NEW-GUIDE: a new approach to representing clinical practice guidelines

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Introduction – Computer-based representation of Clinical Practice Guidelines (GLs) is an important research topic in medical informatics. It has been proposed to promote guideline dissemination and to help improve physicians’ compliance with guidelines. There are several aspects to tackle, in order to implement efficient, real world decision support systems built on GLs. Some aspects concern the representation formalism, others concern the implementation: among the former there are representation syntax and semantics, use of standard medical terminologies and ontologies, reusability of medical knowledge. Among the latter there are the interface to the legacy system, reminds to the guideline text, tailoring the system functionality to the specific user role, setup of evaluation procedures to measure guideline impact, etc. In the middle there is the link with the electronic medical record (also for deriving abstractions, both qualitative and temporal), that involves both representation and implementation issues.

A number of representation formalisms are currently under development [1,2], and a new paper [3] comparing 6 of them has been submitted for publication. GUIDE [4], developed at the University of Pavia, is one such guideline representation formalism. In GUIDE, through a graphical editor, the GL is hierarchically structured in “pages” representing different abstraction levels: the first, high level, page is normally composed by a flow-chart of non-atomic tasks, whose expansion is described in inner pages. The main features of GUIDE are: the capability to represent sequential, parallel and iterative paths, the possibility of running analytic-decision models when decisional tasks are not associated with specific rules, the use of a terminology server to define the GL task names, and finally the possibility of generating a Petri net written in WPDL for GL simulation purposes [5].

In this presentation, we will discuss recent advances in our guideline representation formalism and associated authoring tools (“NEWGUIDE”). Advances are:

a) architectural innovations, concerning the introduction of medical knowledge components, that we call “modules”. The fundamental medical hierarchy into symptoms, signs, clinical tests etc. has been used as the root of the conceptual basis for the design of the new modules’ organization (Figure 1). Using XML, we can provide a library of building blocks to be integrated with the NEWGUIDE guideline editor. We think that the modularisation approach

Figure 1. The guideline managers’ hierarchy
will facilitate the management of GL for multiple diseases (i.e. running more than one guideline at the same time) through reusability.

b) improvement of the rule-language expressiveness, by supporting qualitative and temporal abstractions resolved by an external temporal server [6].

c) improvement of the GL general description, using the GEM-suggested attributes [7], allowing to frame the GL in a precise context about developers, users, releases, verification plans, etc., very useful when creating a GL repository.

Guidelines modularisation - In this work, we focus on a particular guideline aspect: tasks concerning diagnostic tests, belonging to the class of “Data Acquisition” tasks. We refer to them to illustrate the modularisation approach to guideline representation that we have adopted.

![Image of a guideline module](image.png)

Figure 2 - The definition of a “Data Acquisition” task. In the right panel, first the task name is chosen from SNOMED (not shown). Second, the module for “Echocardiography Transesophageal” is loaded (shown). Some of the findings from the list will be used, by a sort of cut & paste, to populate the specific guideline task. They will have a corresponding item in the electronic patient record.

Strongly connected to modularisation is the concept of task granularity. Let us consider, for example, the “urine culture and antibiogram”. In clinical practice, when looking for a particular bacterium in order to choose the best antibiotic treatment, the culture and the successive antibiogram, in case of positive culture, are always considered as a whole, because the urine sample is the same, as well as the laboratory performing the examination. But, if the guideline inference engine has been designed in such a way that it waits for a task to be completed before it can go ahead (and we consider a task to be “completed” when all relevant data have been obtained), we risk to loose time, because some of the results (from urine culture) may be available in few hours,
and may be sufficient to prescribe some emergency drugs, while other results (from an antibiogram) will be not be available for one-two days. Thus, in such as case, the solution is to split the diagnostic test into two (i.e. “urine culture” and “antibiogram”), with additional (therapeutic) tasks between them. Another solution is to design the engine in such a way that it only looks at the data entered into the electronic medical record (EMR) in order to continue with the guideline plans, without taking explicitly into account the notion of “task completed”.

To summarise, when representing the guideline, the granularity level that we assign to a task depends on the inference engine functionality and on the expressiveness that we desire from the guideline representation. Thus, it is important to have common knowledge sources (modules) that allow different representations of the same concepts in a flexible way.

There is a second, more interesting, way of looking at granularity. Examining different guidelines, one can easily realise that the same diagnostic test may be used with different goals in different contexts. What we mean is that, usually, a diagnostic investigation provides a number of data, and only a subset of them is used in the guideline, and this subset is different for different guidelines. One could argue that what is crucial to represent in each guideline is the set of results, among the ones that can be obtained, necessary to continue with the specific guideline plans. This is true, but we also know that, building a tool for knowledge representation and management, it is worthwhile building reusable pieces of knowledge, and a guideline-specific approach is in contrast with that.

Let us illustrate these concepts by an example. In guidelines for the management of acute ischemic stroke, there is a recommendation for trans-esophageus-echocardiography (TEE). The subsequent tasks, useful for the differential diagnosis of the stroke, only need TEE results about aneurysm, thrombus, vegetation of the aortic valve and patent foramen ovale. In fact, when the test is performed, much more information is derived than is needed. (The same occurs for some blood tests: even if only “haemoglobin” is needed, a complete blood count is performed, because, given the blood sample, the machine automatically computes not only the haemoglobin concentration, but also the blood cell count, the haematocrit, etc.). Maybe another guideline will use it more extensively.

Thus, our approach for diagnostic tests is to store their whole specification in the knowledge base (through an XML module), and make it available to the NEW-GUIDE editor users, for specifying the test results useful in the particular task of the guideline that is being edited. The same XML file is used to obtain the task documentation, at an educational level (i.e. clicking on the task, one can have its complete description).

**NEW-GUIDE functionality**

The NEW-GUIDE interface (figure 2) is split into two main windows. The left one is dedicated to development of a flow-chart, the right one gives help with the development itself. This is the main difference compared to the original GUIDE editor: we have aimed to make explicit and available a set of reusable knowledge sources. As shown by the window panel tabs, the user is able to:

- (button “Easy text”) look at the guideline mark-up, that can be performed with the GEM Cutter guideline mark-up program [7];
- (button “terminology”) choose a term from the available terminology servers, for example SNOMED;
- (button “modules”) call a knowledge source (module) that can be used to define a guideline task, for example to choose the necessary findings among a list of findings, as explained
before for a diagnostic test. A module can also be a task expansion, i.e. a set of actions that define a complex task, that may be reused in some points within the same guideline or in different guidelines. A module can also be a fixed structure that can be parameterised, like the “monitoring” task: we define several monitoring structures, which require parameters values for frequency, deadline, control variable threshold, exiting condition, a.s.o.

- (button “text”) read the whole textual guideline, when a text exists;
- (button “tree”) see the complete hierarchy of the guideline tasks.

The figure illustrates the definition of the task “Echocardiography Transesophageal”. First of all, the user defines the type of the task (in this case “Data Acquisition”), then he accesses SNOMED and chooses the correct task denomination. Then he calls, if any, the module associated to that task. In the picture, the right window shows the module containing all the possible findings obtained by the test. The user clicks on the findings necessary to the specific guideline. In fact, the “Data Acquisition” task allows the specification of the list of data to be acquired.

Current use of NEW-GUIDE

We are using NEW-GUIDE to represent guidelines for the management of stroke patients. There are several guidelines for these patients because they pass through different healthcare organisations. There are separate recommendations for the emergency, acute, post-acute and hospital rehabilitation phases, and finally, for the home rehabilitation period. The relevant Italian Association SPREAD (Stroke Prevention and Educational Awareness Diffusion) has recently published a book [8] embedding all these guidelines in a textual format, and we are involved in a national project for their electronic representation.

References