Chapter 7
HeCaSe2:
A Multi-Agent System that Automates the Application of Clinical Guidelines

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ABSTRACT

Clinical guidelines (CGs) contain a set of directions or principles to assist the healthcare practitioner with patient care decisions about appropriate diagnostic, therapeutic, or other clinical procedures for specific clinical circumstances. It is widely accepted that the adoption of guideline-execution engines in daily practice would improve the patient care, by standardising the care procedures. Guideline-based systems constitute part of a knowledge-based decision support system in order to deliver the right knowledge to the right people in the right form at the right time. The automation of the guideline execution process is a basic step towards its widespread use in medical centres. To achieve this general goal, different topics should be tackled, such as the acquisition of clinical guidelines, its formal verification, and finally its execution. This chapter focuses on the execution of CGs and describes the design and implementation of an agent-based platform in which the actors involved in health care coordinate their activities to perform the complex task of guideline enactment.

INTRODUCTION

In electronic healthcare (e-Health) it is increasingly necessary to develop computerised applications to support people involved in providing basic medical care, reducing costs and providing relevant patient information at the point of care (Lenz, et al., 2007; Wyatt & Sullivan, 2007). A clinical guideline (in the following, CG) is a highly matured therapeutic plan that compiles optimum practices for treating patients in a well-defined medical syntax. Thus, the adoption of CGs is a promising way for standardising and improving health care practices (Field & Lohr, 1990; Mersmann & Dojat, 2004; Michie & Johnston, 2004).

More concretely, CGs are a set of directions or principles to assist the health care practitioner with patient care decisions about appropriate diagnostic,
therapeutic, or other clinical procedures for specific clinical circumstances. CGs are developed by government agencies, institutions, organizations such as professional societies or governing boards, or by the convening of expert panels. They provide a foundation for assessing and evaluating the quality and effectiveness of health care in terms of measuring improved health, reduction of variation in services or procedures performed, and reduction of variation in outcomes of health care delivered (CancerWEB, 2008).

CGs are usually published as technical reports, papers and books, which are mainly disseminated through the Web. The data format includes natural language statements, tables, workflows of processes, and they report information about decisions to be made, drug therapies, diagnostic procedures, doses, etc. (e.g., a CG can describe the screening, early detection, diagnostic and treatment of pre-eclampsia in pregnancy (Milne, et al., 2005)). From the creation of these documents, to their final use in daily care, several stages must be followed: representation, acquisition, verification and finally, execution. The first three tasks concern the authors of the guideline (e.g., governmental or professional organizations), whereas the latter is related to practitioners. Briefly, these steps can be described as follows:

a) **Choice of a representation language.** A CG contains several elements to be modelled, such as actions, required patient data, decisions to be made, constraints between tasks, temporal constraints in a global plan, etc. Different researchers have defined formal languages to model computer-interpretable clinical guidelines, such as PROforma, EON, GLIF, GUIDE, SDA* or Asbru (Clercq, Blom, Korsten, & Hasman, 2004; Miksch, Shahar, & Johnson, 1997; Riaño, 2004, 2007; Wang, Peleg, Tu, Shortliffe, & Greenes, 2001). Some reviews of the main guideline representation languages can be found at (Peleg, et al., 2003) and (Mulyar, van der Aalst, & Peleg, 2007).

b) **Acquisition of CGs.** Clinical guidelines are based on the evidence collected from clinical trials and existing literature (Davis, Goldman, & Palda, 2007; Priori, Klein, & Bassand, 2003). Some authors are also currently working in the semi-automatic construction of computer-interpretable guidelines, by applying Machine Learning techniques from a corpus of clinical data collected in a medical centre (Riaño, 2004), directly from textual documents (Hrabak, Campbell, Tu, McClure, & Weida, 2007), or using mark-up techniques to guide the extraction of the main data structures and relations (Shahar, et al., 2004).

c) **Verification of CGs.** Verification includes two aspects: is a medical guideline well formed?, and, which of these two available CGs is the best? The first question seeks to verify the formal correctness of the guideline (Hommersom, Groot, Lucas, Balser, & Schmitt, 2007; ten Teije, et al., 2006). The second question is more difficult to answer since it is necessary to quantify how appropriate is a clinical guideline. To tackle this problem, some authors proposed an evaluation procedure called AGREE which calculates a set of parameters for a given guideline to evaluate its quality (AGREE, 2003). In addition a methodology to facilitate the whole development and evaluation of CGs can be found in (Ricci, Celani, & Righetti, 2006).

d) **Execution aspects.** As mentioned above, a CG contains a great amount of information to be considered (decisions to be made, constraints between tasks, temporal restrictions). Proper management and evaluation of heterogeneous data from different sources (e.g., family doctor, nurses, and medical devices) during the enactment of CGs is a crucial task. In any case, these decision-support tools are used to assist the practitioner during a treatment in a supervised way. The patient, at the