

DeGeL: A Clinical-Guidelines Library and Automated Guideline-Support Tools

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1. Introduction

Using machine-interpretable clinical guidelines to support evidence-based medicine promotes the quality of medical care. In this paper, we present the Digital Electronic Guidelines Library (DeGeL), a comprehensive framework, including a Web-based guideline repository and a suite of tools, to support the use of automated guidelines for medical care, research, and quality assessment. Recently, we have developed a new version (DeGeL.NET) of the digital library and of its different tools. We intend to present a brief up to-date explanation of a Digital Library for GLs that we had developed. We explain how it assists physicians and knowledge engineers in acquisition and representation of the GL's knowledge and how it assists users in searching, retrieving, and applying a relevant GL in a manner customized to each patient.

In order to support the automation of guideline-based care, there is a need to convert the GL from its free-text representation into a machine interpretable format. The guiding principle followed in our research is specifying GLs through the collaboration between expert physicians (EPs), clinical editors (CEs), (i.e. physicians who are not necessarily experts in the GL medical domain, but are familiar with the semantics of the representation format, known also as the GL ontology), and knowledge engineers (KEs). EPs and CEs transform the clinical knowledge represented in free text GLs into intermediate, semantically meaningful representations while KEs convert these intermediate representations into a formal, machine-interpretable representation.

2. DeGeL: Digital Guidelines Library Server

To convert clinical GLs into a formal representation, we have developed the Digital electronic Guidelines Library (DeGeL), which uses a hybrid representation, namely a representation methodology that includes several intermediate formats; these formats are increasingly formal. All intermediate and final formats are stored within the knowledge base. The current representation formats include (1) the original full text, (2) a semi-structured representation (marked-up text), (3) a semi-formal representation which includes control structures such sequential or parallel sub-plans order, and (4) a fully formal, machine-comprehensible format. The intermediate representation levels have additional benefits; the semi-structured level is crucial for context-sensitive search of GLs; the semi-formal level supports application of the GL by a clinician at the point of care, without access to an electronic medical record (EMR).

To overcome several limitations of the web-based architecture of the previous version of DeGeL, we have developed a new version (DeGeL.NET) of the digital library and of its different tools. Our goal when designing the new version was to create a distributed, web-service based, open architecture implementation according to the Service Oriented Architecture (SOA) design specification. This new approach grants the ability to develop a suit of tools for guideline specification, retrieval and application. In addition, the open architecture may host alternative tools for guideline specification and application. The DeGeL.NET implementation includes the following main modules: (1) a knowledge base server, (2) a guideline-specification tool (Gesher), (3) a runtime application engine for clinical guidelines (Spock).

DeGeL's server allows development of rich client tools by using web-service methods to retrieve and edit guidelines in the knowledge-base. The server's architecture is assembled of the following modules: (1) a guideline database that contains the overall schema to support the hybrid multiple ontology representation, (2) a module that is responsible for guideline-knowledge creation, reading, updating, and deletion, (3) a new guideline search engine, which facilitates full-text, context-sensitive and concept-based search methods for enhanced guidelines retrieval (4) an authorization & authentication module, which supports the group-based authorization model, and (5) a web-service API that enables the guideline knowledge-base server to accept client requests and to orchestrates multiple steps, in order to perform the requested transactions.

3. Gesher – A Graphical Framework for Specification of Clinical Guidelines

The Gesher system is a client application designed to support the process of incremental guideline specification at multiple representation levels according to target specification ontology. Gesher is designed to support the gradual knowledge acquisition process performed by a collaboration of an expert physician familiar with the domain-specific clinical knowledge, a clinical editor familiar with general medical knowledge and with the semantics of the target GL ontology, and a knowledge engineer. This collaboration, which includes specification of the guideline ontology specific consensus, is critical for achieving high quality specification. Gesher supports the gradual process through all the steps of creating formal representation of the guideline and for further maintenance and modification of the guidelines.

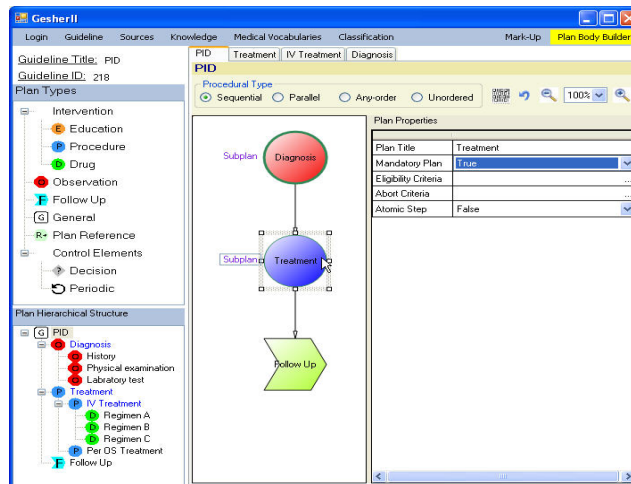


Figure 1. The Hierarchical Plan Builder in Geshel used by the EP for specifying the procedural aspects of the guideline. In this case the root plan of the GL for treating pelvic inflammatory disease composed of three different sub-plans that should be performed in sequence.

4. Spock – Runtime application of Hybrid-Asbru clinical guidelines

DeGeL support runtime application of intermediate-represented Hybrid-Asbru GLs, with or without an available EMR, capitalizing on the DeGeL framework as a knowledge repository of machine-interpretable guidelines and on the IDAN architecture for access and sophisticated querying of heterogeneous clinical-data repositories. The new approach was implemented as the Spock system [10], which provides the necessary functionality to support the task of applying clinical guidelines at the point of care.

The Spock system's architecture includes the Spock engine responsible for the actual interpretation of the knowledge encoded in the intermediate-represented guidelines, and a Spock server, which provides remote services to store and retrieve the history of guideline applications from a GL application log repository, and remote external services, such as the DeGeL server's services for retrieving GL's knowledge.

The hybrid runtime application model of Spock allows the application of GLs in several scenarios implied by the level of representation of the currently applied GL, and by the availability of an effective electronically patient data. Each GL can be represented in more than one representation level, for example, a fully formal representation of the GL's abort-condition, and semi-structured text or semi-formal representations for the GL's plan-body.

Storing the GL application history is necessary to support the time spanning nature of the application process which is usually performed in an episodic fashion during patient's visit. The GL application log consists of detailed records for each session of the GL application. One major purpose of the application log is to allow resuming GL application which was previously paused. In order to enable GL application in a distributed environment, the GL application Log is stored in a repository which is located on a remote server which is available to all instances of the Spock client application. The application log may be used for other purposes, such as retrospective quality assessment of the medical care.

5. Summary

In this extended abstract we have presented the DeGeL framework, which we have developed in order to support the specification, storage, search, retrieval, and application of automated clinical guidelines for medical care, research, and quality assessment. We have focused on the major components of the framework; The GL library server, the GL specification module, and the GL runtime application. We have also presented our hybrid model for representing GL knowledge at several co-existent levels of representation, and the methodology that we propose, as well as its main participants, for the GL specification process. In future research, we intend to further improve the integration of the procedural and declarative elements of the GL knowledge, an integration that is crucial for obtaining high quality formal representation and thus for GL application and sharing. We also intend to continue evaluating the framework and its components with the collaboration of physicians in several medical domains.

Reference to previous publication of this research:

- Hatsek A, Shahar Y, et al (2006). "Demonstration of DeGeL: A Clinical-Guidelines Library and Automated Guideline-Support Tools", Proceeding of AI Techniques in Healthcare: Evidence-based Guidelines and Protocols, ECAI 2006, Riva del Garda, Italy.