Guideline Assessment and Implementation in Congestive Heart Failure

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Abstract

In this study the feasibility of representing guidelines on the pharmacological management of heart failure was assessed using, a toolbox specially designed to enter and during runtime manipulate guidelines., The toolbox distinguishes three layers to define guidelines. In the first layer, the flow charts derived from the guidelines are drawn, and annotated using natural language. Secondly, the respective rules are entered, using a domain specific vocabulary. The decision support system applies this guideline knowledge to the actual patient status and relevant laboratory results, entered by the physician or obtained from an existing data source, resulting in advice regarding this patient. In this limited study the selection and titration of three classes of drugs was modeled and for each category a prescription strategy was defined, based on severity of overfilling, co-medication and laboratory data. The decision support system selects, based on the current clinical state of the patient, the underlying pathophysiology and presence of co-morbidity, the most appropriate drug strategy.

1. Guideline development

During the last decade, studies have shown benefits of clinical guidelines in the practice of medicine [1] such as a reduction of practice variability and patient care costs, while improving patient care [2]. According to the Institute Of Medicine (IOM), a guideline is defined as: 'a systematically developed statement to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances' [3]. Although guidelines have been developed for more than 50 years, recently the emphasis has focused on the development of systematic and evidence-based guidelines as well as their evaluation and ease-of-use in daily practice.

Regarding the specialty of cardiology, worldwide many organizations are generating guidelines to standardize diagnosis and treatment of cardiovascular disorders. Although the potential application of these guidelines in daily care is enormous, a number of difficulties exist related to the development and implementation of guidelines. One of them is the interpretation of the content of a guideline: the exact meaning of terms is not always defined, recommendations are not always clearly articulated and sometimes vague wording is used (e.g., what is meant when a guideline states: 'start the prescription of an anti-hypertensive when the patient has a blood pressure that is *too high* for *too long a period*'). Also, most of these guidelines are written down as large documents in a textual format [4], which are often cumbersome to read and difficult to integrate in the patient care process. For example, the ESC Guideline on Sudden Cardiac Death is 76 pages long, with an executive summery of 16 pages.

2. Decision support systems

One of the problems with presenting guidelines as (structured) textual documents to cardiologists is that it is a passive method of decision support: the cardiologist must decide whether consultation of a guideline is necessary. Often, care providers in general are convinced that their actions agree with guideline standards and there is no need to consult the corresponding guideline in order to be sure. In reality however, these actions may oppose the guideline's intentions [5]. Implementing guidelines in active computer-based decision support systems promises to improve the acceptance and application of guidelines in daily practice because the actions and observations of cardiologists are monitored and advice is generated whenever a guideline is not followed. Various studies, covering a wide range of clinical settings and tasks, concluded that the use of these systems significantly improves the quality of care, especially when used in combination with clinical information systems such as Electronic Patient Record (EPR) systems. It is stated that these decision support systems are in fact not only crucial elements in long-term strategies for promoting the use of guidelines [6] but also necessary for the future of medical decision making in general [7].

3. The Gaston framework for building guideline-based decision support systems

Modern knowledge technology techniques might be useful in making guidelines available, tailored to the individual patient. During the last 15 years, a number of frameworks have been developed that focus on the subject of acquiring and implementing guidelines for use in daily care.

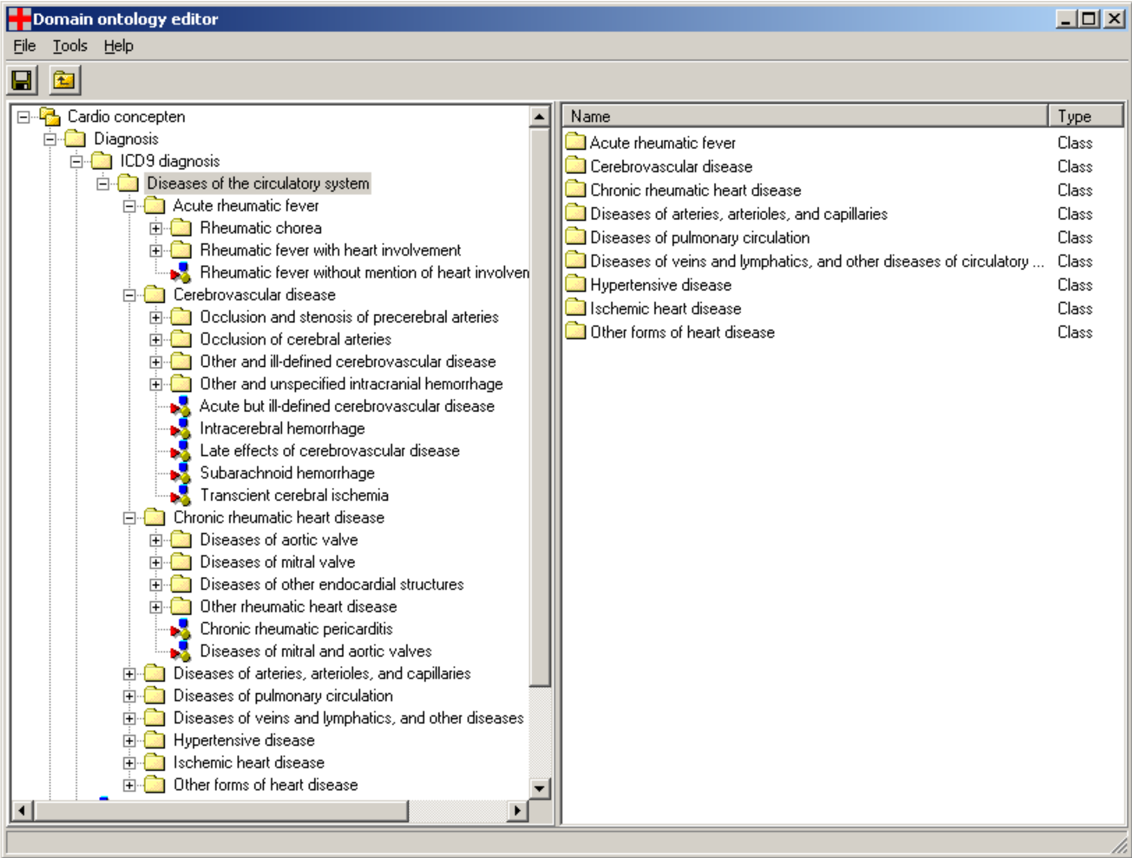

Figure 1: Part of the ICD-9 terminology, entered in Gaston.

One of these frameworks is the Gaston (Guideline Assessment Supporting Tools and Ontologies) framework. GASTON consists of a suite of tools and reusable software components that support the various stages in guideline development, from guideline design to guideline execution. The framework includes design-time components to facilitate the guideline authoring process along with execution-time components for building decision support systems that incorporate these guidelines [5]. Building guidelines by means of Gaston consists of three stages [8]: 1) creating a terminology, 2) entering the guideline using terms from the terminology created in phase 1, and 3) creating a decision support system that is able to give advice to cardiologists based on the guidelines entered in phase 2.

3.1. Phase 1: terminology

First of all, a terminology is chosen that reflects the guideline application domain. For cardiology for example, the ICD-9 or ICD-10 terminology can be used. Figure 1 shows part of the ICD-9 terminology in Gaston. Such as terminology can be build from scratch or can be reused from other projects (for example, projects that also use ICD).

3.2. Phase 2: entering guidelines

The second stage in Gaston consists of entering the guidelines using the so-called Gaston guideline editor, which is a graphical editing tool used for formalizing and visualizing guidelines through flowcharts. In this project the domain of congestive heart failure was chosen.

Figure 2 shows part of a guideline that addresses the pharmacological management of congestive heart failure, which was entered using the Gaston guideline editor.

The guideline editor consists of four panes. The left-upper pane shows an overview of all entered guidelines. When a guideline is chosen in this pane, the large right pane shows a detailed overview of the chosen guideline (in figure 2, a guideline concerning the prescription of beta-blockers is chosen). In the Gaston framework, a guideline is visualized as a flowchart, which contains a number of building blocks (the rectangular and diamond shapes in the right pane). Each building block represents a characteristic step in a guideline such as a decision (e.g., ‘does the patient have complaints’) or an action (e.g., start a beta-blocker with the minimum dose’). The left-middle pane shows a overview of all building blocks that the Gaston framework defines. The left-lower pane shows an overview of the terminology that was developed in phase 1.

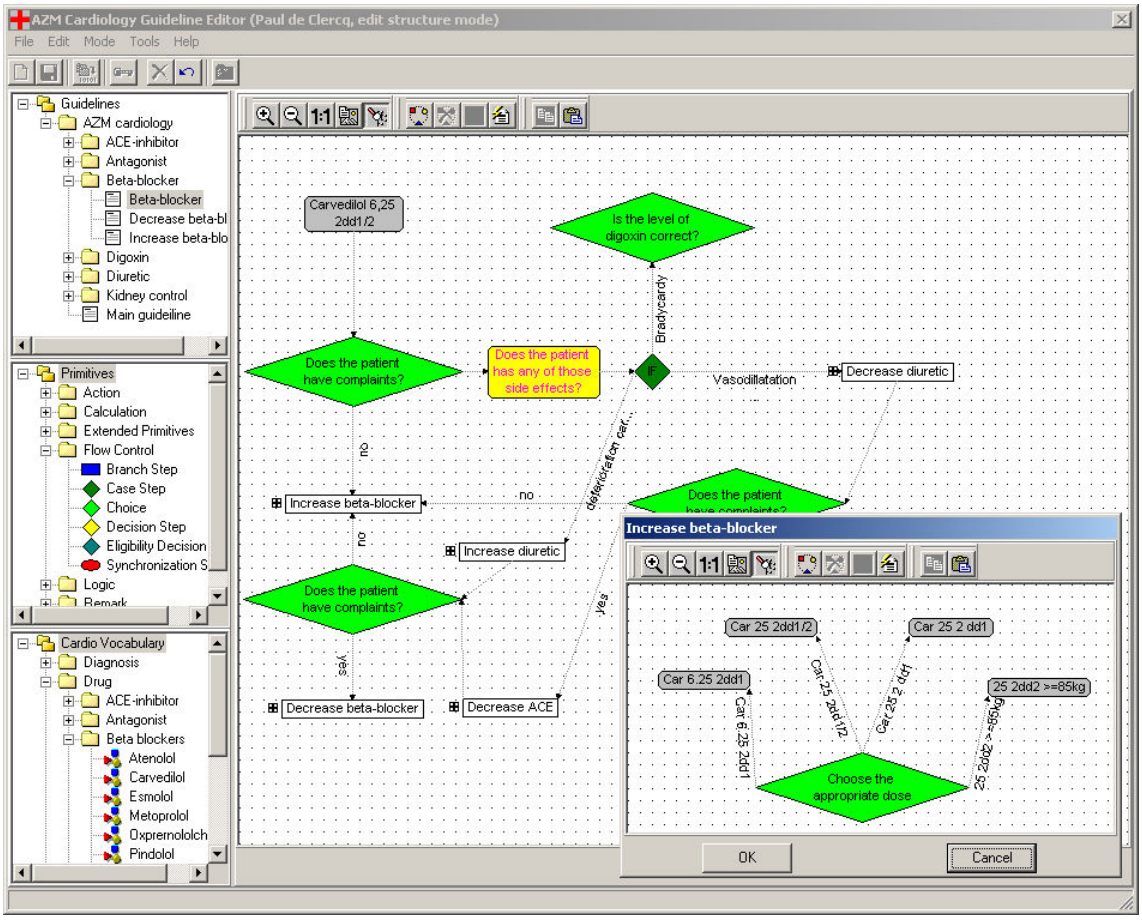

Figure 2: A guideline for the pharmacological management of heart failure in Gaston.

The guideline editor distinguishes three layers to define guidelines: the flow diagram, the underlying rules and the communication layer. In the first layer, the flow charts derived from the guidelines are drawn using the various building blocks from the left-middle pane. Also, each step in the flowchart is annotated using natural language. Secondly, the respective rules are entered for each step, using the domain-specific terminology that was created in phase 1. In this way, guidelines are understandable by cardiologists (who can view the guideline as a flowchart) as well as by decision support systems (who can interpret the underlying rules). The third layer defines the method of communication between the decision support system and other information systems such as EPRs. This layer is necessary, as there exist different EPRs in the medical world; and often each EPR defines its own communication protocol.

3.3. Phase 3: providing automated guideline-based decision support

Entered guidelines are automatically transferred to another program that is part of the Gaston framework: the Gaston Decision Support System (DSS). This system is able to apply guideline knowledge to the actual patient status and relevant laboratory results, entered by the physician or obtained from an existing data source, resulting in advice regarding this patient. Figure 3 shows an example of advice that was generated by a Gaston DSS that provides advice on the topic of secondary prevention.

The upper part of the system, shown in figure 3 consists of a web-based EPR that enables cardiologists to enter and view patient data. The lower part shows the advice that was generated by the Gaston DSS. During daily practice, a Gaston DSS runs in the background and continuously monitors the actions and decisions of the cardiologist. When Gaston concludes that, based on the guideline knowledge and the data from the EPR, that a cardiologist may need advice (e.g., when a cardiologist does not follow the guideline), Gaston will generate an advice, reminder or warning.

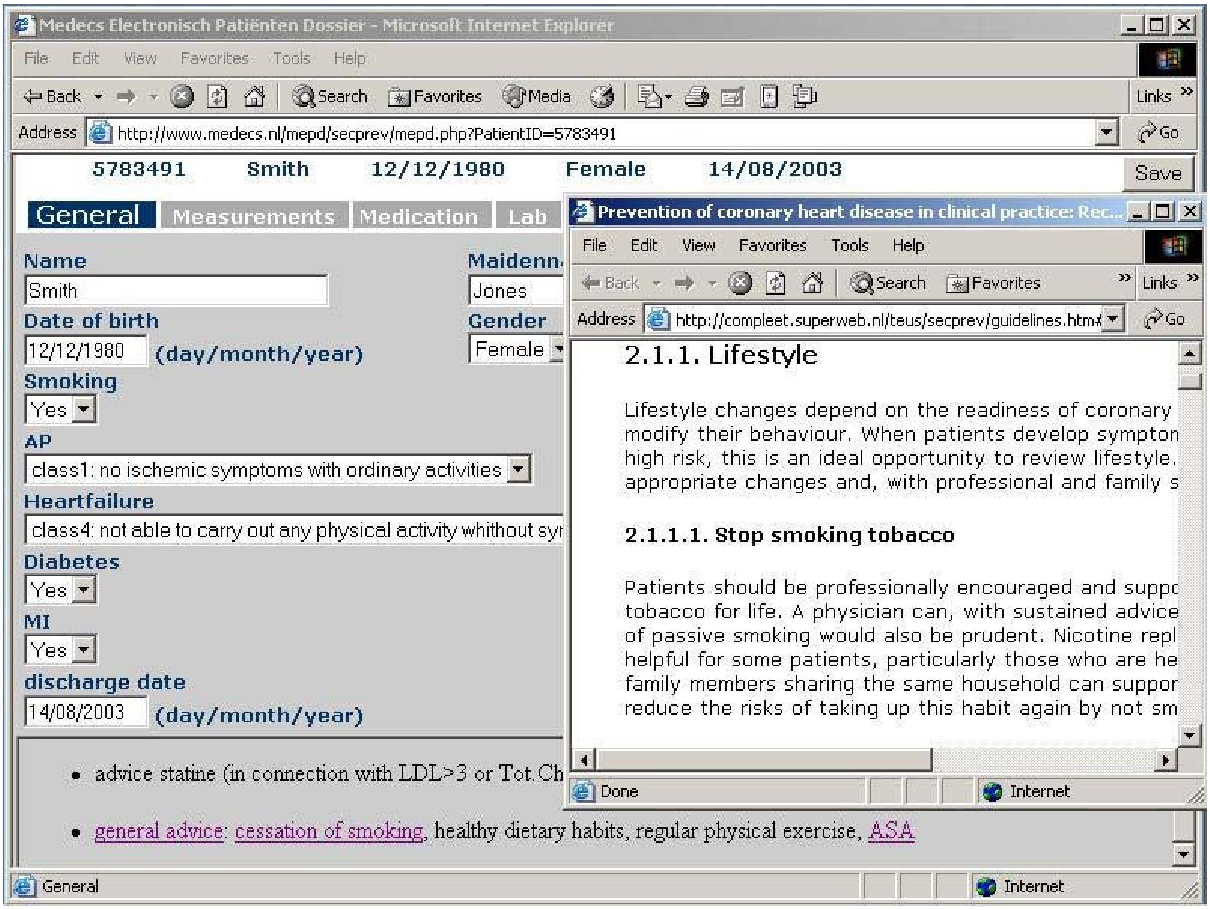

Figure 3: Guideline-based advice, generated by Gaston

4. Current state of the study

In this limited study the selection and titration of three classes of drugs was modeled: beta-blocking agents, diuretics and ACE-inhibitors, and represented in three sets of sub-guidelines. For each category a prescription strategy was defined, based on severity of overfilling, co-medication and laboratory data (liver and kidney function and electrolytes). These three strategies were combined by a separate set of rules. The system selects, based on the clinical state of the patient, the underlying pathophysiology and presence of co-morbidity, the most appropriate drug strategy. In this project, launched by the Interuniversity Cardiology Institute of the Netherlands, the process of defining rules using these user friendly tools and their evaluation in clinical routine initiated a better understanding of the rationale of drug treatment in congestive heart failure.

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