# Towards iconic language for patient records, drug monographs, guidelines and medical search engines

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## Abstract

*Practicing physicians have limited time for consulting medical knowledge and records. We have previously shown that using icons instead of text to present drug monographs may allow contraindications and adverse effects to be identified more rapidly and more accurately. These findings were based on the use of an iconic language designed for drug knowledge, providing icons for many medical concepts, including diseases, antecedents, drug classes and tests. In this paper, we describe a new project aimed at extending this iconic language, and exploring the possible applications of these icons in medicine. Based on evaluators' comments, focus groups of physicians and opinions of academic, industrial and associative partners, we propose iconic applications related to patient records, for example summarizing patient conditions, searching for specific clinical documents and helping to code structured data. Other applications involve the presentation of clinical practice guidelines and improving the interface of medical search engines. These new applications could use the same iconic language that was designed for drug knowledge, with a few additional items that respect the logic of the language.*

### Keywords:

Iconic languages, Nonverbal communication, Computerized medical records systems, Practice guideline, Documentation.

## Introduction

During consultations, physicians frequently need to refer to medical knowledge; however they have very little time to do so, and the amount of knowledge available to them is becoming increasingly vast. It has been shown that, when trying to find the answer to a clinical question, physicians give up after a short time, usually less than two minutes [1]. A possible solution to this problem is to display medical texts in a graphical form. We previously [2, 3] developed VCM (*Visualisation des Connaissances Médicales*, medical knowledge visualization), an iconic language for drug monographs, and we have shown that these icons can help physicians to search for contraindications, cautions for use or adverse effects.

Although initially developed for drug knowledge, the VCM iconic language contains icons that represent most general medical concepts, including diseases, antecedents, risk factors, drug classes, tests and procedures. VCM could thus potentially be used in many other applications outside the initial scope. Drug monographs only represent a small part of the vast amount of medical information and knowledge required by physicians during consultations. Medical knowledge also includes clinical practice guidelines that provide recommendations related to specific diseases. Patient records present physicians with certain challenges, whether looking for specific information or to obtain an overview of the patient. Physicians also need to use search engines efficiently to navigate and search the large number of existing medical documents.

These considerations prompted us to start the L3IM (*Langages Iconiques et Interfaces Interactives pour la Médecine*, iconic language and interactive interface for medicine) project [4], financed by the French National Research Agency in the program TecSan (ICT in Health). This project aims to explore the potential use of VCM for other medical applications, and to identify the icons that are lacking in VCM but that are needed for an iconic language that covers the whole medical domain. The objective of this paper is to investigate the potential of iconic approaches for patient records, clinical practice guidelines and medical search engines.

We firstly briefly describe the VCM iconic language and its use for drug monographs. We then describe the methods used for identifying new areas of potential application of VCM. In the results section, we describe these applications and the new icons that will be required in addition to the existing icons in VCM. Before concluding, we discuss the limitations of our

study and the advantages and disadvantages of using iconic languages.

## Background: the VCM iconic language and "Mister VCM"

Drug monographs are texts describing drug properties, such as contraindications and adverse effects. Our previous work involved the creation of VCM [2], an iconic language for drug monographs, including a set of graphical primitives (about 100 pictograms, shapes and colors), and a few rules for combining the primitives to create icons for the major patient states, diseases, antecedents, risk factors, drug classes and follow-up procedures (Figure 1). For instance, the heart, kidney or lung pictograms can be combined with insufficiency, pain or bacterial infection shape to create icons for heart failure, renal failure, pulmonary infection,... and colors are used for distinguishing past, current and potential future diseases. The design of the iconic language took into account findings from cognitive sciences studies, in particular for the graphical representation of *is-a* relations. Consequently, when a physician visually searches for icons meaning "cardiac diseases", he will also find icons meaning "angor" or "cardiac failure".
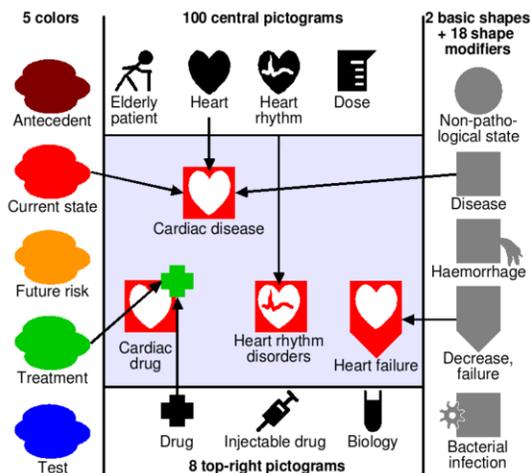


*Figure 1 - Examples of VCM icons, created by combining pictograms, shapes and colors*

Drug monographs are far too precise for the entire text to be replaced by icons. These texts also serve as legal references. However, icons may still facilitate the comprehension of the text, help to find a specific information, and provide an easy-to-memorize summary. Thus, we designed "Mister VCM" (Figure 2), an iconic interface for conveying information on the drug properties described in drug monograph to a physician during consultation [3]. VCM icons were used to represent contra-indications, cautions for use or adverse effects of a drug. These icons were displayed in a schematic diagram, based on anatomy and etiology. Rules were defined for com-

bining icons when several of them apply to the same case on the diagram, using icons' *is-a* relations. When the physician clicks on an icon, the corresponding textual paragraph from the drug monograph is displayed. "Mister VCM" uses grey icons to indicate the absence of contraindication or caution for use related to a given anatomical system or etiology. This allows the physician to quickly view, for example, that a drug has no renal contraindication, whereas in the drug monograph text, he must read the entire contraindication section.
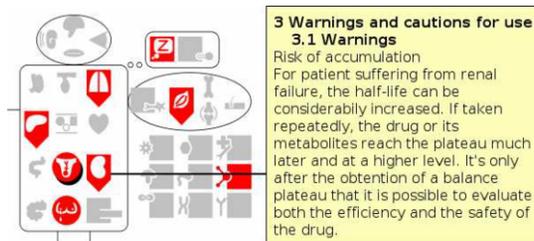


*Figure 2 - "Mister VCM" displaying the contraindications of zolpidem, after the clicking on the renal failure icon*

Evaluation in a controlled environment showed that with "Mister VCM", physicians briefly trained in VCM identified drug properties twice as quickly as when using a textual interface, and made significantly fewer errors [3]. The physicians were enthusiastic about using VCM, asking for such icons in their software.

## Materials and Methods

The various potential applications of VCM that may be of use to physicians were identified through several steps. The use of "Mister VCM" to obtain information about drugs knowledge was firstly evaluated and followed by a focus group; during the discussion, the participating physicians suggested a few uses for, such as the use of "Mister VCM" for displaying information contained in patient records. We then carried out some preliminary investigation, involving master students. This led us to set up the L3IM project [4], involving eight academic, industrial and associative partners. The project design process also entailed some individual reflection.

During the first six months of the project, several focus groups containing GPs or hospital physicians were set up (for a total of 20 physicians). An initial set of focus groups, formed before presenting VCM to the physicians, was aimed at determining the problems they encountered in the use of the existent medical software. A second set was formed after the physicians learned VCM. These groups were dedicated to determining possible applications for VCM. All discussions during the focus group meetings were recorded and analyzed.

## Results

### Possible applications for VCM

At least three areas for the applications of VCM were identified: patient records, clinical guidelines and search engines.

### *The use of VCM for patient records*

During consultation, physicians often have difficulties obtaining a clear overview of a patient's state, or finding a specific document relating to the patient, such as a hospital discharge summary. This is particularly true for patients with a long history of chronic diseases, or who are not regularly seen, for example for a patient followed by a doctor replacing a colleague on holidays.

Patient records contain patients' information including antecedents, current diseases and treatments, risk factors, biological test results... Patient records also contain clinical documents, such as radiographies, post-operative reports or discharge summaries, particularly for patients in hospital. We identified three possible uses of VCM to help the interpretation of patient records.
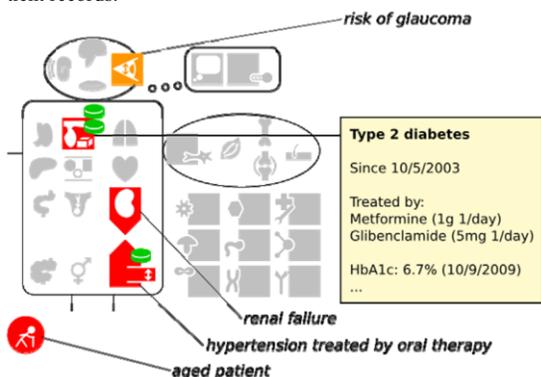


*Figure 3 - Example of the use of "Mister VCM" for presenting a summary of a patient's conditions. Labels have been added to explain the meaning of the VCM icons.*

- Icons can be used to summarize and to give a quick overview of the patient's conditions, possibly using a "Mister VCM"-like diagram. Figure 3 shows an example for an elderly diabetic patient, with hypertension and renal complications, and a risk of glaucoma. It displays a summary of the patient's current clinical conditions (diabetes, renal failure, hypertension) and risks (glaucoma), organized as a function of anatomy and etiology on a schematic human silhouette. Additional patient characteristics, such as age classes, are indicated below the silhouette. The icons also provide some information about treatments (*e.g.* oral bitherapy for diabetes). This iconic summary could be useful when reading medical knowledge such as contraindications, and may help to prevent an element being forgotten in the follow-up of the patient. Additionally, further in-

formation, such as related biological test results or prescription details, could be displayed by clicking on the icons.

- Icons can help physicians to search the various documents attached to a given patient. Documents could be placed within "Mister VCM" as a function of the various hospital services they come from, which are usually associated to an anatomical system or a particular etiology, *e.g.* cardiology or infectiology. Documents can also be characterized by other attributes, such as the type of the document (for example discharge summaries) or the author; this information could be added to the icons.

- Icons could help physicians to add structured data into patient records, for example the ICD10 (International Classification of Disease) code I10 instead of simply writing "hypertension" in plain text. Terminology browsers used for coding patient antecedents could be enhanced by adding icons in addition to, or in place of, the term's textual labels. Given that many terminologies are based on anatomy and etiology, "Mister VCM" could also be used to display the first level of the terminology, *e.g.* ICD10 chapters. Terms could also be searched for by composing the corresponding VCM icon, *i.e.* combining a color, a shape and a pictogram.

### *Applications in clinical practice guidelines*

As for drug monographs, clinical practice guidelines are long texts that are difficult for the physician to read during a consultation. They often include many paragraphs applying only to certain patients, such as the elderly or patients with renal failure. Two applications were considered:

- Icons can be used by the physician to find the paragraphs that apply to the patient. This can be achieved by adding icons in the margin of the text, the icons indicating the various categories of patients addressed (Figure 4). Icons could also indicate the associated recommendations such as recommended prescriptions. Another possible application is the use of "Mister VCM" to summarize the various conditions, displaying the relevant paragraphs on demand.

- Icons can also be used to summarize the decision process recommended by the guideline, possibly using a decision-tree structure. Such a diagram could indicate the disease covered by the guideline, the various patient conditions and the associated recommended treatments or tests to be performed. The diagram could be used as a quick summary of the guideline, but also as an interactive table of contents, *i.e.* by clicking on the icons the physician could navigate through the text of the guideline.

### *Applications in search engines*

Several search engines are dedicated to medical documents, such as Pubmeb for research articles or CISMeF [5] for French medical documents, including guidelines and medical
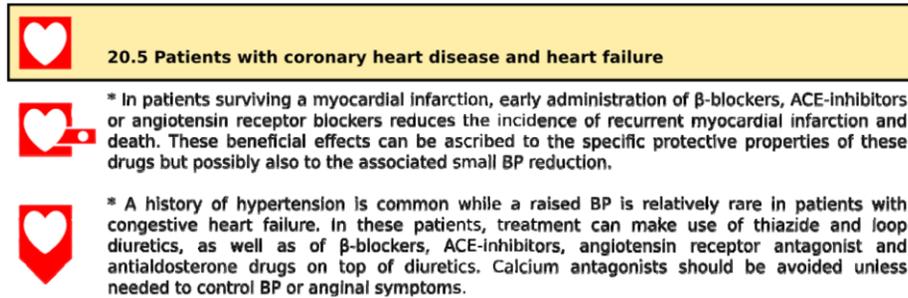
*Figure 4 - An excerpt from the European Hypertension Guidelines 2007, tagged with icons inspired from the VCM iconic language. Icons tag the patient conditions addressed by the paragraphs.*

courses. However, searching for medical documents is not easy, because the request can be complex and difficult to phrase. Additionally, the list of documents returned by the engine can be long, making it difficult to find the relevant documents, especially if the documents themselves are long, involving several topics like epidemiology, diagnosis, therapy... as it is often the case for guidelines.

Two different applications of VCM icons to facilitate the use of search engines were considered:

- Iconic interfaces could be used to help to formulate a query in a search engine, possibly using a "Mister-VCM"-like interface for choosing the icons on an anatomical and etiological basis. The use of icons eliminates language-related problems, such as synonymy, for example by using the same icon for angor and angina pectoris. However, since icons are not as precise as text, text may be required to refine the query.

- Icons can improve the list of documents resulting from the search. Documents in the list can be tagged by icons, according to their corresponding keywords. The use of a "Mister-VCM"-like diagram for this purpose would not be practical, as each document may involve many anatomic locations and etiologies.

In search engines, resources are indexed with various terminologies, for example MeSH (Medical Subject Headings) terms for CISMeF. Therefore, if these terminologies are mapped to VCM icons, icons could be easily associated with each resource.

**Additional icons required for the new applications**

In the previous section, we have described several new applications for the VCM iconic language. Given that VCM was initially developed for drug knowledge, some of these applications would require the language to be complemented with new icons, representing additional medical concepts. We have identified the following possible new icons:

- Icons for the different categories of health professionals. These icons could be used to identify the authors of documents attached to patient records. Existing anatomical pictograms could be reused to design icons that represent many different specialists, *e.g.* heart for cardiologists. Other health professionals, such as GPs, pharmacists, nurses,..., would require new pictograms, as well as would some other specialists, such as radiologists.

- Icons for representing document types. Two categories can be considered: documents attached to patient records, such as medical imaging document, postoperative reports or discharge summaries, and documents indexed in a search engine, including clinical guidelines, medical courses and patient leaflets. Within the second category of documents, it would be of interest to distinguish guidelines supported by national or local authorities, from foreign guidelines.

- Icons for representing social aspects of the patient, for example whether the patient lives alone or has low health literacy. These icons would be helpful in patient records, but could also be used in some clinical practice guidelines.

- Icons for diseases need to be extended, to incorporate additional elements representing the severity of the disease, or its evolution: aggravation, stabilization, improvement,... These icons could be used in clinical guidelines, since the recommendations given in guidelines are frequently dependent on the progression of the disease.

These new icons can be added to the VCM iconic language without modifying the existing icons and combinatory rules.

## Discussion

In the results section, we have described seven applications for the VCM language, relating to patient records, guidelines and search engines. These new applications would use the already existent VCM icons for patient conditions, drug treatments,... and eventually new icons requiring a few additional elements to be incorporated into the VCM language. These elements must be added taking care that the language remains coherent. We considered new icons for distinguishing between different pharmaceutical classes, such as beta-blocking agents or angio-

tensin converting enzyme inhibitors for antihypertensive drugs, which may be useful for clinical practice guidelines. However, these new icons were not retained due to the limited empty space available on VCM drug class icons, and because pharmaceutical targets are difficult to represent by pictograms without adding textual abbreviations such as "ACE". The implementation of the new applications we described would be facilitated by mapping VCM icons to standard medical terminologies, which is an undergoing work.

These new applications for VCM need to be properly evaluated, possibly using a method similar to the one used to evaluate VCM application for drug knowledge. It would also be interesting to evaluate the successive use of VCM in various applications, such as in the following scenario: a physician searches for a guidelines document using a VCM-powered search engine, then views a VCM-annotated copy of this document, at the same time looking for information in a patient records featuring a "Mister VCM" summary. In particular, it would be important to determine whether the successive use of the same iconic language has a synergetic effect, or whether it is likely to cause confusion.

The use of icons has two main advantages over text (including short abbreviations, *e.g.* HbA1c for glycosylated haemoglobin): icons can be visually searched very quickly, and they are (at least partly) independent of native languages. However, icons may not be easily visualized for certain individuals, such as people with daltonism. Another inconvenient is that iconic languages such as VCM require a short training phase before being able to understand all icons of the language. For VCM, the learning phase is short, and was estimated to about four hours [2].

A few other uses of icons for presenting medical knowledge can be found in the literature, mostly for giving instructions to patients [6- 9], but also for helping medical students to understand physiopathology [10] or for summarizing the solubility and stability of injectable drugs for hospital pharmacists and nurses [11]. However, these icons are limited to the specific application they were designed for, and most of them are simple sets of pre-defined icons without compositional rules for creating new icons.

The new applications that we identified for VCM were focused on use by physician. Other applications could be identified for other groups of individuals, in particular medical students, pharmacists and nurses. However, VCM is probably not appropriate for patients. Indeed, the VCM language was designed taking into account the medical knowledge acquired by health professionals, especially anatomy, whereas patients have only limited knowledge in this domain [12].

In conclusion, iconic languages have many possible applications in medicine. In order to avoid health professionals having to learn several icon systems, and to prevent the potential confusion between icons developed for different applications, a single, coherent and standardized iconic language should be used across the various applications. In this paper, we have shown that, with the addition of a few new icons, VCM could be this iconic language.

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