A semi-automatic semantic method for mapping SNOMED CT concepts to VCM icons

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MEDINFO 2013 – Copenhagen 8/2013
Introduction

- VCM (Visualization of Concepts in Medicine) is an iconic language for representing key medical concepts by icons

  - Symptoms, diseases, physiological states (e.g. age classes), risks and history of disorders, drug and non-drug treatments, lab tests and follow-up procedures...

Cardiac disease
Heart failure
Renal failure
Heart rhythm disorders
Introduction

- These icons are intended to help health professionals to:
  - access medical textual knowledge (e.g. drugs' Summary of Product Characteristics, or clinical practice guidelines)
  - handle medical terminologies (e.g. SNOMED CT or ICD10) in patient records

- However, these applications require mappings between VCM and medical terminologies

**Objectives:** to design a semi-automatic semantic method for mapping SNOMED CT clinical finding concepts to VCM icons, and to evaluate this method
Introduction

Four possible methods for creating a mapping (H. Saitwal et al.):

1) **Manual mapping**

2) **Linking together several existing mappings** (typically using UMLS, the Unified Medical Language System)

3) Using **lexical methods** to search for identical or similar terms

4) Relying on **semantic ontology alignment** or matching methods
   - Rarely applied to medical terminologies
   - Requires terminologies described in description logic (DL)
   - But both SNOMED CT and VCM are described in DL!
Material: the VCM iconic language

A compositional language

- Color is for the temporal aspect (past, current or risk of disorder)
- Central pictogram is for anatomico-functional location
- Shape modifiers are for generic pathological processes and transversal anatomical structures

![Diagram of VCM iconic language](http://vcm.univ-paris13.fr/)
Material: the VCM ontology

- The **VCM ontology** was designed to formalize in OWL the semantics of VCM icons, and includes three parts:
  - **Graphical concepts** corresponding to VCM graphical primitives (the various colors, pictograms and shapes)
  - **Medical concepts** (the main anatomical structures, biological functions and pathological processes, but not the various disorders)
  - **Relationships between graphical and medical concepts** (e.g. the “ear” central pictogram is associated with both the ear (anatomic structure) and the auditory function)

- High level of granularity
**Material: SNOMED CT**

- **SNOMED CT** (Systematized Nomenclature of Medicine-Clinical Terms) is a medical terminology covering anatomy, clinical findings and disorders, procedures, organisms, social contexts,...

- **SNOMED CT** includes relationships, in particular:
  - "is a" relationships
  - relationship between clinical findings and finding sites
  - relationship between clinical findings and morphologies

- These relationships can be organized into groups

- We used SNOMED CT 2012 provided by the National Library of Medicine
Methods: mapping SNOMED CT concepts to VCM icons

- In a first step, we manually mapped SNOMED CT anatomical structures and morphologies to the medical concepts of the VCM ontology (n=370)
- Multiple inheritance in SNOMED CT
- This is problematic: ear ossicles' disorders will be associated to both the “bone” and “ear” pictograms, while these disorders belong to the ENT (Ear-Nose-Throat) specialty and thus physicians expect them to have the “ear” pictogram
- => Each anatomical structure was mapped to a single pictogram in VCM, according to medical specialties and monoaxial terminologies (ICD10)
Methods: mapping SNOMED CT concepts to VCM icons

- In a second step, we automatically generated a mapping of SNOMED CT clinical finding concepts (n=98,590) to VCM icons.
Methods: evaluating the SNOMED CT to VCM mapping

- **100 concepts** were randomly selected from the clinical findings and disorders in the SNOMED CT CORE Problem List

- **Three experts** (researchers in the field of medical informatics with a medical background: MD or PharmD) independently reviewed the icons associated with each concept

- Relationships were extracted from SNOMED CT and made available to the experts; they were asked to consider them as a **“gold standard”**

- Finally, disagreements between experts were resolved by seeking a consensus by collective discussion.
Results: the SNOMED CT to VCM mapping

- On the SNOMED CT CORE Problem List (5,345 disorder and clinical finding concepts):
  - 4,874 concepts (91.2%) associated with a single icon
  - 435 concepts (8.1%) with 2 icons
  - 32 concepts (0.6%) with 3 icons
  - 4 concepts with 4 icons or more
  - 327 concepts (6.1%) associated with no icon:
    - Loosely defined clinical signs: “General symptom”
    - Concepts related to treatment rather than clinical findings: “Already on aspirin”
  - 758 different VCM icons in the mapping

Viral pharyngoconjunctivitis (disorder) 186675001
Evaluation results

Out of the 100 randomly selected SNOMED CT concepts:

- 82 were considered as correctly mapped by experts
- 15 were considered as erroneously mapped
  - 8 missing pictograms or shape modifiers
  - 4 erroneous pictograms or shape modifiers
  - 3 errors due to missing information in SNOMED CT
- 3 were considered as outside of the scope of the study (i.e. the SNOMED CT concept was not really a clinical finding)

Most errors were easy to fix by complementing or correcting the manual mapping.
Discussion

- We proposed a semi-automatic method for mapping SNOMED CT concepts to VCM icons, in two steps:
  - **the manual mapping** of a **limited** number of concepts (370 concepts from the VCM ontology)
  - **the automatic mapping** of any SNOMED CT concept

- The mapping can easily and automatically be updated when a new version of SNOMED CT is available

- This semi-automatic method was faster and easier to apply than a manual method:
  - In previous manual mapping attempts, **most of the problems encountered were not related to VCM** but rather to disorder definitions (e.g. what are the finding sites of cystic fibrosis?) => the use of SNOMED CT relationships solved these problems
Discussion

We found the **compositional structure of VCM and SNOMED CT very similar**; the main differences are:

- VCM distinguishes pathological patient conditions, versus physiological conditions
- SNOMED CT has no general concepts for describing disorders of biological functions, such as hypofunctioning
1) **Mapping lab tests, procedures or drug treatments** from SNOMED CT to VCM icons using a similar method

2) Analysing the expressiveness of VCM with respect to SNOMED CT and, possibly, the extension of VCM to **improve coverage**

3) **Mapping other terminologies** to VCM:
   a) Using a similar method
   b) Or combining the SNOMED CT to VCM mapping with the existent mappings in UMLS

4) Using VCM icons to **display elements of electronic patient records** coded in SNOMED CT
References


