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The development of CCAM: The new French coding system of clinical procedures

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Abstract

A new French coding system of clinical procedures, the *Classification Commune Des Actes Medicaux* (CCAM), has been developed at the turn of the millennium (between 1996 and 2001). Two methodologies were used: a traditional domain-experts consensus method, and an artificial-intelligence-based semantic representation. An economic evaluation of clinical procedures was also undertaken for the rating for fee-for-service payment. We present the methodologies used and stress how the European Union research project, 'European Consortium, Generalised Architecture for Languages, Encyclopaedias and Nomenclatures in Medicine' (GALEN), facilitated the sharing and maintaining of consistent medical knowledge. This country case study highlights the significant cost to individual countries in developing their own classifications in isolation. It also demonstrates the benefits of contributing to international efforts such as GALEN that enable harmonisation, yet still allow for diversity.

Key words: Artificial intelligence; coding system; clinical procedures; terminology; GALEN

Introduction

Following an Act passed in the National Assembly and issued in January 1993, the Ministry of Health and CNAMTS (*Caisse Nationale Assurance Maladie des Travailleurs Salariés*¹) embarked on an ambitious program to merge the two existing French procedure coding systems into one multipurpose procedure coding system. Under the *Classification Commune des Actes Medicaux* (CCAM) program, the current procedure coding system for billing the physician fees, the *Nomenclature Générale des Actes Professionels* (NGAP), and the current procedure coding system for coding hospital discharge abstracts, the *Catologue des Actes Médicaux*² (CdAM), would both form the basis of the new procedure coding system, CCAM.

Clinical terminology coding system developments in France follow the mainstream of diversity that is seen in most western countries. The computerisation of health care information systems has slowly reduced the mix of such coding systems, depending upon their purpose (epidemiology, management, payment or funding). The CCAM program was initiated because of an unsatisfactory situation with the two existing clinical

procedure coding systems, a situation similar to many other western countries. They had many drawbacks: lack of exhaustivity, lack of consistency between chapters, ambiguous descriptions, redundancy (overlapping descriptions) and obsolescence (outdated descriptions). Mapping between the two classifications was also not possible in most cases.

The CCAM program began in 1994 and has been managed jointly by the Ministry of Health and CNAMTS through their respective agencies: Pôle of Expertise and Reference National of the Nomenclatures of Health (PERNNS), and the Department of Division de la nomenclature ([Albaret & Girardier, 1999](#)).

We present the goals of this new procedure coding system, and the methodology used for the development of the terminology, and the process to rate the procedures for fee-for-service resource allocation.

The goals of the CCAM program

There were two goals of the CCAM program:

1. To identify all clinical procedures, regardless of where they are performed, the healthcare professional responsible, or the purpose addressed. CCAM will be used for benchmarking, sentinel case survey, resource allocation and epidemiological studies.

2. Resource allocation.

a) Fee-for-service physicians and surgeons

Since 1945, computation of fees for physicians and surgeons has been based on relative value scores that are related to the NGAP. However, there is no coding schema applied to the NGAP, thereby preventing any knowledge of the clinical activity performed by fee-for-service practitioners working outside of hospitals.

b) Casemix for hospitals

There are two primary objectives of the casemix system in France:

- to adjust the resource allocation to hospitals based on the measure of activity identified by the Casemix classification (GHM [*Classification des groupes homogènes de malades*] — a system very similar to AR-DRGs)
- to make exhaustive hospital clinical data available for internal management, and clinical, epidemiological and economic research.

Since 1997, these objectives have been reached for acute care inpatients, and pilot studies have begun for midterm (non-acute) care, psychiatry and ambulatory care. The clinical data set used for casemix is based on the ICD-10 diagnosis (with a few French modifications) and CdAM procedures.

Development of CCAM terminology

[CCAM terminology-building using the traditional consensus method](#)

The first stage of the CCAM program was conducted using the traditional clinical domain-experts consensus method. Between

October 1996 and June 1999, 250 clinical domain experts from 40 different clinical specialties were appointed to the program on the advice of the *Conseil National de l'Ordre des Médecins* (CNOM). The experts were nominated by the most recognised national clinical colleges (comprising 15 surgical colleges, 22 medical colleges and specialised colleges for anaesthesiology, resuscitation, oral surgery and orthodontics).

Each clinical domain-expert group had the same composition: six clinical experts proposed by the specialised colleges (three working in the public sector and three in the private sector); one university hospital consultant physician; one department of health physician; and one physician from the national health insurance agency. Procedural terms were distributed among the clinical domain-expert groups. The procedures that are performed by more than one clinical specialty were discussed by each relevant domain-expert group, and the merging of these rubrics was co-ordinated by the representatives from the department of health or the national health insurance agency, as the same representatives attended several different domain-expert groups.

The effort involved, measured in total person-months, was considerable: approximately 1200 months, or 100 person-years within three calendar years.

The following four phases have been achieved during this stage:

- **Phase one. Cleaning of CdAM:** The initial step was to update a flat list of rubrics from CdAM by noting the different purposes, clinical description and billing.
- **Phase two. Revision of the cleaning process** with the university hospital consultant physician from each clinical domain-expert group.
- **Phase three. A pilot study** in six hospitals: three public and three private-for-profit (the hospitals were appointed by the relevant clinical domain-expert college). Over a 15-day period, 250 clinical experts used the work resulting from phases one and two to code their activities.
- **Phase four. Revision and redesign:** A transversal group (a cross-section of clinical domain-experts), which included the university hospital consultant physicians, revised the full list of rubrics, taking into account the comments from the pilot studies. The list of rubrics was then reorganised from a clinical specialty grouping to an anatomic system clustering. The exhaustivity of each chapter and of the whole list was reviewed, the level of detail of the rubrics made uniform and redundancy removed. Advice was also sought from an expert in health care terminology and neologisms, and from the specialty colleges related to the *Académie Française*. Their comments were incorporated into a further update of the rubrics.

The final output from the surgery field had 15 chapters of 500 rubrics each, comprising 7500 rubrics including combined interventions. A more detailed clinical procedure coding system, splitting the different components of the combined interventions, could have 15000 rubrics.

Semantic representation terminology validation method

The second stage of the CCAM program involved analysing and controlling the semantic representation of the rubrics to ensure overall coherence of meaning and linguistic expression and compliance of each rubric to the *Comité Européen de Normalisation TC 251* preliminary standard (CEN/ENV 1828) (CEN, 1995).

This stage was performed by the European Consortium, Generalised Architecture for Languages, Encyclopaedias and Nomenclatures in Medicine (GALEN), a consortium of several universities, research centres and software companies from Manchester (United Kingdom), Geneva (Switzerland), Nijmegen (The Netherlands), Rome (Italy), Saint Etienne (France) and Zonnegem (Belgium) (Rector, Nowlan et.al. 1993). The GALEN project is an artificial-intelligence tool that provides language-independent and structured domain knowledge upon which various multilingual applications (terminologies) can be supported. The GALEN artificial-intelligence technology has been used within the GALEN-IN-USE Health Care (HC 1018) Telematics project of the European Union Fourth Research and Development framework program to support the development of the CCAM. The work has been realised within contracts between the UK Ministry of Health, CNAMTS and the consortium represented by the University of Saint Etienne.

Each chapter from phase four of the first stage of the CCAM program was delivered to the French GALEN centre as an electronic list of rubrics. The output received back was a comparison between the phase four rubrics and the French GALEN-generated rubrics (controlled expressions generated from semantic meanings) based on the GALEN CORE model (see Box 1). The phase four rubrics were considered acceptable when the GALEN-generated rubrics had the same meaning. Where the meaning differed, the differences were resolved during face-to-face meetings with the French GALEN centre and the transversal group in charge of phase four of the first stage of the program. The total discrepancies were approximately 30%; 10% were due to GALEN processing errors and 20% were due to incorrect descriptions in the phase four rubrics. Although 70% of phase four rubrics matched with the rubrics generated by the GALEN CORE model, it was recognised by the transversal group that the GALEN-generated rubrics were, in most instances, more meaningful than the phase four rubrics. However, the GALEN-generated rubrics are very different from the professional jargon used by French health care professionals.

1: The GALEN CORE (Common Reference) model

The GALEN CORE model, which formalises the meaning of the terms used in the medical domain, currently contains more than 13000 conceptual entities, among which 818 are semantic relationships and the remainder are concepts. Among these concepts, 5700 are composite, thus requiring the maintenance of corresponding definitions. Approximately 9400 sensible statements and their reverse forms, when relevant, are currently maintained in the GALEN CORE model.

In order to model the meanings of the phase four rubrics (7500 descriptors of surgical procedures) into GALEN's formal representation language called GRAIL (GALEN Representation and Integration Language), it was necessary to consider 700 new concepts; these have now been added to the CORE model, which, in

turn, has increased the coverage of the GALEN model. For the 7500 phase four rubrics, 2407 concept descriptors and 59 semantic relationships have been used.

Validation of GALEN-generated rubrics

The French GALEN centre used an integrated set of tools named 'Classification Workbench' (CLAW) ([Zanstra, 1993](#)) to validate the GALEN-generated rubrics. CLAW consists of three purpose-built tools that ease the work of end-user clinician modellers and allow classification ([Rogers et al. 1997](#)). There were four steps to the validation method.

1. Intermediate dissection

GALEN has developed an intermediate representation (which we call an 'intermediate dissection') that enables the meaning of a rubric to be expressed in a simpler syntax than the more complex representations achieved when modelling in GALEN Representation and Integration Language (GRAIL). The intermediate dissection was produced using Surgical Procedures Editor Tool (SPET); this is a tool that clinical modellers find easy to use (only one day's training is needed for people fluent in clinical language) and which can be mapped automatically to the GALEN CORE model. It uses descriptors and semantic links (relationships) available in the GALEN knowledge base or generated by the GALEN modelling centres in coherence with the GALEN ontology model.

2. Validation of the compliance with CEN/ENV 1828

The European Standard organisation Comite Europeen de Normalisation (CEN) has produced around 40 pre-standards (ENVs) in the field of health informatics since 1994. It is presently organising the transformation of 10 such pre-standards into standards (ENs). Among the pre-standards, ENV 1828, on classification and coding systems of surgical procedures, is meant to standardise the categorical structures (or formal representations) used in computer-based concept systems. This pre-standard identifies the concepts underlying existing procedure classifications within and outside Europe, and also the natural language used in surgical reports. It defines the conceptual structure of a concept system, which contains the definition of a set of concepts and the internal semantic relationships that combine them.

The second step of the validation method tested the compliance of the dissections against the three combinatorial rules of CEN/ENV 1828. The first rule validates the existence of a 'surgical deed' and an 'object' (both of which are mandatory for the GALEN scheme for surgical procedure [GASP] model). The second rule validates the presence of the anatomy descriptors related to the main surgical deed, and the third rule validates the usefulness of the pathology descriptors.

3. Representation with the GRAIL CORE model

The GALEN CORE model aims to represent all sensible medical concepts which are believed to be shared across professional and national boundaries (but not all medical knowledge), allowing easy cross-referencing and reuse by different application organisations ([Rector, Gangemi et al. 1994](#)). In order to perform the task of automatic translation of the intermediate dissections into the formal GRAIL representation, it is necessary to use the Template Interpreter and GRAIL

Generator (TIGGER) tool. The tool checks the compliance of the surgical procedure terminological phrase to the overall coherence of the high-level ontology ([Rector, Rogers et al. 1996](#)) and with the shared basic medical knowledge. The 700 new concepts mentioned previously (see [Box 1](#)) could not be automatically translated, and so had to be manually mapped to the concepts of the CORE model.

4. Natural language generation

A multilingual natural language toolkit, Langage Naturel (LNAT) ([Rassinoux, Michel, et al. 1994](#)), was used to generate controlled French natural language sentences. The tool includes both a generator and analyser of surgical procedure descriptions that have been adjusted to the degree of detail and modelling style adopted in the GALEN CORE model ([Rassinoux, Baud et al. 1998](#)).

Natural language generation is of paramount interest for information presentation, as it allows complex formal representations (like those in GRAIL) to be displayed in a language that is natural to the user through sentences formulated in his or her native (or at least well-known) natural language. The main strategy adopted for natural language generation is to produce sentences as detailed as necessary but as concise as possible. The co-operation between GALEN and the CCAM program was possible only for the reason that the comparison of phase four rubrics with the GALEN-generated rubrics could be performed in the French natural language, without the need for an artificial-intelligence formal representation in English or comparison with English rubrics translated to French.

For 47% of cases, no real differences were detected between the phase four rubrics and the GALEN-generated rubrics. In 20% of cases, minor differences were observed and these were due to the explicit and pedantic formal description captured in the GRAIL expressions. Thus, GALEN-generated rubrics were slightly more detailed than the phase four rubrics. In 30% of cases, important differences were detected between the phase four rubrics and the GALEN-generated rubrics. For a third of these cases (ie, 10% of the GALEN-generated rubrics represented in GRAIL), there was a mistake at the level of the dissection (90%) or at the level of the GRAIL expression that is automatically expended from the dissection (10%). For the remaining two-thirds of cases (ie, 20% of the GALEN rubrics represented in GRAIL), the major observed differences were related to ambiguities, error detection and inconsistencies in the meanings of the phase four rubrics. [Box 2](#) is an example of an ambiguity detected, [Box 3](#) an example of an error detection and [Box 4](#) an example of an inconsistency in the phase four rubric. Finally, in the remaining 3% of cases, there was no relation between meaning embedded in the phase four rubrics and the GALEN-generated rubrics. In most cases, this was related to discrepancies in the phase four rubrics.

2: Example of an ambiguity detected in the phase four rubrics

The prefix '*cervico*' must be interpreted as an annotation of the concept:

- cl_UterineCervix in the rubric 'Sampling for **cervico**-vaginal smear test',
- cl_UrinaryBladderNeck in 'Installation of a **cervico**-prostatic prosthesis',

- and
- cl_Neck in 'Ligation of the subclavian artery by **cervicotomy**'.

These are common ambiguities due to the medical jargon adopted by health care professionals that must be resolved. Otherwise, they can be misleading for other professionals not fluent in the jargon who may be retrieving data for non-clinical reasons.

3: Example of an error detection in the phase four rubrics

'*Hystérectomie with coéliopréparation*'. Hysterectomy can be done through a vaginal approach only if mobilisation of the uterus has been successful during an early endoscopic procedure. Such a procedure is not the meaning intended by this phase four rubric, which describes a concomitant endoscopic procedure on the peritoneal cavity.

4: Examples of inconsistent meanings in the phase four rubrics

Phase four rubric: *Lithotritie extracorporelle d'une lithiase unique pyélique ou calicielle inférieure, avec repérage échographique et drainage urétéral. (Extracorporeal lithotripsy of pyelic or lower calyces single calculus with ultrasonographic checking and urethral draining.)*

GALEN-generated rubric: *Extraction d'un calcul unique du bassinnet ou du calice inférieur avec fragmentation par un lithotriporteur extra-corporel et avec imagerie par échographie pour repérage du calcul et avec évacuation du calcul par l'uretère. (Pyelic or lower calyces single calculus extraction with fragmenting by means of an extracorporeal lithotripter device and with ultrasonographic imaging of calculus and with evacuation of calculus by ureteral route.)*

'Lithotripsy' in the phase four rubric is replaced in the GALEN-generated rubric by 'extracting a lithiasis' and 'evacuation'.

Phase four rubric: *Lithotritie extracorporelle d'un calcul de l'uretère lombaire, sans drainage, chez la femme, avec repérage radiologique. (Extracorporeal lithotripsy of lumbar ureteral calculus without draining, in a female, with radiographic checking.)*

GALEN-generated rubric: *Fragmentation d'un calcul de l'uretère lombaire par un lithotriporteur extra-corporel avec imagerie par radiographie pour repérage sans évacuation du calcul chez la femme. (Lumbar ureteral calculus fragmentation by means of an extracorporeal lithotripter device with radiographic imaging and without evacuation of calculus, in a female.)*

'Lithotripsy' in the phase four rubric is replaced by only two sub-processes in the GALEN-generated rubric: 'fragmentation' and 'imaging', without the final 'extraction'.

The term 'Lithotripter device' ('Lithotritie' in French) has different meanings in the two examples cited. In the first example, the term means the complete extraction of the calculus. In the second example, the term means only the fragmentation of the calculus, the evacuation of which is expected.

The total workload for this second stage of the CCAM program corresponds mainly to the clinical modelling done in the French GALEN centre, specifically ten junior clinical modellers and two senior reviewers, part time, over four years from 1997 to 2001. A fair estimation is 50 person-months or four person-years, plus the marginal cost of the network between Manchester, Geneva, Saint Etienne and Nijmegen.

CCAM terminology: final product

Stage three of the CCAM program was the finalisation of the terminology and the coding schema. The chapters for the surgical procedures were finished at the end of 2001. The total number of rubrics is 7200. The finalisation work was done by the transversal group that was in charge of phase four of the first stage of the program, taking into account the output from the GALEN-based semantic meanings and some revision related to the rating of CCAM for fee-for-service payment

(described below).

The development of the coding schema was also achieved during 2001. The coding schema is seven characters for CCAM terminology and nine characters for fee-for-service payment. [Box 5](#) presents an example of the coding schema.

5: Example of the CCAM terminology coding schema

« GGJA002 *Evacuating a pleural cavity collection by thoracotomy without costal resection* »

The first four characters are alphabetic and represent:
• Topography (G = respiratory system; G = pleura)
• Action (J = evacuating)
• Approach and/or technical device (A = open approach)

The three following characters are numeric and incremental for the same types of procedures.

Nine optional characters may represent:
• The domain of the healthcare professional responsible for the procedure
• The stage of treatment
• Modifiers
• The specific payment code

Training in the use of CCAM is planned during 2002 according to the following three-level process.

1. Ten referent physicians per region (22 regions in France) are trained by the PERNNS and the Department of Division de la nomenclature, then
2. the regional referent physicians train all physicians in charge of the casemix departments in all acute care hospitals, and
3. the physician in charge of the casemix department in each hospital trains all other physicians in their hospital.

The 'real-world' application is planned to begin in 2003.

Rating of CCAM for fee-for-service payment

In order to fix the fee-for-service payment for private practitioners, it was necessary to score each rubric (from the final terminology product) and relate the score to economic statistics to determine a price. It was decided to adapt the works of Hsiao (1998) from the Harvard School of Public Health ([Alies-Patin, 1995, 1999](#)) for the relative scoring methodology. The relative scoring methodology is complex and so only a simple outline will be provided in this article.

The total fee-for-service for each rubric is the sum of two parts:

1. The first part is the variable cost. This is the combination of intellectual (cognitive) skill, physical means (effort), and specific costs which can be directly related to the procedure. It is split in two parts:

- *medical work* is related to the rubric by a measure of four attributes: working time, stress, technical skill and mental constraint (cognitive skill). These four measures are scaled and then tallied to provide a total medical work points score.
- *specific cost* is the cost of staff, material or medical

devices used for certain rubrics. It is expressed directly in monetary units.

2. The second part is the fixed cost (or structural cost). This is based on the mean fixed cost of structural spending (staff and equipment) for each clinical specialty. The source statistics for the calculation of the structural cost are the actual cost statistics produced by the Tax Department of the Ministry of Finance and figures estimated from casemix statistics from private-for-profit hospitals and from *ad-hoc* enquiries from CNAMTS for ambulatory procedures.

The medical work component of the variable cost was determined in two stages. The first stage used an expert structured subjective consensus method. Clinical domain-experts from 39 different clinical specialties were grouped into 43 panels (approximately 20 clinical domain-experts for each panel). The most recognised national clinical colleges recommended these experts.

The methodology applied in the first stage was an evaluation of a base rubric^[3] for each of the 39 specialties, with reference to the medical work attributes. The output of this phase was the mean of the scores from each clinical domain-expert for each rubric within each specialty.

In the second stage, the aim was to produce a single scale across the 39 specialties. Seven hundred and twenty eight 'link procedures' (the same procedure performed by different specialties or a procedure determined *a priori* to have equal or related medical work points) were cross-scaled by clinical domain-experts from the two relevant specialties to form one scale. This was done under the constraint that the base scale produced for the 39 specialty rubrics was correct and definitive.

Conclusion

A new French coding system for clinical procedures, CCAM, has been developed using two different methodologies: the traditional consensus method based on the knowledge of approximately 300 clinical domain-experts, and an artificial-intelligence-based semantic representation, GALEN. An economic evaluation of clinical procedures was also undertaken for the rating for fee-for-service payment.

The CCAM program is a practical example of a contribution to the harmonisation of different medical terminologies independently from the national language used. The GALEN resources (models and supporting tools) provide the means to support different clinical coding systems in their natural language. The CCAM program is also a practical example that may help to convince more countries to participate in a reference terminology representation approach across the world to ensure harmonisation and diversity without uniformity.

The need to develop such a terminology for economic reasons shows the critical importance of clinical terminology in advanced healthcare systems. The total cost of such separate developments in most countries around the world is unreasonable, and international co-ordination is needed to

share such costs while increasing the quality of the clinical information.

It is essential that the available advanced methodologies take the lead in the new century. A reference terminology approach as an open source is strongly needed by most of the healthcare systems across the world to support such harmonisation with diversity. Such open source work needs to be funded by the organisations and the countries concerned by the issue.

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[1] The national agency of the main mandatory health insurance system in France.

[2] CdAM is a specifically developed and maintained French procedure coding system that has been in use since 1985. The current version has 7000 procedure codes.

[3] For example, the base rubrics for digestive surgery and cardiology were, respectively, 'right colectomy' and 'treadmill exercise ECG test'.



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