Chapter 32
Knowledge-Based Support to the Treatment of Exceptions in Computer Interpretable Clinical Guidelines

Alessio Bottrighi
University of Piemonte Orientale, Italy

Luca Piovesan
Università degli Studi di Torino, Italy

Giorgio Leonardi
University of Piemonte Orientale, Italy

Paolo Terenziani
University of Piemonte Orientale, Italy

ABSTRACT

Clinical guidelines are one of the major tools that have been introduced to increase the rationalization of healthcare processes, granting both the quality and the standardization of healthcare services, and the minimization of costs. Computer interpretable clinical guidelines (CIGs) are widely adopted in order to assist practitioners in decision making, providing them evidence-based recommendations based on the best available medical knowledge. However, a main problem in CIG adoption is the fact that, in the medical context, some degree of uncertainty is often present. Thus, during guidelines executions on specific patients, unpredictable facts and conditions (henceforth called exceptions) may occur. A proper and immediate treatment of such exceptions is mandatory, but most of the current software systems coping with CIGs do not support it. In this paper, the authors describe how the GLARE system has been extended to deal with this purpose. They identify different types of exceptions, considering their "pre-locability" and "pre-plannability". On the basis of such parameters, the authors propose different treatment modalities, consisting of both data structures to model the different types of exceptions, and the algorithms to treat them. The resulting methodology is an innovative one, integrating different Artificial Intelligence techniques (ranging from planning to ontology-based reasoning). Finally, they also discuss how they implemented their system-independent methodology on top of GLARE, and describe its application in the ROPHS project, considering the management of the severe trauma guideline.

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1. INTRODUCTION

1.1. Context

The rationalization of the healthcare system is important to grant both the quality and the standardization of healthcare services, and the minimization of costs. *Knowledge* is the cue factor to promote such a rationalization: it may support both strategic *decisions* at the organization level, as well as diagnostic/therapeutic *decisions* concerning specific patients. *Evidence-based* medicine has gained a major role in this context. Clinical Practice Guidelines (CPGs) are one of the major tools that have been introduced to provide *evidence-based medical decision support*. CPGs are, in the definition of the USA Institute of Medicine, "*systematically developed statements to assist practitioner and patient decisions about appropriate health care in specific clinical circumstances*" (Institute of Medicine, Committee on Quality Health Care in America, 2001). In short, CPGs provide evidence-based recommendations to suggest to physicians the set of diagnostic/therapeutic actions to be executed to cope with a specific disease. Notably, the last decision on the activities to be performed on the patient is always left to the user-physician. Thousands of CPGs have been developed in the last decade, or so. For instance, the Guideline International Network (http://www.g-i-n.net) groups 100 organizations of 48 countries, and provides a library of more than 6500 CPGs. Despite such a huge effort, CPGs have not provided all the expected advantages to clinical practice yet. Recent research has shown that Computer Science can help to drastically improve the impact of CPGs in clinical practice, by developing tools to manage computer-interpretable clinical guidelines (**CIG**s henceforth), defined as formal representations of CPGs in some computer format. The adoption of CIGs, and of computerized approaches to acquire, represent, execute and reason with provides crucial advantages to:

1. Patients, enabling them to receive the best quality medical treatments;
2. Physicians, providing them with a standard reference which they may consult, with a way of certifying the quality of their activity (e.g., for insurance or legal purposes), and, above all, with advanced support for their decision-making activity;
3. Hospitals, and healthcare centers, providing them with tools to enable the quality and the standardization of their services, as well as with a tool to evaluate quality, and to take strategical knowledge-based decisions for optimizing costs and resources.

In recent years, the research about CIGs has reached an important role within the Medical Informatics community, and many different approaches and projects have been developed to create domain-independent computer-assisted tools for managing, acquiring, representing and executing them. See e.g. the systems Asbru (Shahar, Miksch, & Johnson, 1998), EON (Musen, Tu, Das, & Shahar, 1996), GEM (Shiffman et al., 2000) GLARE (Terenziani, Molino, & Torchio, 2001) (Terenziani., Montani, Bottrighi, Molino, & Torchio, 2008), GLIF (Peleg et al. 2000), GUIDE (Quaglini, Stefanelli, Lanzola, Caporusso, & Panzarasa, 2001), PROforma (Fox, Johns, & Rahmanzadeh, 1998), and the collections (Gordon, & Christensen, 1995; Fridsma, 2001; Ten Teije, Miksch & Lucas, 2008; Peleg, 2013). One of such approaches is GLARE (Guideline Acquisition, Representation and Execution), which started from 1997 in a long-term cooperation between the Department of Computer Science of the University of Eastern Piedmont Alessandria, Italy, and the Azienda Ospedaliera San Giovanni Battista in Turin (one of the largest hospitals in Italy). Besides supporting CIG acquisition, representation, storage and