MUDRLite Components Usage for Sharing EHR Data in Dental Medicine

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Abstract:

Several partners from academy as well as from industry are joined within the project Information Technologies for Shared Health Care in order to cooperate on new approaches to the electronic health record design with the main goal of solving various problematic issues connected with sharing medical data among heterogeneous hospital information systems (HIS) and electronic health record (EHR) applications. Together they are preparing solutions to model various EHRs and HISs using worldwide-used standards, based mainly on the HL7 version 3 specification; however, taking into account the specifics of the environment in the Czech Republic. Cardiology is chosen as the main pilot field to test these solutions; nevertheless, in order to prove that they are independent on the application area we are also trying to apply it to dental medicine. A pilot application chosen to test this approach in dental medicine is the MUDRLite universal EHR system that provides interfaces to include user-defined components or modules. These interfaces enable to develop and integrate special components to share data of this EHR application among other systems based on a defined EHR communication standard. Moreover, these interfaces are universal and thus they were used to integrate a high-advanced component representing the dental cross, which is a crucial part of medical documentation in dental medicine. This component is described in the paper more in detail.

Keywords: electronic health record, dental medicine, dental cross

Introduction

Currently, possibilities of integrating and sharing medical data from various sources are very poor although most hospitals have an electronic form of health records integrated into their hospital or clinical information systems. The crucial problem is that these systems are often more suitable for the hospital management than for physicians, the clinical part is not structured enough and the set of collected attributes is fixed and practically impossible to be extended. Moreover, current electronic health record standards lack sufficient depth to enable communicating the content of the health record in a structured form.

In order to support a shared health care several partners from academy as well as from industry joined within the project *Information Technologies for Shared Health Care* to cooperate on new approaches to the electronic health record with the main goal of solving various problematic issues connected with sharing medical data among heterogeneous electronic health record (EHR) applications and hospital information systems (HIS). Collectively they are preparing solutions to model various EHRs and HISs using mainly the *HL7 version 3* specification; however, taking into account the specifics of the environment in the Czech Republic. Cardiology is chosen as the main pilot field to test these solutions; nevertheless, in order to prove that they are independent on the application area we are also trying to apply them on completely different health data originating in dental medicine.

The participation in European projects as well as the CEN TC 251 [1] standards and the cooperation with physicians had produced much experience, which helped to develop a pilot EHR system called MUDR (*MUltimedia Distributed Record*) [2], [3]. It is based on the three-tier architecture with a unique data-storing approach based on *knowledge base* and *data-file* principles. Within MUDR development an extra branch was separated simplifying both the MUDR architecture and the MUDR data-storing principles. It creates the *MUDRLite EHR* [4] application, which can be effortless deployed to a particular environment. The MUDRLite application is chosen to verify the approach of sharing health care data in the dental medicine area.

Materials and Methods

The MUDRLite architecture is based on two tiers. The first one is a relational database (e.g. MS SQL) and the second one is a *MUDRLite User Interface* (MUDRLite UI). The database schema corresponds to particular needs and varies therefore in different environments, as opposed to the fixed database schema in the MUDR data layer. Thus, a basic way to share the health care data is to use this client-server architecture, install more user interfaces and access the data in a common database. However, this is not the issue we are currently concerned, because it would share data just in a single environment within homogenous applications. What we would like to support is a sharable electronic health record among various heterogeneous applications based on standards defined to communicate the structured contents of EHR.

The core of MUDRLite – *MUDRLite Interpreter* – is able to handle varied database schemas. This feature often simplifies the way of importing old data stored with other databases or files. The visual aspects as well as the behavior of the MUDRLite UI are completely described by an XML configuration file. The end-user can see a set of forms with various controls placed on them by appropriate XML elements. MUDRLite operates as a kind of commands' interpreter; it processes the instructions encoded in *MLL Language* as described in [4] and manipulates the database layer as well as the visual aspects of the MUDRLite UI.

As the set of predefined controls is limited MUDRLite provides interfaces to include user-defined controls and components. These interfaces can be used to offer graphically and functionally advanced components as well as new features, e.g. an advanced security policy, integration with other existing information systems, or sharing of electronic health data based on standardized EHR communications.

If such a user-defined component is trusted it gets the access to the structured electronic health record. However, this access can be prohibited or limited by MUDRLite Interpreter for security reasons in accordance to a defined security policy. Anyway, the MUDRLite Interpreter may be able to monitor the access and create a record concerning all the R/W actions. By virtue of the interfaces a trusted component can access the data in the electronic health record and thus it serve as a kind of "intelligent proxy" implementing a standardized EHR communication. This is the way we are going to use to share the health care data in dental medicine. More about modeling an electronic health record can be found in other articles in these proceedings. However, in order to start sharing dental data we need to get them in a well structured form. To collect them in this way and to gain the user-acceptance in the field of dental medicine we have developed a high-advanced component representing the dental cross, which is a crucial part of healthcare documentation in dental medicine. Its development was motivated by clinical practice in the dental medicine domain. The *DentCross* component was included dynamically by means of the mentioned interfaces.

Information storage in dental medicine is basically in the form of free-text-based documentation. In this case, data structuring is on a relatively low level and it is given by the filling characteristics of preprinted forms, which include more or less standardized symbols (e.g. "/" for caries, "-" for pulpitis, or "x" for a tooth to be extracted). Symbols are placed in the section corresponding to a particular tooth. Disadvantages of using such a system are the loss of detailed information on the localization, the size and the character of hard dental tissues defects. Structuring of further information on an oral cavity is not very high, information concerning changes of oral cavity mucosa, periodontitis, orthodontic anomalies, preventive oncological examinations, etc. are described in a limited space of one line of the form or together as other findings in the form of a free text.

On the basis of commercially available software products analyses we have found out that the application of these systems in the clinical practice is fairly limited, the health record is not structured sufficiently, it contains a lot of a free text and a set of collected and structured attributes is poor, practically without possibilities of any extension. Further analyses in the Industrial Property Office showed that not even among given patents and industrial models there are no suitable technologies for keeping electronic health documentation in the field of dental medicine. A survey showed only two relevant objects of industrial protection: the industrial model *Dental Cross Graphic Scheme*, the registration number in the Czech Republic is 25297 (no. 24791 in the Slovak Republic), whose proprietor is Dialog MIS, Ltd., Prague

and the patent *Method for Displaying Dental Related Information, its Display Unit and Treatment Assistance Unit*, the registration number JP10229993, whose owner is Daryl Raymond Beech, Morita MFG, Japan. The industrial model of the Dental Cross Graphic Scheme protects the dental cross graphic modification implemented in the PC DENT application that combines advantages of dentition graphic illustration with automated generation of an examination plan. The Japanese patent protects automatisms by which a dentist enters a proposal or a treatment technique in the graphic dental cross by a keyboard. Neither of these documents and applications overlaps the approach that we have used for the DentCross component development.

The DentCross component is implemented as a stand-alone library DentCross.dll that was completely developed for the .NET Framework platform using the Microsoft Visual Studio .NET 2003 development tool. For the end user the DentCross component looks like a kind of a dental panoramic tomograph. This component is fully interactive and enables to record full structured dental medicine information that can be inserted user-friendly by mouse or keyboard. A dentist can choose among about 60 different actions, treatment procedures or tooth parameters that are displayed graphically and lucidly.

All the features of the component are above the scope of this article, so let us mention just some of them. The component can represent various forms and shapes of a tooth, e.g. permanent vs. deciduous tooth, various genetic diseases affecting the form of a tooth, it can precisely store the exact position of a tooth in two coordinates, it can distinguished various types of caries and filling materials, it can describe, store and graphically depict a root canal treatment, it can record an agenesis of a tooth, it can store unerupted teeth, it can store and depict various pulpal and periodontal problems, e.g. pulpitis, necrosis, periodontitis, chronic periodontal abscess, it graphically distinguishes among various crowns, e.g. full-metal crown, metal-ceramic crown, all-ceramic crown, it supports even partial veneer crowns, e.g. half-crowns and three-quarter crowns, it supports various types of bridges, various intracoronal restorations with a range of materials, it supports post and core, implants, dentures, dentoalveolar surgeries and pericoronitis, it stores the Papilla Bleeding Index and much more, while new features are still being added within a new – even extended – version development.

The data specification of this component determines the data model of the component in the relationship to the MUDRLite Interpreter and the MUDRLite database layer. This model originates from a logical data model that we have designed in close co-operation within the EuroMISE Centre. In total, it describes about 30 independent entities with more than 160 attributes. Together with these colleagues we have further generalized this model to the *Dental-Medicine Data Structuring Technology Using a Dental Cross*. Recently, this technology was applied for a Czech national patent under the No. PV 2005-229.

Results and Conclusions

Within our research and development our aim was to keep on the already initiated cooperation in the research field of structuring of dental medicine health documentation. The main goals were to setup new technologies and to develop software tools to help with the data structuring in the dental medicine field as an essential basis for sharing of structured data among heterogeneous information systems in medicine. For these purposes MUDRLite disposes of interfaces enabling to connect graphic and high advanced functional components. The DentCross component was designed and is nowadays being evaluated and fine-tuned by cooperating computer scientists and physicians. It has verified the component itself as well as the mentioned MUDRLite interfaces. The collectively developed technology of information structuring the field of dental medicine by the dental cross gives the possibility of advanced electronic health documentation application in this field. Accomplished analyses of the current state of commercially available software products and patent technologies suggest that the software support of keeping health documentation is on a relatively low level. The primary motivation why we have started this research and development was that we believe that it can be increased significantly by implementation of interactive graphic dental cross components. This advanced form of health documentation will lead to an easier and more complex treatment plan based on the bigger amount of relevant information, which is concentrated transparently in the dental cross. The assumption is that this is the way to bring benefit for the patient as well as it has the potential to reduce the expenditure for dental health care by means of sharing structured electronic health record and thus reduce the amount of needlessly repeated examinations.

Acknowledgments

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References

[1] CEN TC/251: European Standardization of Health Informatics, prEN13606, Electronic Health Record Communication.

[2] Hanzlíček P., Špidlen J., Nagy M. 'Universal Electronic Health Record MUDR', in Duplaga M. at al. (eds.): Transformation of Healthcare with Information Technologies, Amsterdam, IOS Press (2004), pp. 190-201.

[3] Hanzlíček P., Špidlen J., Heroutová H., NAGY M.: User Interface of MUDR Electronic Health Record, in Baud R. at al. (eds.), IJMI Vol. 74, Issues 2-4 (2005), pp. 221-227.

[4] Špidlen J., Hanzlíček P., Zvárová J.: MUDRLite – Health Record Tailored to Your Particular Needs, in Duplaga M. at al. (eds.): Transformation of Healthcare with Information Technologies, Amsterdam, IOS Press (2004), pp. 202-209.