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Toward an adaptive computer-interpretable clinical guideline for personalization of treatments

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Abstract: **Computer-Interpretable Clinical Guidelines (CIGs) are Clinical Guidelines expressed with computer-interpretable languages. This paper presents the iCareflow framework, which proposes to constraint CIGs with external data in order to personalize medical treatment plans.**

Introduction

Clinical Guidelines (CGs) are recommendations on the appropriate plans for treatment and care of patients with specific diseases and conditions. They are developed based on the best available evidences and are used to make clinical decisions and medical actions more effective. The aims of CGs are to reduce interpractice variations and costs, to develop standardize clinical procedures, to assess healthcare professionals, to educate and training caregivers and to improve the communication between patient and caregivers [1]. The weaknesses of CGs are that they are defined based on: (i) Ideal patients. Patients that have “just the single” disease considered in the CG, and are “statistically relevant”, not presenting rare peculiarities/side-effects. (ii) Ideal physicians executing the CG. Physicians, having the basic medical knowledge, properly applying the CGs to specific patients. (iii) Ideal context of execution. All necessary resources are available. In reality, the patients’ reactions to treatments are different and some customizations are necessary in order to improve the quality of care. These customizations are either based on the experience of the care providers and on the set of data that care providers have access.

The Information and Communication Technologies (ICT) has been used to improve this scenario by promoting the deployment of CGs and integrating a subset of information from CGs into the Decision Support

Systems (DSS) used by Practices Medical Systems (PMS). According to [2], "*ICT have a tremendous potential to improve the quality of health care, to change the paradigms inherent to medical practice as well as the bases underlying the development and usage of knowledge*". However, the information contained in the CGs is still expressed for human interpretation. Some works propose computer-interpretable languages to express CGs, as shown in [3], in order to build computer-interpretable guidelines (CIGs). But, the methodology to build CIGs are not the same and the quality of the CIGs can change according to authors' methodology.

This paper aims at showing the impact of authors' methodology over the computer interpretation of CIGs and at presenting the outcomes of our works to deal with actions description and multiple constraints integration.

The iCareflow Framework

The iCareflow framework was proposed for refining CIGs into personalized careflows. It relies on the two most popular trends in eHealth, the *Evidence-Based Medicine* (EBM) and the *Patient-Centered Medicine (*PCM*)*, to obtain a treatment plan adapted to the patient needs.

The main difference between EBM and PCM is that the former searches for standardizing procedures based on observation and generalization. The last focuses on the individual's characteristics and on the potential heterogeneity of patients (or institutions or geographical regions) for customizing care actions. Both approaches are used in a complementary way. For instance, a set of CIGs is selected by a healthcare professional (HP) as the general knowledge used to compose a treatment plan. Then, applying specific knowledge (i.e., information about the health state and preferences of patients, hospital procedures, etc.) the HP adapt the treatment plan to get a personalized one. This process can be supported by IT systems, even though the validation of the resulting treatment plan by the HP is mandatory.

The general idea of this approach is illustrated in Fig. 1, and detailed in [4]. In the left side, a set of actors that participate to the definition and to the customisation of the CIG are represented, and their roles in the process. In the right side, the data sources and the steps needed to customize the CIG are indicated. At this point, the quality of the CIG is supposed to be good and only the customisation process is illustrated. The CIG is supposed to be validated by a standard organization or committee. This CIG is described in a specific language according to a specification approach.

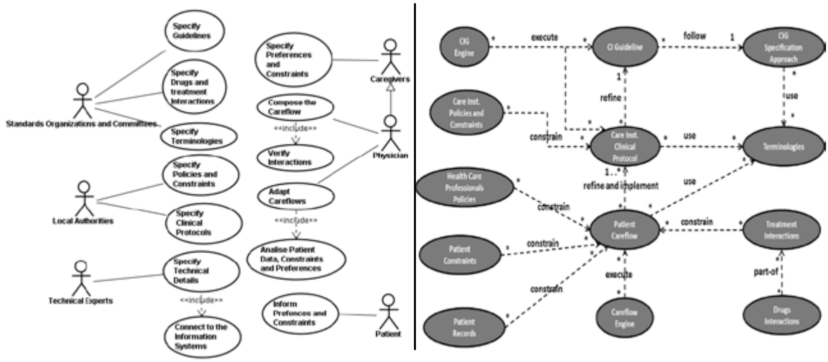

Figure 1: iCareflow framework

The terminology used in the CIG is supposed to be based on standard ones (e.g., ICD10, SNOMED, etc.). Any information that is not directly related to the disease is not included in the CIG. However, this information can be considered during the customization process if they are defined by one of the other actors. For instance, during the period of July to December 2009, all cases of flu were considered as potentially dangerous in Luxembourg and the analysis to identify the H1N1 virus was often requested. This was not included into the CIG describing the treatment of the flu, but it was a local information sent by local authorities to concerned physicians. In the iCareflow approach, the constraint (check if the flu virus is the H1N1) can be included in the customization process without modifying the content of the CIG. This is also valid for patients' will (e.g., blood transfusion) or caregivers' preferences.

One of the main challenges of this approach is to harmonize and combine the information coming from different sources. We are working on a description-language independent approach. Thus, several data sources are considered (e.g., CIG editors, local constraints editors, PMS, hospital information systems, etc.). Even if each of them can have different structures and are expressed in natural language, we are formalizing their content using standards like UMLS and HL7/RIM, and Semantic Web technologies. The overall framework is decomposed into two modules: one to transform the input information (care actions) into a format based on HL7/RIM standard; the output of the first module is an ontology used by the second module to constraint the CIG. The rules used to constraint the CIG are expressed in SWRL, and the result of this module is the personalized CIG. The main advantage of this approach is that several CIGs can be evaluated in parallel during the treatment customization, and external constraints can also been considered.

The current state of this work is the implementation of two supporting tools (called MedAForm and CPS), used to evaluate/validate the modules. A set of CIGs were imported from the Tallis Composer Web Repository (http://www.cossac.org/tallis) and has been used in the evaluation process. The main problems founded are related to the quality of the contents. Some samples of it are presented in table 1.

Table 1

CIG Name	Action description	Action Name
Aspirin V1	If sure of dose ingested patient may be medically discharged (consider psychiatric assessment). If in any doubt confirm with salicylate levels.	Discharge_patient
Paracetanol	Start treatment with IV N-acetylcysteine (Parvolex) as directed in the BNF. Take blood for paracetamol levels and baseline INR, LFTs, creatinine and venous bicarbonate (if bicarbonate abnormal, check arterial blood gases).	Treat

In the same element of the CIG (e.g. actions) we can find, mixed in the same sentence, conditions, explanations or a set of complex procedures. This misuse of the tools can be avoided if a standard description methodology is defined, supporting the correct transcription of the CGs into CIGs.

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