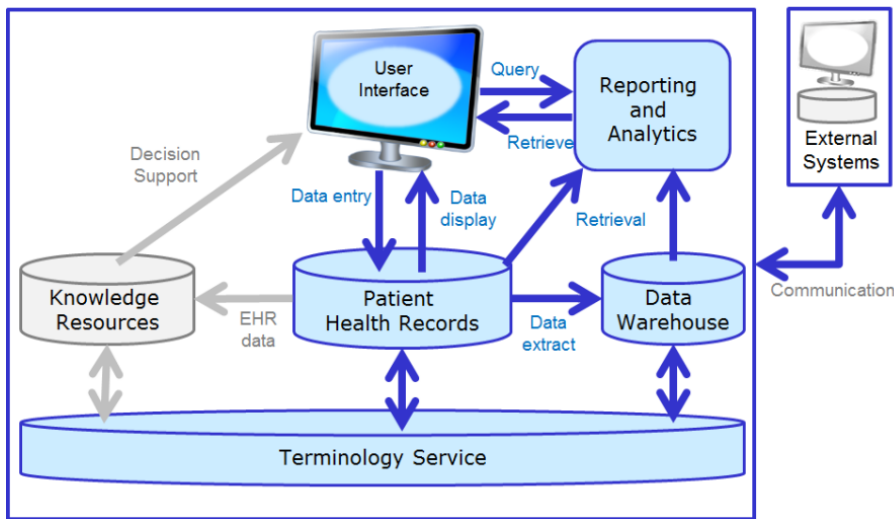
Figure 12. SNOMED CT as a dictionary for simple aggregation and analysis of data

Building on the previous implementation approach, the addition of analytics functions using SNOMED CT, as shown in Figure 12, provides enhanced capabilities. For example, this approach enables the identification of cohorts of patients based on given criteria, the ability to review conformance to care standards and responding to mandatory reporting requirements. A key advantage of this approach is that it does not rely on any terminology mappings, either from a local terminology or from an interface terminology. Using SNOMED CT's hierarchies and defining relationships, this approach supports querying and aggregation over health records. Both data analysts and clinicians gain the analytic power from SNOMED CT.

Benefits

- Supports the use of SNOMED CT for analysis and reporting purposes, such as:
    - To improve the user experience of longitudinal record review
    - For exploration of data in support of clinical process review
    - For identification of cohorts of patients for research studies
    - To meet mandatory reporting requirements
- Can utilize internationally developed mappings such as the mappings to ICD-9 and ICD-10
- Standardized descriptions in the user interface
- Patient data stored using SNOMED CT concepts
- Communication using shared meaning

7. SNOMED CT for Analytics Using Description Logic
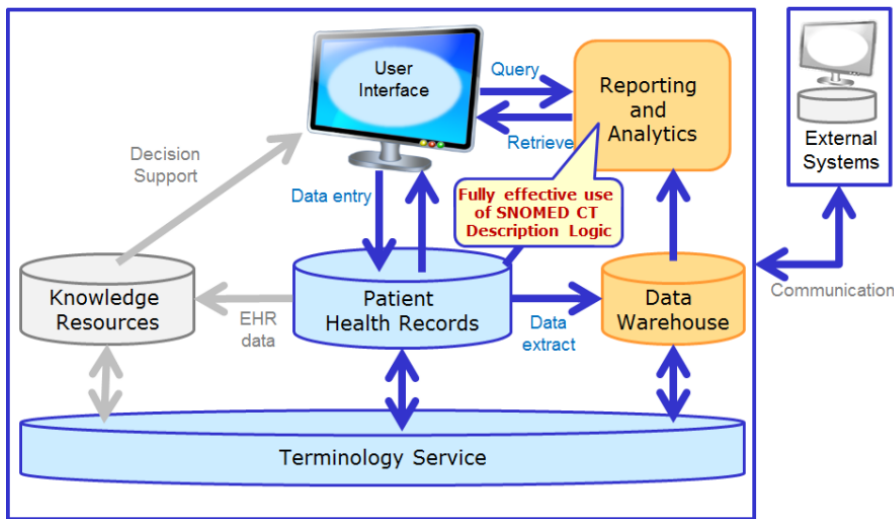
**Figure 13. SNOMED CT as a dictionary for analytics using Description Logic**

This approach may suit users who value the additional analytics capability that may be achieved with full computational use of SNOMED CT concept definitions. The enhanced analytic capabilities of this approach enables more effective record retrieval by minimizing the occurrence of false negative results, thereby improving the user experience.

In the Reporting and Analytics tools, this approach uses techniques from Description Logic. It does not include the use of SNOMED CT postcoordinated expressions for data entry and storage, however it does exploit the definitions of each SNOMED CT concept based on description logic.

Benefits

- More sophisticated and flexible reporting and analysis

8. SNOMED CT for Knowledge Linkage
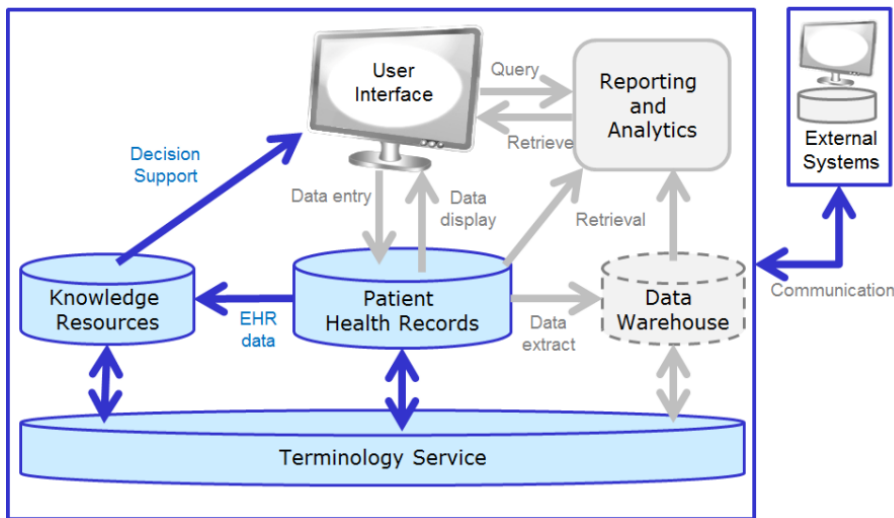
Figure 14. SNOMED CT for knowledge linkage

An enhancement to the approach set out earlier in Figure 11 is the addition of one or more SNOMED CT-enabled knowledge resources. This configuration includes a collection of knowledge resources (such as clinical guidelines or decision support systems) which use the SNOMED CT codes stored in a patient's record to determine which actions should be performed. This may include presenting alerts to the user, displaying relevant clinical guidelines and treatment protocols, or automatically populating an order, message or report.

Benefits

- Enables integration of EHR with knowledge bases
- Rules can use SNOMED CT's hierarchy and defining relationships for aggregation and querying
- Can be used to provide real-time clinical alerts relevant to the given patient
- Can be used to suggest relevant clinical guidelines and protocols relevant to the given patient

9. SNOMED CT as an Extensible Foundation for Representing Clinical Data
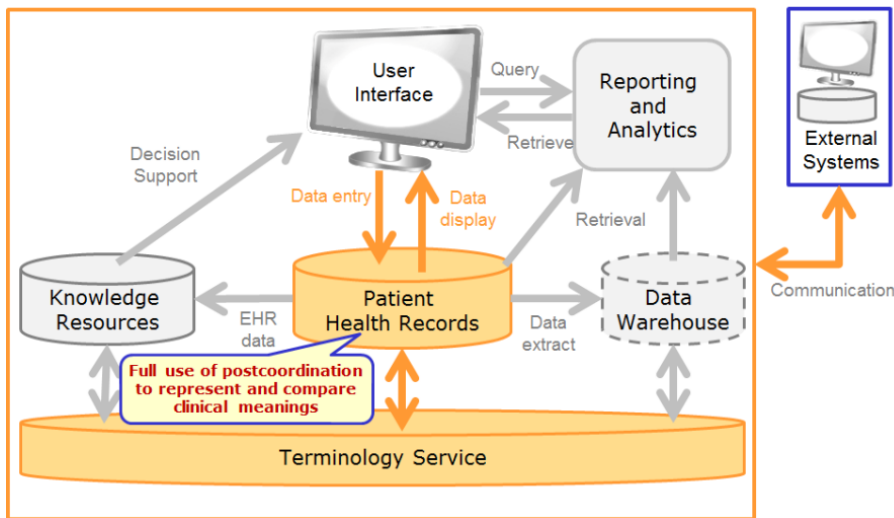
Figure 15. SNOMED CT as an Extensible Foundation for Representing Clinical Data

Figure 13 showed the exploitation of SNOMED CT concept definitions for analysis, but did not feature postcoordinated SNOMED CT expressions in the patient records. In contrast, the approach illustrated in Figure 15 supports the creation, storage, retrieval and display of records which use postcoordinated SNOMED CT expressions. It does not necessarily feature analytics tools dedicated to postcoordinated content. One reason to adopt this approach is to enable combinations of content to be stored together as a single data field e.g. to record the laterality of a procedure together with the procedure in a single field, rather than using separate fields.

This approach allows a variety of refinements to be made to existing concepts, e.g. 'pneumonia caused *by streptobacillus*' (as illustrated on page). An option for this approach is to use a SNOMED CT expression repository to identify, store and share the postcoordinated expressions which have been used. This aspect of the approach is described in the Technical Implementation Guide.

Benefits

- Increases the scope of supported clinical meaning using structured data
- Supports the construction of concepts as SNOMED CT expressions either:
- By the end users themselves
- During system design and configuration

Considerations

- External systems to which patient data is sent may not have the capability to process postcoordinated SNOMED CT expressions
- Data storage and message fields, which need to include SNOMED CT postcoordinated expressions, must support an adequate field length
- Retrieving patient records with postcoordinated content may require a more sophisticated approach to querying

10. Full Use of SNOMED CT to Deliver all its Powerful Features in an EHR
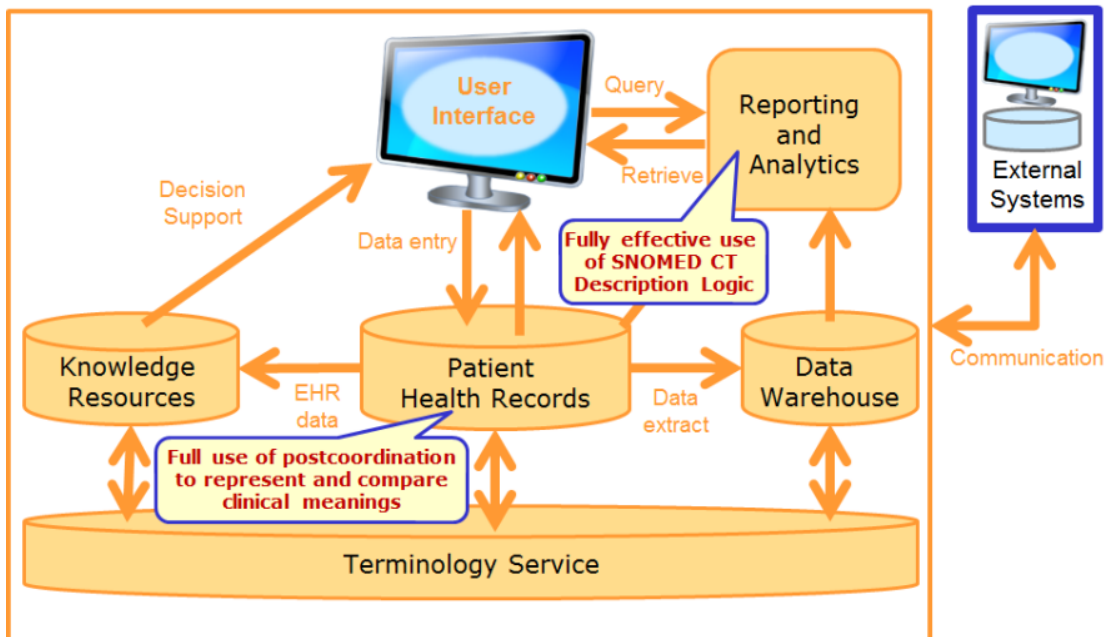
Figure 16. Full use of SNOMED CT to deliver all its powerful features in an EHR

This illustration shows a system in which all components are capable of using and exploiting the full features of SNOMED CT. Throughout the system it is possible to exchange, interpret and use information encoded as postcoordinated SNOMED CT expressions, and to perform analytics using Description Logic.

Benefits

- This system combines all the benefits identified for the preceding approaches.

Summary

The collection of approaches listed in this section illustrate that there are a variety of ways by which this 'Full use' can be reached. These approaches can be summarized by considering the set of SNOMED CT features that are used in each:

- Concepts and maps (approaches 1 and 4)
- Concepts, relationships and maps (approaches 2 and 3)
- Concepts, descriptions and subsets (approach 5)
- Concepts, descriptions, relationships and subsets (approaches 6 and 8)
- Concepts, descriptions, relationships, subsets and description logic (approach 7)
- Concepts, descriptions, relationships, subsets and expressions (approach 9)
- Concepts, descriptions, relationships, subsets, description logic, expressions and maps (approach 10)

While the last approach (approach 10) could be considered as a possible target configuration, for most EHR products a staged journey towards a more comprehensive design is most appropriate.

5. Implementation Strategies and Considerations

- To what extent will the use of SNOMED CT differentiate this product from others?
- What use cases can SNOMED CT be applied to?
- What migration paths will be offered to customers to move from their current coding system(s) to SNOMED CT?
- Will SNOMED CT be implemented into an existing EHR product or as a new product variant?
- Will implementation be achieved in more than one stage and if so in what stages?
- What, if any, parts of the system will be delivered by external providers?
- To what degree, and for what period, will previous designs be maintained in parallel?
- Will SNOMED CT be a design time terminology or a run time terminology?
- Will SNOMED CT be the interface terminology or just the storage, interoperability and reporting terminology?

A variety of implementation approaches were outlined in Section 4. This section references the approaches summarized in Section 4, and discusses some potential SNOMED CT implementation strategies, factors influencing implementation success, and possible measures of success.

Staged Implementation

Numerous pathways exist for the incremental implementation of SNOMED CT. These allow control of the timing and degree to which the existing designs and terminology resources are superseded.

Some Vendors have chosen to introduce SNOMED CT as part of a distinct, new product in their line of products. Many Vendors have introduced SNOMED CT in increments, with minimal disruption to their customers or end users. If a Vendor builds a new product, it is likely that a single-stage implementation would be appropriate.

Section 4 summarizes a range of implementation approaches that differ in the extent to which they utilize different features of SNOMED CT.

Single vs Multi-stage Implementations

Single stage implementations can:

- Minimize the impact from multiple cycles of customer training
- Launch a significant variant of a product into the market

Multi-stage implementations can:

- Minimize the impact of any single stage
- Match the extent of change to the needs and desires of the customers

One possible example of a staged implementation could involve a sequence of:

- Initially: Reworking the design of electronic messages used to interoperate with data in other systems, this would then feature SNOMED CT as part of the payload within these messages (Approach 1).
- Subsequently: Reworking existing data extracts and reports, using SNOMED CT indexes, to ensure the successful transition to a reliance on SNOMED CT based reporting (Approach 3).
- Subsequently: Retaining the existing terminology at the user interface but mapping that to a store in which SNOMED CT was recorded in addition to the existing code system (Approach 4)
- Subsequently: Migrating to the use of SNOMED CT at the user interface for new record entries (Approach 5).
- Subsequently: Adopting new analytics tools which exploit the meaning held in SNOMED CT (Approach 7).
- Subsequently: Extending the use of SNOMED CT to capture more structured data as SNOMED CT expressions (Approach 9).
- Finally: Using all SNOMED CT features throughout the EHR (Approach 10).

Relationships and Dependencies

Commercial and technical concerns about dependence on third-party components may be a valid reason for in-house development of all the required 'terminology services'.

However, a range of off-the-shelf terminology resources, such as SNOMED CT subsets, may be available to reuse, for example, to improve the user's data entry experience. Some of these resources will be usable worldwide and free of charge, while others may be available under some type of license. A dependence on a third party to maintain derivatives, such as subsets, can be eliminated by taking that responsibility in-house. Three distinct options are therefore:

- Adopt and use a third party terminology resource (e.g. a subset), relying on the owner to maintain them.
- Adapt an existing terminology resource (e.g. a subset), and so take on responsibility for maintaining a separate version.
- Enter into a collaborative relationship e.g. to jointly maintain the subset.

Language and Dialect strategies

SNOMED CT implementation can greatly simplify the configuration of an EHR product with terms expressed in the language or dialect required by the customer. A SNOMED CT implementation strategy should exploit the benefits of SNOMED CT for language and dialect localization. For example, using a SNOMED CT language reference set, which represents the preferred and acceptable terms in a given language or dialect, a subset used to populate a drop-down box can be simply re-configured to show terms in a different dialect. For other parts of a localization, such as the headings in a form, it is also possible to use SNOMED CT language reference sets as a reference source. The extent of use of language reference sets should be considered as part of a product strategy.

To exploit the language and dialect capabilities of SNOMED CT, a Vendor can use the localized content provided by a National Release Center.

A language or dialect variant needed by the customer can be used in any of the following scenarios:

- The SNOMED CT International Edition is used and this reflects the language used in the healthcare records.
- A specific dialect of a language is needed, such as Australian English, UK English, or US English.
- There is a dominant local spoken language, but this is not used in healthcare or health records (which are recorded using a language or dialect already available in SNOMED CT).
- Multiple languages are spoken, e.g. Canada, where any of those may be used.
- A translation of SNOMED CT is intended only to be used as a reference terminology i.e. not for use at the user interface.

Measures of Implementation Success

The extent to which a SNOMED CT implementation is successful can be evaluated in many ways, including the evidence-based evaluation of:

- Delivery of the planned benefits, along with continuity of existing value provided by the system
- The ability of customers and users to accommodate the changes with minimal training or disruption
- Extent and quality of interoperation with external systems and its value to customers: Electronic messages which retain the meaning of the clinical content, with effective reuse in the receiving system
- Uninterrupted, undisturbed operation of the healthcare enterprise through the period of introduction and use of SNOMED CT
  - Health outcomes of patients
  - Staff satisfaction
  - Enterprise remuneration and/or prestige
- Peer-recognition for good work
- Success in exploiting shared works such as off-the-shelf subsets or queries
- Minimal cost and maximal benefit from successive releases of SNOMED CT

Factors which Influence Implementation Success

Vendor Perspective

The factors which may influence implementation success, from a vendor perspective, include:

- Careful planning, understanding of key objectives and engagement with customers
- Successful matching of the user needs to the relevant SNOMED CT features and setting realistic goals for the delivery of specific benefits
- Selection of an appropriately staged implementation roadmap giving continuity of service plus an incrementally improved user experience
- Judicious selection of techniques and tools
- Consistent representation of stored clinical information
- Optimization of information retrieval and analysis
- Maximizing the reuse of existing configuration artifacts such as queries or subsets
- Separation of the terminology: discrete configuration data and avoidance of hard coding of terminology directly into software code

Customer Perspective

The factors which may influence implementation success, from a customer perspective, include:

- Ease and effectiveness of data entry and display of SNOMED CT. For example, speed of data entry, ease of search and navigation, limited search scope based on the context, aggregation of details, and highlighting of critical information are all important techniques for busy clinicians
- Minimal additional configuration and training burden for the users
- Adequate opportunities to adjust the product and its configuration for local needs, including exploitation of pre-existing, local designs
- Significant value from their own preparatory work to deploy the product and associated services
- Quality of the product, its flexibility and a future value sufficient to retain it beyond the current contract period

6. Enhancing EHR Design with SNOMED CT

Storing Clinical Records with SNOMED CT

Storing SNOMED CT encoded clinical records involves the storage of:

- Codes: Concept codes (SNOMED CT Identifiers for concept)
- Terms: User-selected terms (which may be SNOMED CT terms)

In some implementations of SNOMED CT this may also involve the storage of:

- Expressions composed of multiple codes
- Identifiers for expressions which are held in an Expression Library

Clinical data which is stored using SNOMED CT will use SNOMED CT concept identifiers. SNOMED CT Identifiers are represented as a string consisting of between 6 and 18 digits. Further detail can be found in the Release File Specification: SNOMED CT Identifiers.

In most cases, the term selected by the user is also stored. The structural representation of stored clinical information is important. This must store similar information consistently, and the storage design must support effective querying.

Binding and Mapping to SNOMED CT

User interfaces commonly restrict the data that can be selected by the user and stored. Electronic messages are also often constrained in terms of the permissible values that may be meaningfully included in each field. Decisions are made on whether some semantics, such as the priority for a procedure, is expressed in a reserved part of the message structure, or if it is expressed as part of the SNOMED CT expression within the message.

As part of implementation there may be a need to either:

- Bind SNOMED CT to relevant parts of the design, and/or
- Create and use a map between a pre-existing terminology and SNOMED CT

The implementer should balance the cost of developing and maintaining an inter-terminology map, with their target quality for that map. Unless an existing terminology scheme represents clinical ideas in a comparable way to SNOMED CT then a perfect (i.e. lossless and reversible) map may not be possible.

Data Entry with SNOMED CT

Existing data entry interfaces may be modified to incorporate SNOMED CT in the required places, often as a direct replacement of another coding scheme.

Data entry features which may be enhanced or enabled using SNOMED CT include:

- Search and entry of single codes
  - Optimized design of a search tool for effective use with SNOMED CT is addressed in the Search and Data Entry Guide. This is available in the SNOMED CT Document Library at http://snomed.org/doc.
- Clinical data entry interfaces comprising numerous data items, including selection from short pick lists, and selectable singe items (check boxes).
  - Data entry interfaces have discrete items or lists of items from SNOMED CT 'bound' to a field. An example would be the binding of a single SNOMED CT Concept to a checkbox, so that when checked the SNOMED CT Identifier for the concept is stored in the clinical record.
  - Pick list can be configured by 'binding' to a SNOMED CT subset, or by enumerating the members of the pick list within the interface design.
- The encoding of free text data entry using SNOMED CT, for validation by a user
  - Using Natural Language Processing tools which work with SNOMED CT
- The use of images as a way of selecting coded entries e.g. anatomical images

▪ This is a variation in which SNOMED CT is bound to regions of an image, rather than a coded or text based field

Attention is needed to identify which parts of the data entry interface are both in scope of SNOMED CT and which the implementer intends to be encoded using SNOMED CT. For example, when implementing a scored assessment with many questions, an implementer may choose to encode only the assessment result with SNOMED CT.

SNOMED CT allows a level of precision of meaning that is rarely matched by the content of proprietary terminology systems. For this and other reasons, there may need to be modifications or enhancements to the user interface and how it allows users to search, enter and express clinical ideas.

Maintaining SNOMED CT Enabled Products

Routine scheduled maintenance of EHRs is anticipated and supported by SNOMED CT, which also has a program of continuous improvement. Unlike some classification or coding schemes, SNOMED CT updates, adds and inactivates content where it is useful to do so.

The changes to SNOMED CT content include changes to the status of a concept or term e.g. from active to inactive. Relationships between concepts change for a variety of reasons, including the refinement of a concept definition, in response to new medical understanding, or the introduction of new concepts.

The most common activities relating to changes to SNOMED CT content are:

- Substituting a prior version of a subset with its more recent version, for example, in a data entry interface
- Substituting an inactivated Concept with a suitable nominated replacement
- Substituting an inactivated Term with a suitable alternative
- Evaluating the impact to an existing subset
- Updating of bindings and SNOMED CT queries

Messaging with SNOMED CT

Implementation of SNOMED CT within a system is not always concurrent to the adjustment of external electronic clinical data flows. The design of the electronic message, and the definition of the data extract which is used to populate the message, may need to be modified to accommodate its SNOMED CT payload. Similarly to data storage, an electronic message may require the inclusion of:

- Codes: Concept codes (SNOMED CT Identifiers for concepts)
- Terms: User-selected terms (which may be SNOMED CT terms)

For a more extensive use of the features of SNOMED CT, messages may include:

- Expressions composed of multiple codes
- Identifiers for expressions which are held in an Expression Library

Migrating Clinical Records between Systems

Some implementation strategies include the bulk migration of data between different versions of their system or between different systems. In this or similar circumstances, the tasks of data Extraction, Transformation and subsequent Loading ['ETL'] are performed.

Data migration can include the use of:

- Maps between items from the existing terminology to the SNOMED CT equivalent
- Transformation of data between the different physical data structures (or the more abstract 'information models') of the source and the target system

SNOMED CT supports multiple different ways for a concept to be expressed and stored. A concept may also have some parts of its meaning expressed within the data structure itself. For example, some of the different ways in which SNOMED CT can be used to represent a 'family history of' a disorder include:

- As a single SNOMED CT coded item

- As a SNOMED CT expression comprising two or more SNOMED CT concepts, one of which gives the context of Family History
- By representing the 'family history' via a dedicated table within the storage schema reserved for family history records, and populating this with the SNOMED CT Concept for the relevant disorder

Reporting with SNOMED CT

System outputs such as mandatory reports need to be supported at each implementation stage.

Reports can be used to guide resource allocation, for reimbursement, or for clinical quality evaluation, so the ability to provide these reports before and after any systems change is important to customers. Beyond the initial task of replicating existing reports and results, the analysis power of SNOMED CT can be exploited to generate new reports or types perhaps not previously possible.

SNOMED International distributes a map from SNOMED CT to ICD-10. This supports the generation of ICD-10 classified data from data originally recorded using SNOMED CT, or later mapped to SNOMED CT.

Transition to the use of SNOMED CT for clinical records will require, in some cases, re-development of the data processing to populate the reports. However, in many cases SNOMED CT will enhance previous reporting capabilities.

7. Licensing

The three types of license that govern use of SNOMED CT are Affiliate licenses, Sub-licenses and National licenses.

Affiliate licenses

Vendors and other organizations that develop or distribute products or services that include or provide access to SNOMED CT must be SNOMED International Affiliates.

An Affiliate license is a contractual agreement between SNOMED International and the Affiliate. The Affiliate license grants rights to use SNOMED CT worldwide, subject to:

- Meeting conditions for reporting its use and making appropriate payment where used in non-member territories
- Holding and conforming to the conditions of a National license for use in Member Countries

The Affiliate license agreement can be found at: http://snomed.org/license.

To obtain a SNOMED International Affiliate License:

- In an Member country, please check the relevant Member web page for advice on how to register: http://snomed.org/members
- In countries that are not Members, or in Member countries that use the MLDS, you can request a license using the SNOMED CT Member Licensing and Distribution Service (MLDS): https://mlds.ihtsdotools.org.

Organizations that use SNOMED CT must all be either an SNOMED International Affiliate or a sub-licensee of an SNOMED International Affiliate. SNOMED International Affiliates are required to issue sublicenses to organizations (or individuals) who use their products or services, unless the user organization is itself an SNOMED International Affiliate. More information on sublicenses is available later in this section.

Sub-licenses

Affiliate license holders who supply SNOMED CT enabled products or services to others are required to:

- Issue and manage sub-licenses and make information about these available to SNOMED International
- Report and ensure appropriate payment when SNOMED CT is used in non-member territories

National Licenses

Members can impose additional requirements related to the use of SNOMED CT International Edition in their territory. For example they may require use of their National Extension of SNOMED CT.

Members may issue National licenses to SNOMED International Affiliates. A National license usually grants use of a National SNOMED CT Extension which may include translations, content additions and reference sets. The terms of a National license may apply similar conditions on the use of the National Extension as the SNOMED CT Affiliate License applies to the International Edition. It may also be part of a broader licensing scheme covering other nationally licensed works.

National licenses can only be issued to SNOMED International Affiliates. However, if an applicant for a National License is not already an Affiliate, the Member may issue an Affiliate License on behalf of SNOMED International. Note that an Affiliate license issued in this way is still an agreement between SNOMED International and the licensee and the terms of the Affiliate License Agreement are the same.

License charges

- SNOMED International does not charge for licensed use of SNOMED CT in Member countries
- Members are permitted to charge for the use of SNOMED CT within their country, provided that these charges are limited to cost recovery
- There are fees for use of SNOMED CT in non-Member territories

- These charges depend on the wealth of the country in which the use of SNOMED CT occurs. For detail of the fee structures see http://snomed.org/license.
- Intended use in non-Member territories must be reported to SNOMED International (via MLDS: https://mlds.ihtsdotools.org) before this use begins.
- Fee-waivers may apply for limited use of SNOMED CT in SNOMED International approved research projects and 'public good' initiatives.
- Fees for Web and Mobile Apps can be found here https://www.snomed.org/licensing.
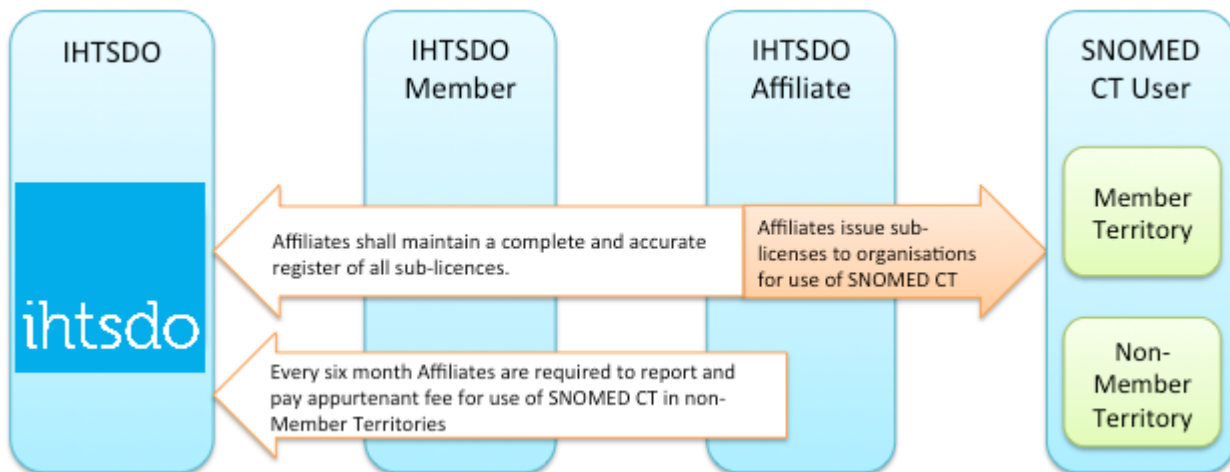
Figure 17. Responsibilities of Affiliate license holders to report usage and where appropriate to pay the fees which are due

Further details can be found via the SNOMED International website at http://snomed.org/license.

Online Browser Licensing

SNOMED International has published guidance about licensing implications of web-based SNOMED CT browsers and other publicly available software or services and which incorporate, or provide access to SNOMED CT: https://confluence.ihtsdotools.org/download/attachments/73368648/Ihtsdo_Guidance_PublicAccessBrowserAndTools_20141211.pdf

8. References

The Vendor Introduction is intended as a useful starting point for Vendors. More detailed information and a range of informative documents and training materials can be accessed from the SNOMED International web site www.snomed.org and the SNOMED CT Document Library http://snomed.org/doc.

The table below provides links to many of the key resources for further learning about SNOMED CT.

Topic	Key reference
General information about SNOMED CT Materials include what is SNOMED CT?, value and benefits, and information about licensing, software and tools, other SNOMED products. Also focused sites for vendors, members and implementers.	https://www.snomed.org/what-is-snomed-ct https://www.snomed.org/value-of-snomedct http://snomed.org/license https://www.snomed.org/software-tools https://www.snomed.org/other-snomed-products https://www.snomed.org/vendors https://www.snomed.org/members https://www.snomed.org/implementers
SNOMED CT Document Library Access to a wide range of documents about SNOMED CT	http://snomed.org/doc
SNOMED CT Browsers The SNOMED International Browser and a list of other tools for exploring SNOMED CT content	http://browser.ihtsdotools.org http://snomed.org/browsers
SNOMED CT in Action Examples of how SNOMED CT is being used around the world.	https://www.snomed.org/snomed-in-action
SNOMED CT Starter Guide A general purpose introduction to SNOMED CT which complements this guide.	http://snomed.org/starterguide
SNOMED CT E-Learning Server Access to a growing range of online training resources about SNOMED CT. Including formal courses and open-access materials.	http://snomed.org/elearning https://www.snomed.org/education
SNOMED CT Expo Presentations Presentation materials	https://www.youtube.com/@snomedct/playlists
About SNOMED International More information about the organization that owns and maintains SNOMED CT	http://snomed.org/newsletter http://snomed.org/events https://www.snomed.org/about-us https://www.snomed.org/get-involved http://snomed.org/members https://www.snomed.org/our-partnerships https://www.snomed.org/snomed-ct-marketplace

Appendix 1. - User Experience of SNOMED CT

No matter which EHR design is used for implementing SNOMED CT, they will each incorporate some form of interaction between the end users and SNOMED CT. The way that SNOMED CT is implemented makes a significant difference to the user experience. Various simple techniques can be used to seamlessly integrate SNOMED CT with user interfaces that match the needs of clinical users.

This section offers high-level guidance on ways to deliver a positive user experience of SNOMED CT as part of an EHR system. More details on topics discussed in this section can be found in the Documents in the SNOMED CT document library - https://confluence.ihtsdotools.org/display/DOC and the Search and Data Entry Guide (http://snomed.org/search).

SNOMED CT Concept Identifiers

Unlike some classification schemes in which the characters used in each code convey some meaning, SNOMED CT concept identifiers are a sequence of digits which in no way reflect the meaning of the concept. For this reason, there is usually no value gained by displaying the identifier to the user, and in most cases it should be hidden to simplify the user interface. Instead users should see and interact with the terms used to represent the concepts, and the SNOMED CT concept identifier should purely be used in the stored record.

Preferred Term and Synonyms

Where SNOMED CT is being used as an interface terminology, the preferred term for each concept should be used as the default for display on the user interface. Each concept may have a different preferred term in different languages, dialects, specialties or care settings, and so these can be configured to a specific clinical environment. To improve the ease for users in searching for a given concept, user interfaces may support searching over any acceptable synonym for each concept. Preferred terms and acceptable synonyms are defined in SNOMED CT using a Language reference set, which references the subset of descriptions used in a given language, dialect, specialty or care setting. SNOMED International distributes two language reference sets (for US-English and UK-English), and various member countries distribute their own national Language reference sets. Additional language reference sets may be created at the regional, specialty, institute or software product level to truly customize the local user's experience.

Where a separate interface terminology is being used, each term may be bound (or mapped) to an appropriate SNOMED CT concept. When the interface term is selected, the identifier of the bound SNOMED CT concept is stored in the record. It is important when an interface terminology is being used that the mapping to SNOMED CT is of sufficient quality (ideally equivalent) to support the use cases for which the data will be used. Using an interface terminology, for example, may be useful for structured data entry, where only part of the meaning is represented by the selected term, and the rest by the surrounding interface context. An example of this is illustrated in Figure 18. In this example, when the radio button next to the term 'Full' is selected (from the 'Mobility' section on the user interface), the concept 160680006 |fully mobile (finding)| is recorded in the health record to fully represent the meaning of the selection and make future queries on this data more reliable.
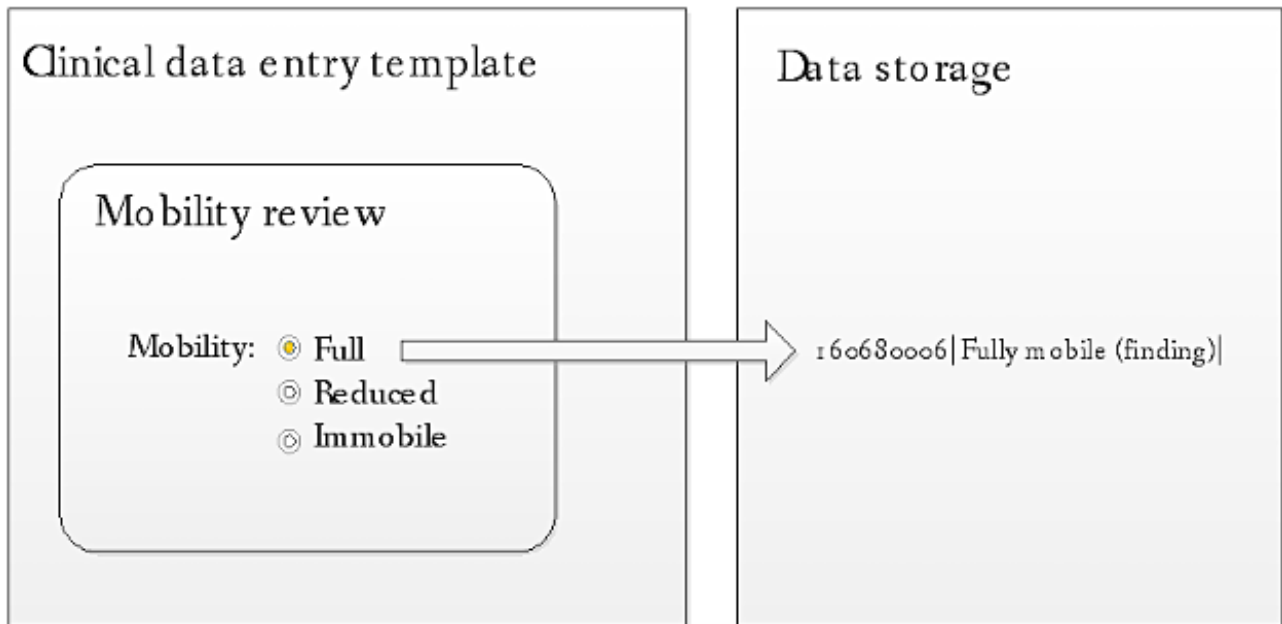
Figure 18. Example of interface terminology used as part of structured data entry

Fully Specified Name

Identical words or phrases may sometimes have multiple meanings. In these cases, it may be helpful to display the fully specified name (FSN) of a concept in order to disambiguate each identical term.

For example, Figure 19 illustrates three terms that match the search for "cold" which have very different meanings. In practice, such ambiguities can also be minimized by appropriate search constraints (e.g. only two of these results refer to disorders).

Figure 19. Search results matching "cold" with their FSNs displayed to the right

Constraining Search Results

SNOMED CT is a large terminology with broad coverage. Consequently, unconstrained searches can result in long and unhelpful lists of matching terms. Ideally, users should only be presented with content relevant to their task. There are several ways to constrain search results to deliver a shorter and more relevant list of search results, including constraining concepts:

- To a particular hierarchy
  - For example, only concepts from the procedure hierarchy
- To the subtypes of a given grouper concept

- For example, only concepts that are subtypes of the |pharmaceutical dose form| concept
  - Based on membership of a defined subset of concepts or descriptions
    - For example, only body structure concepts referenced by the |lateralizable body structure reference set|
  - Based on particular attributes of the concept
    - For example, only disorder concepts defined with an |associated morphology| of |inflammation|

If searches are not constrained, the result may include a long list of irrelevant concepts, from which it is difficult for a user to find the appropriate term. Unrestricted searches also lead to errors in coding where similar terms are associated with concepts from different hierarchies. For example the term "emphysema" can refer to a morphological abnormality in the lung or to the disease caused by this abnormality. While these concepts are related, using morphological abnormality as a patient diagnosis will lead to incorrect retrieval results.

An example of constraining to a particular hierarchy is shown in Figure 20. This example illustrates a search, which is performed with two different constraints. On the left the results are limited to the 'clinical finding' hierarchy, and on the right they are limited to the 'procedure' hierarchy.

It should be noted that some SNOMED CT hierarchies are never relevant for clinical data entry. In particular, concepts in the |SNOMED CT Model Component| hierarchy are technical artifacts that should be excluded from searches used for clinical data entry.
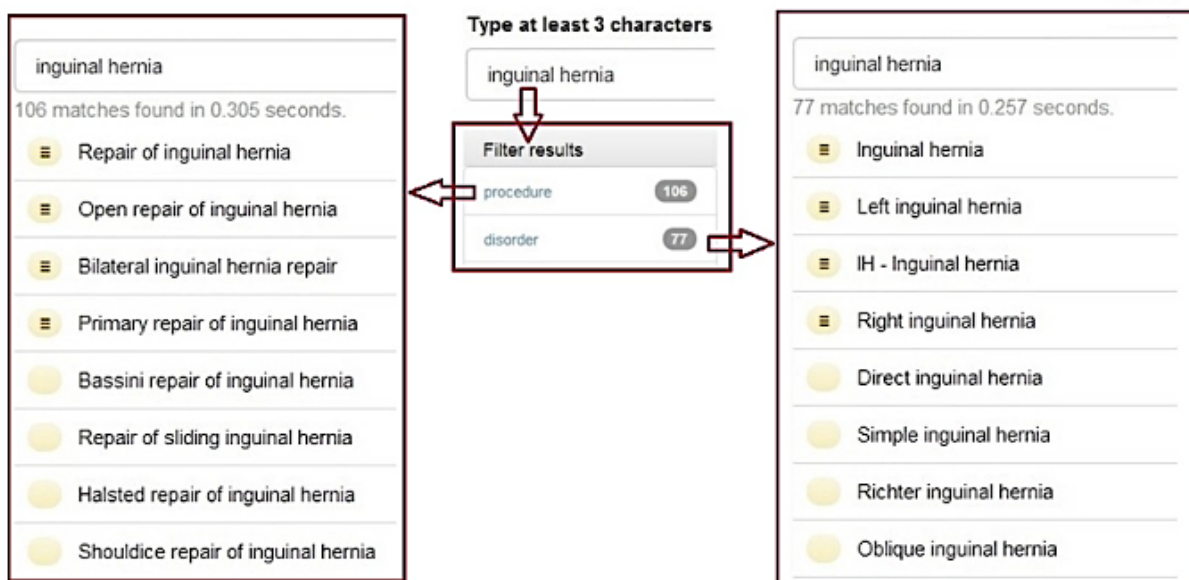
Figure 20. A search constrained to the procedure hierarchy (on the left) and the disorder hierarchy (on the right)

Ordering Search Results

For many purposes it is helpful to order search results by ascending term length. This ensures that the terms that match the search string without other additions are seen first. Other list sequences may have their own merits but alphabetical ordering is often unhelpful, except in a very short list of search results.

Tree Navigation

A user interface may include the use of tree navigation to allow the user to navigate up or down content arranged in a tree structure, expanding and collapsing nodes as required. A tree hierarchy may also be used to arrange search results into a nested list that displays the most general matches first, with more specific matching subtypes nested below them.

The SNOMED CT subtype hierarchy may, in some cases, be used for these purposes. Alternative navigation structures can also be developed using an ordered reference set, which is customized to a specific use case. For example, users may wish to navigate to diagnosis content using customized groupings relevant only to the local region.

Data Entry Forms

For structured types of data entry, templated forms are often used. In these cases, SNOMED CT concepts or expressions can be bound to each relevant field, option or list item. Preparing these bindings is part of the customization of an implementation to use SNOMED CT.

Encoding Free Text

Another type of interface that some tools provide enables free text to be coded using Natural Language Processing (NLP) enhanced by the semantics within SNOMED CT. This can provide an excellent user experience for typed or dictated data entry, but requires careful attention to quality to avoid inappropriate coding.