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# Some views about SNOMED-CT by a General Practitioner

Abstract

SNOMED- CT is is a concept-oriented and machine-readable medical terminology which has gained popularity this last ten years.  It has been proposed as the reference terminology for use in electronic medical records and is supposed to cover the entire field needed to care and cure.  This paper is examining its complexity and ability to cover the fields of general practice/family medicine, presented as the focus point of information in medicine.

# Sommaire

# 1. Semantic interoperability and general practice

This paper is driven by the acquisition of knowledge in the field of semantic interoperability. This involves the ability of two or more computer systems to exchange information and have the meaning of that information accurately and automatically interpreted by the receiving system. In the field of interoperability, user's interface and consequently language is one of the main issue of the relationship with the computer.

Basic information about SNOMED CT is difficult to find, material available[a] lacks complete understandability by other than experts in formal terminology. Moreover SNOMED CT is a complex product, being the meeting point of medicine, computer sciences and computational linguistics. SNOMED-CT, a mix between US and UK terminologies, represents also a move from the terminological field to the ontological one and it is not so easy to understand the concept of ontology. One view of ontology is that it is a formal specification of a conceptualization for the purpose of enabling knowledge sharing and reuse[1]. This implies that relations between concepts are as important as the concept themselves.

Understanding the domain of terminologies, ontologies and their relationships, particularly of SNOMED- CT, represents a challenge for the general or family practitioner who is progressively facing the charge to gather in his EMR all the information generated by the health system for a particular patient. One can say that Information is to general practice / family medicine as technology is to medical specialties. Managing information is a new duty for the GP/FM, a complex domain as is General Practice itself, a crossroad between human and collectivity, between to do and to be[2], between patient interests and public expenses. If biomedical field is the first training step and experience, reality drives the practitioner through the depths of this symbolic animal called 'human being' (psychodynamics). This one lives in community and quantitative (epidemiology) and qualitative (anthropology) interactions are daily modifiers of practice. Consequently GP/FM is also the crossing point of Narrative Based (NBM)[3] and Evidence based Medicine (EBM) Let us assess whether SNOMED –CT's complexity is able to render the GP/FM one.

|  | To do | To be |
|---|---|---|
| individual | Bio math medicine | Mental health |
| community | Epidemiology | Anthropology |

**Figure 1 Four fields of General Practice / Family medicine**
**Adapted from M. Van Dormael[2]**

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[a] This paper has been written form material received at SNOMED CT® Training Class , April 27, 2010 during the IHTSDO conference in Copenhagen and from several Internet sources.

## 2. About SNOMED-CT & IHTSDO (nickname itsido)

SNOMED-CT means Systematized Nomenclature of Medicine - Clinical Terms. SNOMED is patented as a system and method for medical language extraction and encoding. SNOMED-CT is a standardized clinical cerminology, comprised of codes, terms and relationships, for use in recording and representing clinical information across the scope of health care which allows data to be captured (coded), retrieved, exchanged and understood. SNOMED-CT has been created by combining[4] SNOMED RT, the terminology produced by the College of American Pathologists (http://www.cap.org ) and a computer-based nomenclature and classification known as Read Clinical Codes Version 3 (CTV-3)The Read Codes were invented and developed by Dr James Read in 1982, for use in General Practice. In 1990, the NHS bought the Read Codes from Dr Read and made them NHS standard. *Systematized Nomenclature of pathology* (SNOP), ancestor of SNOMED, has been published in 1964.

In the Medical subject heading of the National Library of Medicine, SNOMED has gained its place between MeSH and UMLS. It has been proposed – but not yet accepted - as the interface vocabulary for all the Electronic Health Records in the USA. Since 2003 there is an agreement between the U.S. Secretary of Health and Human Services, and the College of American Pathologists that will make SNOMED-CT available to U.S. users at no cost for the users, but a unknown cost to the US government through the National Library of Medicine's Unified Medical Language System® (UMLS).

In April 2007 the International Health Terminology Standards Development Organization , a non profit organization based in Denmark (http://www.ihtsdo.org ), acquired the intellectual property rights of SNOMED Clinical Terms (SNOMED CT) and its antecedents from the College of American Pathologists for $7.8 million.
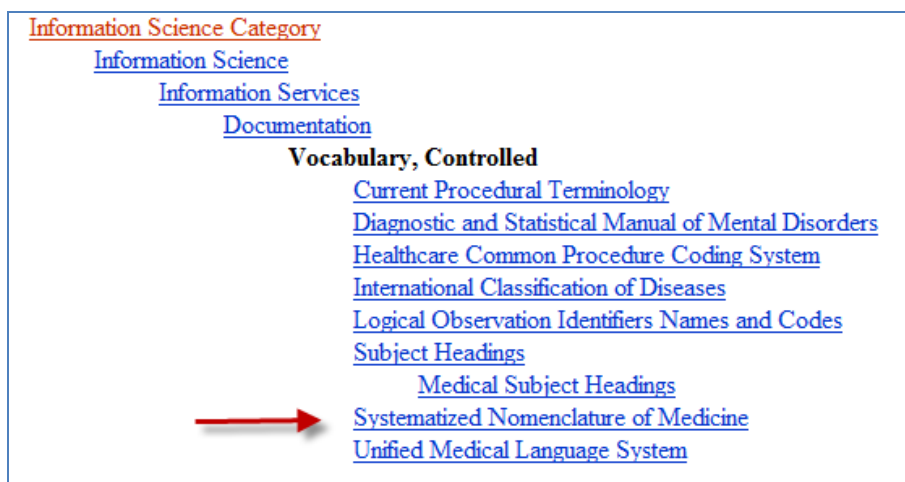


**Figure 2 SNOMED finds its place in the controlled vocabularies of the NLM (http://www.ncbi.nlm.nih.gov/mesh/68018875)**

### 2.1. International Health Terminology Standards Development Organization

By acquiring the SNOMED CT standard, the IHTSDO, which was established by a group of nine founding nations (Australia, Canada, Denmark, Lithuania, The Netherlands, New Zealand, Sweden, the United States and the United Kingdom), will help to ensure the continued maintenance and

evolution of SNOMED CT as well as its availability on an international scale. The IHTSDO assumed responsibility for the ongoing maintenance, development, quality assurance, and distribution of SNOMED CT. SNOMED Terminology Solutions, a specialized team of the College of American Pathologists has been commissioned to support IHTSDO operations under an initial 3-year contract and will separately continue to provide SNOMED-related products and services as a licensee of the terminology.

## 2.2. IHTSDO member countries (2010)

| | | |
|---|---|---|
| Spain | Australia | Lithuania |
| Sweden | Canada | New Zealand |
| The Netherlands | Cyprus | Singapore |
| United Kingdom | Denmark | Slovak Republic |
| United States | Estonia | Slovenia |

# 3. SNOMED CT,  a complex controlled medical vocabulary

## 3.1. What's a SNOMED concept

### A unit of meaning

In SNOMED CT, a concept is a "Unit of meaning", described by a unique numeric code,  a unique name (Fully Specified Name), a set of terms (descriptions), one "Preferred Term", and one or more Synonyms. SNOMED CT concepts are either "primitive" or "fully defined". A fully-defined concept can be differentiated from its parent and sibling concepts by virtue of its relationships with other concepts. Otherwise it is primitive.

### Fully Specified Name

Unambigous name of concept, unique for active concepts which includes a trailing "hierarchy tag" in brackets. Ex;
- Hematoma (morphologic abnormality)
- Hematoma (disorder)

## 3.2. Descriptions versus definitions

A concept definition is the list of its relationships to other concepts[5].  There is no cursive definition of concepts available. While SNOMED-CT considers relationships as the unique way to define a concept, other authors of ontologies don't agree with this view, arguing that the ontologies have to  include textual  *definitions*  for all terms and that terms should be defined so that their precise meaning within the context of a particular ontology is clear to a human reader.[6]

Indeed definitions by relationships could quickly become tautological as in the Figure 3. It's interesting to see the lack of stability of the relations used to describe interrelated concepts which are at the aim of the practice[7]  The relation is_a normality findings could also be interpreted as part_of normality findings and one can wonder why normal is_anormality findings while abnormal is_a modifier. Indeed the question of relations in ontologies is still discussed

| SNOMED-CT Term | # occurrences | Definition (by relations) |
|---|---|---|
| Borderline | 188 | is_a reference range interpretation value |
| Normal | 1814 | is_a normality findings |
| Abnormal | 788 | is_a modifier related to clinical specialty AND/or occupator |
| Pathological | 92 | is_a normality findings |

**Figure 3 Occurrences of usual terms in Clinical Clue Browser. (Cliniclue browser extract SNOMED CT International Edition (2010-01-31) http://www.cliniclue.com )**

(WC: the above is of course nonsense)

## 3.3. The hierarchies or Roots  of SNOMED-CT

They are 19 Upper level hierarchies or roots revealed by the Cliniclue browser.  Each hierarchy (roots) has sub-hierarchies



**Figure 4 The 19 hierarchies of SNOMED-CT concepts with their unique identifiers  (Cliniclue browser extract SNOMED CT International Edition (2010-01-31) http://www.cliniclue.com )**

6
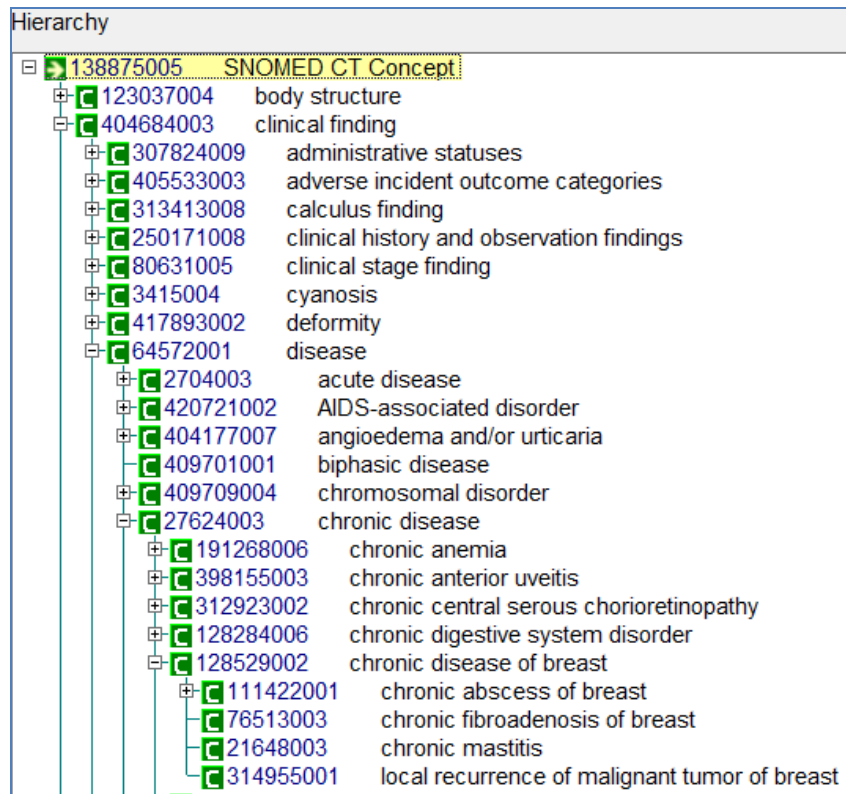
**Figure 5  SNOMED-CT: Disease as sub-hierarchy of Clinical finding. The fig shows the opening of chronic disease of breast. (Cliniclue browser extract SNOMED CT International Edition (2010-01-31) http://www.cliniclue.com )**

## 3.4. Relationships

Controlled vocabularies can be conceived as graph-theoretical structures consisting on the one hand of terms (which form the nodes of each corresponding graph) linked together by means of edges called relations[8].

```
Is_a
Has_finding_site
Has_associated_morphology
Has_method
Part_of
Has_direct_procedure_site
Has_causative_agent
Has_active_ingredient
Has_dose_form
```

**Figure 6 frequent relations in SNOMED CT**

In SNOMED-CT,  *Is_a* links concepts within a hierarchy  while Attribute relationships  allows links between concepts across hierarchies .

**Figure 7 SNOMED-CT : left ; the concept Chronic atrial fibrillation is a sub hierarchy of clinical finding. Right ; relationships of the concept within a hierarchy (is_a) or across hierarchies including mapping to original codes.**
**(Cliniclue browser extract SNOMED CT International Edition (2010-01-31) http://www.cliniclue.com )**
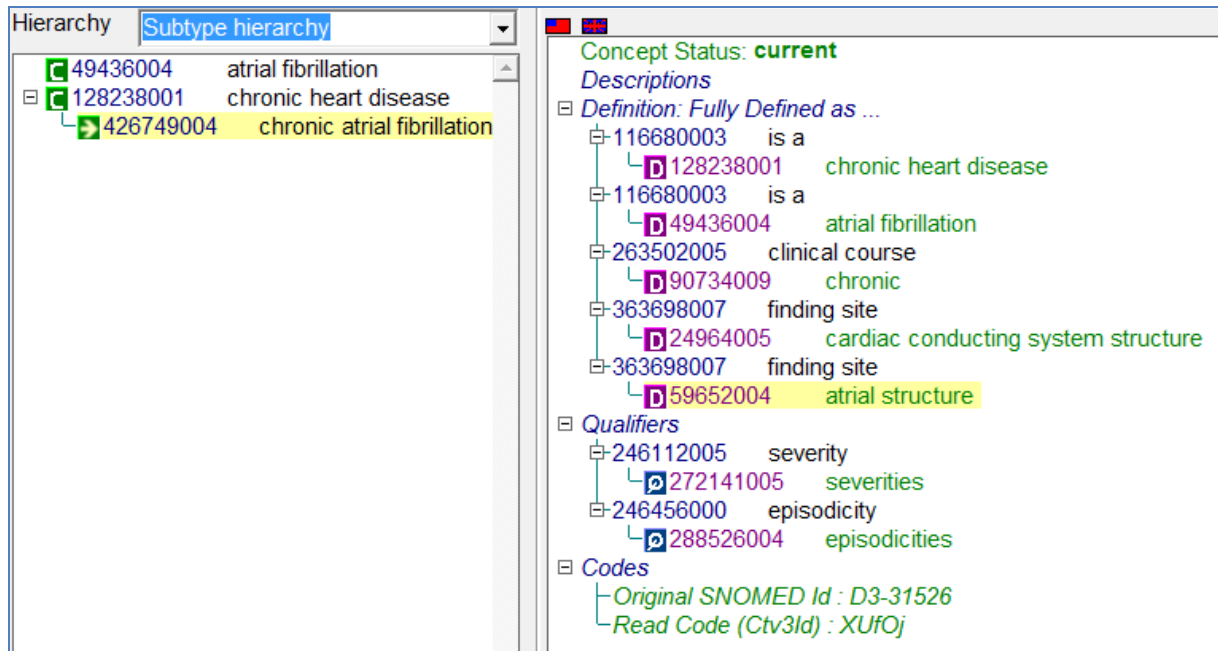
## 3.5. The tables of SNOMED CT

SNOMED CT comprises 9 tables of which 3 core tables (concepts, descriptions and relationships) collectively defining a compositional description logic ontology of the medical domain, and a lexicon of associated preferred or synonymous descriptions. The most recent international release (January 2010) contains more than 308,000 active concepts, 791,000 active descriptions, organized into 19 hierarchies with more than 951,000 relationships

> - 3 : Concepts, Descriptions, Relationships (Core tables)
> - 2 :  Subsets, Subset Members
> - 3 :  Cross Map Sets, Cross Maps, CrossMapTargets
> - 1 :  Component History

**Figure 8  9 tables in SNOMED CT distributed in the form of tab delimited text files**

### Core tables characteristics:

| Concepts | Relationships | Descriptions |
|---|---|---|
| Concept_id | Relationship_id | Description_id |
| Concept Status | Concept id1 | Concept_id |
| Fully Specified Name | RelationshipType | Description Status |
| CTV3_id | Concept id2 | Term |
| SNOMED_id | CharacteristicType | Intial Capital Status |
| Is_Primitive | Refinability | Description Type |
|  | Relationship Group | Language Code |
|  |  |  |
| Gastric ulcer | Is_a | Gastrointestinal ulcer |

**Figure 9  Core tables characteristics**

## 3.6.  The Clinical Terms Identifier (SCTID), a 64 bit integer

Each '_id' is represented by a 64 bit integer (not always presented in full length), the SNOMED Clinical Terms Identifier (SCTID) like "101291657896189 00 9" (the last digit being a Verhoeff algorithm control code) used for primary key for most tables. The two digits before the last one are 10 for concept, 11 for description, 12 for a relationship but this form of presentation is rather uncommon. For example the Concept_id  22298006 means *myocardial infarction*

The concept-id could contain a Namespace Identifier, a code or that part of the 64 bit integer that identifies the organization responsible for creating and maintaining a standards-based extension or a standards-based derivative. Namespace Identifiers are 7-digit numbers that IHTSDO issues to those who create extensions to SNOMED CT,

The ConceptStatus is quoted by a number :

| | | | |
|---|---|---|---|
| 0 | Current | 5 | Erroneous |
| 1 | Retire without specified reason | 6 | Limited/Classification |
| 2 | Duplicate | 10 | Moved Elsewhere |
| 3 | Outdated | 11 | Pending Move |
| 4 | Ambiguous | | |

Example: the 3 following SCTID (Figure 10) are linked in such way that the Relationship_id identifies the chain of knowledge between two concepts

| readability | Concept id1 | RelationshipType | Concept id2 |
|---|---|---|---|
| human | Cholecystectomy (procedure) | is_a (attribute) | Biliary tract excision (procedure) |
| machine | 302619004 | 116680003 | 38102005 |
| human | Gastric ulcer (clinical finding) | Is_a (attribute) | Gastrointestinal ulcer (clinical finding) |
| machine | 397825006 | 116680003 | 40845000 |

**Figure 10 SNOMED-CT ;  Concepts and relations expressed in readable and coded form.**

## 3.7. Pre and post coordination

SNOMED CT is compositional, allowing concept expressions to be pre-coordinated within the terminology or post-coordinated within the medical record.

**Pre coordinated concepts**

| | |
|---|---|
| 2474726011 | pan retinal photocoagulation for diabetes |
| 2533101018 | attended diabetes structured education program |
| 125663012 | lipodystrophic diabetes with partial lipoatrophy |
| 356077018 | malnutrition-related diabetes mellitus - fibrocalculous |
| 408810010 | DTSQ - Diabetes treatment satisfaction questionnaire |

**Figure 11  Five  of the 877 occurrences of the chain 'diabet' in Cliniclue browser. SNOMED CT International Edition (2010-01-31).These are typical example of pre coordinated concepts**

## Post coordination of concepts

SNOMED CT enables complex descriptions. For example, there might not be an explicit concept for a burn between the toes. But it could be described as

```
284196006|Burn of skin|:
 246112005|Severity|=
  24484000|severe,
   363698007|Finding Site|=
    113185004|Structure of skin between fourth and fifth toes|:
     272741003|Laterality|=
       7771000|left)
```

Figure 12   SOMED interpretation of burn between the toes. Example of post coordination.

Methods have been developed to retrieve pre- and post-coordinated concepts. The process for selectively retrieving pre- and post-coordinated SNOMED CT concepts relies on a syntactic transformation into a standard form[9].

## Loosing redundancy

| | ICPC | ICD | SNOMED-CT |
|---|---|---|---|
| **Signifier** | B25 | i64 | 397825006 |
| **Signified** | Fear of AIDS | Stroke | Gastric ulcer |

Figure 13 Loose of redundancy in  signifier / signified relationship

Machine readable implies that human beings cannot reasonably retain the code of the concept In the Figure 13 , the signifier is the code while the signified is the concept. ICPC has been designed to be used in Paper and Pencil format and incorporate mnemotechnic tricks. For instance B stands for Blood and in the whole classification the number -25 is reserved to Fear of.  A GP who is familiar with the International Classification of Primary care (ICPC)[10]  could quickly recognize the B25 code, in the context, as Fear of Blood disease of which the main one is Fear of AIDS.   ICD10 code are not mnemotechnic and a normal doctor will not retain that i64 is the code for Stroke while a dedicated coder could remember it. But the number 397825006 can only be 'understood" by a computer. One remarks that going from left to right, one looses redundancy. While enhancing its precision ,he code looses internal information which allows human readers to understand it.

# 4.  SNOMED Browsers

SNOMED CT is a complex ontology and sophisticated browsers are required to make it understandable and useful. Rogers & Bodenreider[11] have identified 23 SNOMED CT browsers that have been developed, and inspected 17. They enumerate and provide test criteria for a 'master list' of 143 browsing features supported by at least one inspected browser; future work will determine which of these features are implemented by individual browsers. Only 5 features were common to all 17 browsers; 89 were found in less than one third of browsers. They recommend that a core set of browsing features be defined and harmonized across browsers, particularly for text-to-concept .

Browsers permit searching on the SNOMED-CT terminology by displaying the hierarchy (descendents and ancestors) of a given concept  and by displaying the relationships and terms ("detail") associated with a particular concept search operations. Different implementations of software, offering SNOMED CT browsing capability are available. Do refer to http://www.connectingforhealth.nhs.uk

## 4.1. An example of study with Dataline software

The dataline SNOMED-CT browser allows visual representation (http://snomed.dataline.co.uk/) and is freely available on Internet. One has studied how a concept, in this case Epilepsy, is presented in serial written way with its concept_ids. (left column) and in a visual way (right column) (Figure 15)

The Epilepsy concept has the number 84757009 and pertains to "(disorder)" hierarchy. The chain of character "epileps" is present 216 times in SNOMED-CT International Edition (2010-01-31) (Cliniclue browser) The Figure 15 shows some of them with their respective numerical identifier. For pedagogic purpose, one of the linked concept "Reflex epilepsy (disorder)" has been represented in the visual display of the left windows with its numerical identifier "ID 79745005". This helps to understand that the computer plays with numbers and shows readable items. The lines between concepts are actually relationships which have also their own numerical ID. The concepts are presented here with human readable words but for computer use chains of numerical ID are enough as shown in Figure 10Figure 10. Note that in the upper line of the left window one can read  the SNOMED RT (CAP codes) and CTV3 (former Read code or clinical codes UK)

This kind of formal representation of concept forms the basis of ulterior transfers or analysis. XML is particularly fit to such transfer as in this example (Figure 14); the xml tag <description id> contains all the characteristics of the Epilepsy as a SNOMED-CT entry.

```
<description id="178739011" term="epilepsy" status="0" type="1" language="en"
initialCapital="0" conceptId="84757009" conceptStatus="0"></description>
```

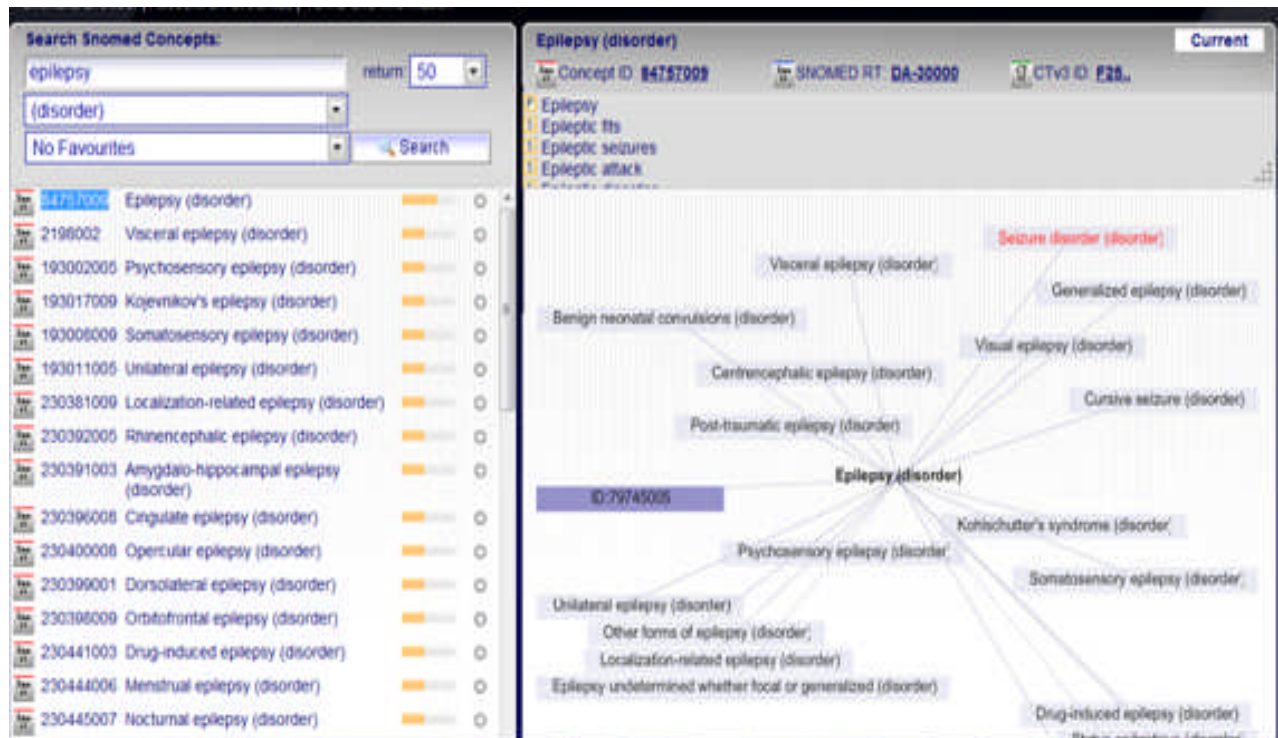**Figure 14 XML tag for SNOMED-CT concept Epilepsy**

**Figure 15 Snomed browser : the occurrence of the concept 'Epilepsy" with visual presentations of its relationships using Snoflake, the Snomed online CT browser from Dataline Software (http://snomed.dataline.co.uk/)**

# 5.  To what extent Is SNOMED-CT in use in practice?

It is unclear if SNOMED is really useful in clinical practice. A review of the available literature, performed in 2006 and published in 2008 examines 250 published studies on SNOMED. These studies look particularly relevant for proving the value of SNOMED in theory. Few studies are available on the usage of SNOMED in clinical practice[12].

An interesting study[13] , but yet outdated, compares the usefulness of 2.739 clinical codes of a dictionary, ICPC based, developed by Bob Bernstein (Canada) versus the 140.000 SNOMED 1993 entries.  "The SNOMED coding specialists took more than 250 hours to encode 2,739 (ICPC based) codes (to SNOMED Xref) and the author took over 100 hours to revise them"

## Practical use

Practical use seems not so easy. A university based hospital of 650 beds, serving 140.000 patients has implemented SNOMED-CT recently[14]. The authors describe three levels of implementation, which implies heavy and time consuming work for skilled professionals in IT and terminology.

> ➢ Entry Terminology: this is the user interface, the terms used to interact with users during data entry process representative of the local natural language, including abbreviations and jargon.

> ➢ Reference Terminology: this is the format used to store data, knowledge information should be stored in this layer

> ➢ Aggregate Terminology: different data formats outputs for user analysis

Smith and Ceusters have pointed a capital point for GP/FM; time[15]. Existing biomedical information systems including SNOMED-CT are not concerned by keeping track how entities (such as symptoms or diseases) develop over time. This is the corner stone of the International classification of Primary Care, the tool created by the Wonca International Classification Committee (WICC)[b] for epidemiological purpose since the 70'. ICPC proposes a retrieval methodology based on Episode which means time.

## Mapping

Mapping, translation of clinical data into alternative representations without corrupting the primary clinical mission is already done for ICD-9-CM. The task has been completed by mapping ICD9 for billing purpose in 200916. IHTSDO has several teams involved in this issue in all the main fields of classifications like ICD10, NANDA or ICPC. Special Interest Group (SIG) has been launched to study the problem and propose ad hoc solution. The IHTSDO Special Interest Group in Primary Care (SIG PC) has been launched in Copenhagen after an agreement between the World Organisation of Family doctors (WONCA) and IHTSDO. Some Wonca International classification committee members will lead this group. The Family Medicine Research Centre at the University of Sydney, of which leading members are also members of WICC is currently mapping ICPC-2 PLUS to SNOMED to form a first cut Australian GP subset for Primary Care[17]

Recently 2.500.000 diagnostic data collected in electronic patient records throughout 2006 within the County Council of Stockholm and coded in ICD10 (Swedish primary care version) have been mapped to SNOMED CT[18]. The use of Is_a relationships in SNOMED CT aggregated the diagnostic data to 2861 concepts, showing a new, multidimensional view of different specific medical aspects, where every view can be further explored. The authors conclude SNOMED CT provides a different view of diagnoses and health problems on a chapter level, and adds significant new views of the clinical data with aggregations generated from SNOMED CT

## Availability of translations

Following a source from Infoway/inforoute Canada, SNOMED_CT translation in French is not yet finished. Inforoute Santé Canada has begun the translation of a list of actives concepts, following determined priorities and actually, only about 10% (30.000 concepts are available in French. From a source in The Netherlands nothing has been translated in Dutch till now but this has to be confirmed. SNOMED-CT is available in several other languages of which Spanish.

# 6. Does SNOMED CT encompass the field of GP/FM?

## Quick look through the Cliniclue browser

Examining the four fields of the Figure 1, one could say that SNOMED-CT succeeds extremely well in the biomedical field. It is probably the most powerful nomenclature for use in pathology, general internal medicine and surgery. A rare disease and related concept as Apoliproteine has 90 occurrences in the Cliniclue browser while the color Blue is quoted 645 times, which is explained by the huge use of this term in tissue stain in Pathology . The field of psychodynamics is clearly dominated by the DSM IV concepts and system of classification, which could be certainly a problem as this particular view of psychiatry and psychodynamic suffers of a story of 'parti pris' and competing interests[19, 20]. Nevertheless, from the Primary Care point of view one will appreciate the

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[b] Wonca International Classification Committee (WICC) http://globalfamilydoctor/wicc

147 occurrences of the term 'fear of'. From epidemiological point of view, the vocabulary looks not so developed with 23 occurrences of the concept Public health, 4 for nosocomial and 3 for normal distribution.  The anthropological field looks very poor and marked more by common popular view than scientific analysis, particularly when addressing the issue of separating the human beings groups. As usual in medical North American literature the term race   is still in use for this purpose despite scientific recommendations[21]  while the concept of ethnicity suffers from a lack of knowledge. It is quite amazing to read that Belgians is an ethnic group, wedged alphabetically between the Basque and the Black ethnic group (Cliniclue browser). A concept like second generation, which is the corner stone of a consultation in European cities where ethnic groups are so prevalent, is not present in SNOMED-CT terminology behalf for second generation drugs.

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Ethnicity : 7 entries
Ethnic group ; 1 entry, defined by *is_a group*
Race : 16 entries
 the term Race alone is defined : *is_a demographic history detail*
Race: white : 1 entry : defined : *is_a racial group*
There is no Race : African or black. But well a Black ethnic group.
second generation : 7 entries but only related to the concept of second generation drugs. The  concept second degeneration of an ethnic group is absent

**Figure 16 Separating the human beings groups in SNOMED-CT**

# 7.  Conclusion

While one can acknowledge the fantastic work of aggregating so huge quality products and the high level of expertise involved in it, on can note that, despite to be owned by a non profit organization, SNOMED-CT is a proprietary product which searches an expansion of his market. This implies some rules of confidentiality which are incompatible with Knowledge as a resource of mankind for thos who don't have full access granted.   Considering the availability of high level Ontologies in open source[6], it is worth to evaluate also this way of dealing with medical knowledge

SNOMED is still growing. In the 90' Dr C. Jeanty  , a Belgian doctor involved in SNOMED use since 1975 was already astonished by the enormous inflation in the terminology of the SNOMED INTERNATIONAL (1993) passed from 44,487 to 132,641 terms[22]. As stated above SNOMED-CT has now 308,000 active concepts, 791,000 active descriptions, organized into 19 hierarchies with more than 951,000 relationships. The great Umberto Eco[23] has written a demonstrative essay "On the impossibility of drawing a map of the Empire on a scale 1 to 1" . Knowledge is not the Empire but it's doubtful that inflation of terms and relations will help to manage it.

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