MEDINFO 98
B. Cesnik et al. (Eds)
Amsterdam: IOS Press

A Collaborative Approach to Building a Terminology for Medical Procedures using a Web-based Application : From Specifications to daily use.

Anita Burgun[a], Olivier Bodenreider[b], Patrick Denier[a], Denis Delamarre[a], Geneviève Botti[c], Philippe Oberlin[d], Jean-Michel Lévêque[e], Marc Brémond[f], Mario Fieschi[c], Pierre Le Beux[a]

aLaboratoire d'Informatique Médicale, CHU., rue H. Le Guilloux, F-35033 Rennes, France
bDépartement d'Information Médicale, CHU., av du Mal de Lattre de Tassigny, F-54035 Nancy, France
cService de l'Information Médicale, Hôpital de la Timone, bd Jean Moulin, F-13385 Marseille, France
dService de Chirurgie Viscérale, C.H. Intercommunal, 40 allée de la Source, F-94195 Villeneuve-St Georges, France
eClinique de la Sagesse, place Saint-Guénolé, F-35013 Rennes, France
fGroupe Image, Ecole Nationale de la Santé Publique, 14 rue du Val d'Osne, F-94410 St Maurice, France

Abstract

The MAOUSSC (Model for Assistance in the Orientation of a User within Coding Systems) Web server supports a collaborative work on the description of medical procedures. The specifications for the MAOUSSC application are conceptual modeling, definition of semantically fully described procedures, re-use of an existing vocabulary, the UMLS, and sharability. This paper reports on some difficulties in applying those principles in a networked building and updating of the terminology. The users are physicians who have to represent procedure terms in the MAOUSSC formalism. They must apply the constraints of the underlying model, and re-use the representation of the UMLS knowledge base. In our experience, we found that the implementation of syntactic and semantic constraints was not sufficient. Guidelines for pragmatical aspects in representation are required to make a collaborative approach in terminology building more operational.

Keywords

Medical Procedures; Nomenclature; Web; Collaborative approach; Knowledge Representation; Pragmatics

Introduction

The goal of the MAOUSSC (Model for Assistance in the Orientation of a User within Coding Systems) project is to develop a model for the description of medical procedures based on a semantic approach [1] .

At the core of the project are the re-use of an existing knowledge source: the UMLS (Unified Medical Language System) [2, 3] and the definition of syntactic and semantic constraints which are implemented on a Web server in order to facilitate a collaborative work.

We have been using the server for several months either internally or externally through a cooperative network of several Medical Informatics Laboratories in France. The first objective was to give descriptions of the 2600 procedure labels that occurred in a representative sample of French hospital coded summary data sets.

That survey is performed by the French governmental Health Statistics Agency (SESI) in order to produce inpatient profile statistics concerning patient demographics and clinical information. The medical information of the 80,000 discharge summaries was coded using the French Catalogue des Actes Médicaux (CdAM) [4] for the medico-surgical procedures.

The description of the CdAM procedures for the SESI survey was made by physicians experts from each medical domain, from several cities in France, assisted by Medical Informatics specialists in four University Hospitals.

As the methodology was defined in previous papers [1,5], we will focus on the principles used for the description of the procedures, using a pre-existing terminology. We also present the pragmatic experience.

Principles

The assumptions that make the background of the MAOUSSC project are listed below.

A model is needed for nomenclature management.

Medical terminology requires a deeper representation than the traditional tree-structured hierarchies [6,7]. There must be a conceptual level that is distinguished from purpose-dependent representations. The MAOUSSC model is based on (i) compositional rules used to describe complex procedures in terms of elementary ones, (ii) a multi-axial model for the description of elementary procedures.

The multi-axial model is based on 8 axes. Four of them are mandatory: Nature (what action is performed), Topography (which part of the body the action is applied to), Instrumentation (what equipment is used to perform the action), and Approach (how the anatomic site involved is reached). The four other axes may be filled out or not depending on the kind of action: Additional topography (required for the description of a shunt), Matter/Device (used to describe what material – organic or not – is moved, removed or implanted, e.g. a prosthesis), Body process (which describes the physiologic process involved). Finally the Disease axis must not be used except if the original procedure description is vague, so that the only possible term is « treatment of a disease ».

Unnecessary characteristics should be avoided or represented as modifiers.

The combinatorial syntax rules can be formalized as follows (the symbol * means 0 or 1 occurrence, the symbol + means 0 to n occurences):

<nomenclature procedure > :: <version> +

<version> :: <compos> | <compos> OR <version>

<compos> :: <assoc> | <assoc> AND <compos>

<assoc> :: <MAOUSSC elementary proc> <modifier>*

<MAOUSSC elementary proc> :: <nature> <topography> <approach> <instrumentation> <additional topography>* <matter/device>* <body process>* <disease>*

The medical terms for procedures must correspond to descriptions of actions.

The objective is to describe actions that are performed independently of the aim of the medical procedure i.e. not referring to diagnosis or pathology. Modifiers can be used to indicate that a procedure is altered by some specific circumstance but is not changed in its definition. Examples of modifiers are bilateral or emergency.

The objective is also to describe procedures out of the context of a given nomenclature. Therefore expressions like « other procedure on the ovary » are excluded.

The description must be semantically fully described. Each basic description of elementary procedures is: (i) complete: every relevant axis in the multi-axial model is instantiated according to the specific rules associated with the action concept; (ii) not ambiguous: an axis value is unique; (iii) without impliciteness. Thus, a description is understandable by anyone.

The possibility of re-using an existing vocabulary is tested.

We have explored the ability of the UMLS Metathesaurus to serve as a source of controlled vocabulary for the MAOUSSC application. The concepts that are used to instantiate the MAOUSSC axes are in priority Metathesaurus ones. If specific terms are needed for the description of procedures, they are added to the vocabulary by the user.

Descriptions and vocabulary are sharable.

The UMLS vocabulary is initially partitioned into distinct medical domains (i.e. cardiology, urology, etc) in order to restrict the set of terms that are suggested to the user for a description. A concept can be assigned to several medical specialities.

A nomenclature term can be described by more than one user, in this case, each user makes his own description but he can access to the descriptions made by the others. Basic descriptions of elementary procedures can be re-used by several users even from distinct medical specialities.

Ontological normalization enables terminology sharing [8]. Sharability and re-usability suppose that rules concerning the model and the controlled vocabulary are respected.

- A computer-based terminology management is needed.

A multi-axial model requires computerized tools to support and to manage the rules associated with the set of axes. Retrievals performed on the UMLS Metathesaurus and on the procedure descriptions can benefit from issuing queries to a relational database.

A Web-based server architecture can facilitate the construction of a common terminology [7,9,10]. The MAOUSSC Web server was created with the intent of supporting a collaborative enrichment of the terminological data-base [11].

Presentation and pragmatic experience

The user is a physician because of his expertise. He has to make the description of CdAM procedures with:

- terms and concepts, which are, used to instantiate the relevant axes for each elementary procedure.
- MAOUSSC elementary procedures that must be created in accordance with the syntactic and semantic constraints.
- the nomenclature labels correspond to a whole procedure described as a logical combination of MAOUSSC elementary procedures.

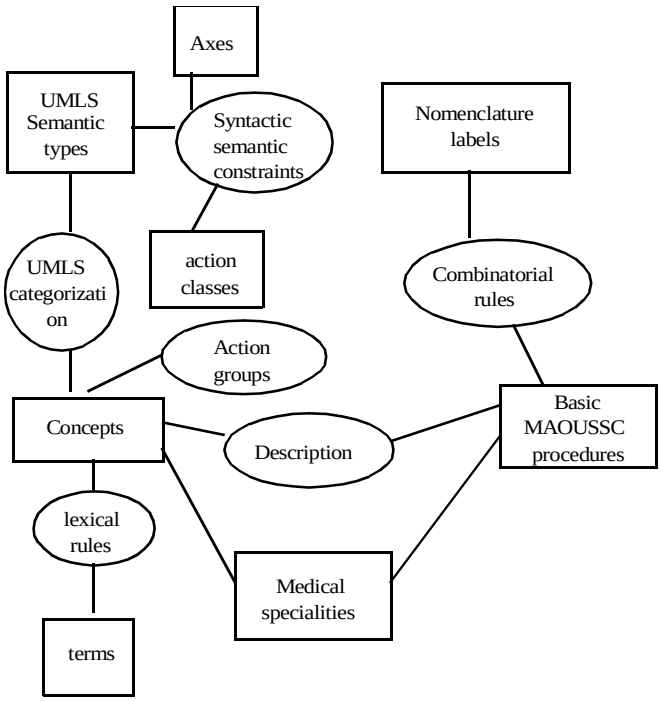

Figure 1 - The MAOUSSC data and constraints

The user has to apply the above principles and to combine the constraints of (i) the controlled vocabulary (ii) the rules for the syntax and the semantics of the multi-axial decription, (iii) the objective that is to describe actions and not their aim, (iv) the logical combinations (Figure 1). Moreover, pragmatics in knowledge representation is a crucial determinant of the sharability of the descriptions.

Re-use of an existing vocabulary : the UMLS

A concept in the MAOUSSC application is either a UMLS concept or an additional one. The rule is not to create concepts that already exist in order to avoid redundancy. To compensate for the lack of completeness of the UMLS Metathesaurus, the user may create new, i.e. additional concepts. But he must search for them first in the UMLS in order to make sure that the concept does not exist. The whole UMLS terminology is on line.

Concept retrieval is based on simple lexical tools and naviga-

tion within the UMLS conceptual network with a browser. Although the current version of the UMLS includes a lot of French terms -- we have found in a previous study that about 66% of the UMLS concepts needed for the description of medical procedures have a name in French within the Metathesaurus [12], the UMLS remains mostly composed of vocabularies in English. Thus concept retrieval must concern both English and French words. Difficulties arise for example because of distinct linguistic units, for example while the French term is thyréoglosse, the English one is thyroglossal.

Thus, French terms could be added to existing concepts to facilitate information retrieval by providing different expressions for the same concept.

If the given concept is found, the user may have to change some of its attributes. (i) Sometimes, the concept C exists in the Metathesaurus but it has not been assigned to the medical speciality M; then it must be added to M: instead of creating a concept, the user just adds a link between the existing data C and M. (ii) The concept exists, the English term exists but the French term is missing; instead of creating a new concept, the user must add the French translation, that is a new term according to the structure of the Metathesaurus that includes concepts (denoted with a preferred term), terms and strings. If the given concept is actually missing, it must be created; the user must instantiate its attributes, i.e. one or more semantic types, one or more medical domains, terms including preferred terms, and related concepts in the conceptual network.

Application of the set of constraints

Each action term belongs to a class corresponding to a generic action. Depending on the action, several syntactic patterns have been defined. Each of them defines both the list of relevant axes and the list of UMLS semantic types tied to each MAOUSSC axis for a particular set of values of the action axis. The choice of the action value is a trigger.

The labels of the generic terms should be more explicit than there are now. For example, the term « Plasty » can correspond to distinct classes labeled « Reconstruction » and « Repair ». The Reconstruction pattern requires to instantiate the axis Matter/Device, the Matter/Device value is mandatory and represents what is used for reconstruction and left inside the body. In the Repair group, the Matter/Device axis is not relevant, no additional matter/device is used to perform the Repair action.

For an action term, the meaning intuitively given by the user can be different from its extensional definition in the MAOUSSC application. Frequently, the vocabularies used by several medical specialists are not harmonized.

An action pattern will be modified only if the modification is needed for the whole generic action class. Several situations can occur: (1) some concepts in the UMLS do not have the expected semantic types [12]; the user has to update the attributes of those concepts, i.e. to assign additional semantic types to those concepts. That modification requires a good knowledge of both the UMLS semantic network and the MAOUSSC semantic constraints. (2) the action is a particular one. Thus it requires a new pattern or it corresponds to a specific semantics despite the fact that the syntactic pattern already exists. What is to be done is not to modify the existing constraints but it is to modify the action classes or to create a new action class. The generic « Delivery » is an example of such particular action classes.

Description of actions and procedures

The user has to give procedure descriptions for existing expressions in procedure nomenclatures. The description consists of combinations of elementary procedures. Combinatorial process does not represent explicitly expressions such as A except B. For example « Vaginal delivery with or without episiotomy » must be decomposed as « Vaginal delivery » OR « Vaginal delivery AND episiotomy ».

Pragmatics

Fragmatical aspects concern the definition of action patterns, the interpretation of procedure labels and the choice of the action concept corresponding to a given elementary procedure.

An example of the first aspect, definition of action patterns, is given by endoscopy procedures. Several variants of the endoscopy pattern can be defined. They can be illustrated with the description of « oeso-gastro-duodenoscopy ».

A first pattern for endoscopy would require to instantiate the Topography axis with the more proximal organ that is explored (here, oesophagus) and the Additional topography axis with the more distal organ that is explored (here, duodenum). Pragmatic knowledge is supposed to be implemented in the model in such a way that the description {Scopy, Topography = oesophagus, Additional topography = duodenum} would be selected by queries like « Endoscopy of Stomach ». A second pattern for endoscopy would require to instantiate the Topography axis with the more distal organ that is explored ; the Additional topography axis is not relevant. The Approach axis has to be instantiated for endoscopy with precise information in order to know if the endoscopy is peroral or retrograde or through stoma. That pattern requires implementation of rather sophisticated pragmatic knowledge. With the third pattern, the user should have to list the endoscopies of each anatomic site examined. Oeso-gastro-duodenoscopy would be described as the association of three elementary procedures, Endoscopy of oesophagus, Endoscopy of stomach, Endoscopy of duodenum. In that pattern for endoscopy, the Topography axis is relevant while the Additional topography axis is not relevant. In the last variant for endoscopy, one considers that there is a concept « Upper digestif tube » and the corresponding meronomy has to be included within the semantic network. Then, oeso-gastro-duodenoscopy would be described like an elementary procedure, the Topography axis being instantiated with « Upper digestive tube » and the Additional topography axis being not relevant.

Another pragmatical aspect is the granularity of the description. Does the description of a nomenclature label like «Excision of cyst, fibroadenoma, or other benign or malignant tumor, aberrant breast tissue, duct lesion or nipple lesion, male or female, one or more lesions » need to describe every variant or can we consider that it is a partial mastectomy ?

In our experience, such questions have received no agreement among the clinicians.

The last point concerns the choice of the action concept by the user. For example, several action concepts might be chosen or suggested by the users for the description of « Treatment of a fistula » :

Exerese	(generic = Endo-exo)
Treatment	(generic = Treatment)
Repair	(generic = Repair)
Closure	(generic = Closure of shunt).

That example shows that several representations of a procedure term can exist.

Discussion

Some of the difficulties encountered by the user are related to the constraints in the description :

- the re-use of a vocabulary : the use of an existing knowledge base such as UMLS may significantly help the developer of a system. Nevertheless, the user has to make more efforts in order to « learn the terminological knowledge representation ». That emphasizes two requirements : the ability of the vocabulary to cover all or almost all the concepts that are needed and the development of easy-to-use browsers.
- the syntactic and semantic rules. No set of rules can be universally applied in medicine. An action term such as scopy inherits the pattern of its generic, i.e visualization. But for example, a specific patten could be defined for endoscopy, which is a scopy. Another obstacle is that the terms used to label actions do not reflect a universal meaning.

Some improvements can be made from this experience :

- The action pattern should be more precise. It is not sufficient to define the Topography axis as « the organ or body part the action focuses on ». The definition of a given axis is closely related with the meaning of the action concept.
- The granularity of the descriptions should be discussed with the Medical Associations. The MAOUSSC technical group has recommended to avoid information about pathology and disease in the description but it should belong to the Medical Associations to determine what must be reported.
- Guidelines are required to assist the user. Instructions for use concerning the Web server functionalities, and the general semantics of procedure description are already available, but pragmatical aspects have to be enlightened to make a collaborative approach in terminology building more operational.

References

[1] Burgun A, Botti G, Lukacs B, et al. A system that facilitates the orientation within procedure nomenclatures through a semantic approach. *Med Inf* (Lond) 1994: 19(4):297-310.

[2] Lindberg DAB, Humphreys BL, Mc Cray AT, The Unified Medical Language System. *Meth Inform Med* 1993: 32(4) : 281-91

[3] National Library of Medicine, *UMLS Knowledge Sources-Eighth Experimental Edition*, Bethesda, MD: NLM, 1997

[4] Catalogue des Actes Médicaux. Paris: Ministère de la Santé et des Affaires Sociales, 1994. *vol Bulletin Officiel 93-13 bis*.

[5] Burgun A, Botti G, Bodenreider O et al, Methodology for using the UMLS as a background knowledge for the description of surgical procedures. *Int. Journal of Bio-Medical Computing* 1996: 43: 189-202

[6] Cimino JJ, Clayton PD, Hripcsak G, Johnson SB, Knowledge-based approaches to the maintenance of a large controlled medical terminology. *J Am Med Inform Assoc* 1994: 1: 35-50

[7] Rector AL, Salomon WD, Nowlan WA, Rush TW, Zanstra PE, Claassen WMA, A medical terminology server for medical language and medical information systems. *Meth Inform Med* 1995: 34(1/2): 147-57

[8] Rossi-Mori A, Galeazzi E, Consorti F, An ontological perspective on surgical procedures. in: *Proceedings of 1996 AMIA Annual Fall Symposium* Cimino JJ Edt, 1996, 115-9

[9] Gennari JH, Oliver DE, Pratt W, Rice J, Musen MA, A Web-based architecture for a medical vocabulary server in: *Proceedings of the 20th symposium on Computer Application in Medical Care*. Gardner RM Edt, 1995, 275-9

[10] Carlsson M, Ahlfeldt H, Thurin A, Wigertz O, Terminology support for development of sharable knowledge modules. *Med Inf* (Lond) 1996: 21(3): 207-14

[11] Burgun A, Denier P, Bodenreider O et al, A Web terminology server using UMLS for the description of medical procedures. *J Am Med Inform Assoc* 1997: 4 (5), 356-63

[12] Bodenreider O, Burgun A, Botti G, Fieschi M, Le Beux P, Kohler F. Evaluation of the use of the Unified Medical Language System as a knowledge source for a terminology server of French medical procedures. *J Am Med Inform Assoc* 1998 (to be published).

Address for corresponding
Dr. A. Burgun
Laboratoire d'Informatique Médicale
Faculté de Médecine
Université de Rennes I
Avenue du Pr. Léon Bernard
35043 RENNES Cédex, France
Tél : (33) 2 99 28 42 15
Fax : (33) 2 99 28 41 60
E-mail : Burgun@sunaimed.univ-rennes1.fr