Computerized decision support systems for breast cancer management: project design.

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Abstract

Currently, international clinical guidelines (CG), provide an evidence-based knowledge approach to the management of breast cancer. However, CG reported in the state-of-the-art neither address the uncertainty in decision making related to the applicability of trials to individual patients nor the uncertainty due to patient preferences on outcomes and treatment risks. For these reasons computerized decision support systems (CDSS) incorporate predictive models for diagnosis, treatment and outcomes in the breast cancer management workflow, providing a unified framework for uncertainty management in clinical guidelines. These predictive models would provide adjuvant evidence to the stakeholders in specific questions of special relevance during the decision-making process in the management of breast cancer, ultimately allowing effective communication of risk and patient preference's elicitation. The purpose of this project is to assess the clinical impact of CDSS on breast cancer diagnosis and treatment.

1. Introduction

Currently, many companies, mainly from United States and the European Union had developed several Health-care supportive tools. The observed fact that identical clinical problems are addressed differently by different physicians, give the observer subjectivity and the different degree of uncertainty that characterizes their professional practice. This has led to focus in the development and implementation of clinical practice guidelines (CG), considered as documents containing guidelines developed systematically to assist clinicians and patients in making decisions about appropriate health care for clinical problems.

The Electronic Clinical Guidelines (ECG) have emerged in the recent years in order to model medical knowledge in a interpretable format by computer systems to support clinicians in alignment with the knowledge of CG and to maximize the benefits associated with its use. This allows:

i) to implement the ECG for the patient care regardless of the health center which offers assistance.

ii) to assist clinicians to make decisions based on evidence and provide recommendations;

iii) to automatically collect all the necessary and relevant information about the patient.

To make sure the decision system is always updated, a mechanism for updating medical knowledge needs to be done. Fernández-Breis *et al*. [2] performed the partial

implementation of the National Comprehensive Cancer Network for the noninvasive treatment of breast cancer by means of acquisition and maintenance of knowledge based on multiple classification ripples down rules. However, this system is far from providing automatic support changing knowledge.

2. Material and methods

In our design, rules upgrades automatically are presented to those responsible for the medical services involved (mainly the head of the Unit of Breast Cancer) with two purposes:

1) Validation of the new update, which would entail the replacement of the old rules by the date.

2) Support the annual review of the care process, as the update of the rules compared to the former, which facilitates the observation of the changes observed during the last period of the assistance process.

The rule-based knowledge is the closest module to clinicians. Unfortunately, rule-based knowledge is a static tool. Once these rules are established, they will not change until a professional make the change. This is not adaptive at all to new changes or evidences. That is the reason why we considered adding the data mining approach. The application of data mining algorithms can obtain rules and decision trees from data obtained from previous records.

At the technological level, we may also mention that the semantic web in general and in particular the ontology, are important elements to achieve semantic interoperability that allows better use of clinical knowledge. The ontology's representation and terminology archetypes [1] allow uniform and combined treatment of the key elements for achieving

semantic interoperability. The specification of clinical information using archetypes is a key to the interoperability of health systems, as manifested in the recent recommendations of the report of the European project Semantic Health 2009 [10]. In addition to interoperability in the exchange, the archetypes are being investigated in combination with formal ontology.

At present time, the market provides partial solutions and integrates some of the functions of a support system for breast cancer treatment, although they fail to provide a global open platform for the multiple medical problems.

3. Architecture

The advantages of the designed system are:

i) Easy installation and configuration on various platforms: Unix, Linux and Windows.

ii) The use of design patterns to build the platform that will host the solution,

adapted to most of the patterns and design best practices for Java2 Enterprise Edition (J2EE) applications and architectures. These patterns provide important advantages in terms of adaptability, maturity and longevity of the applications, which allows more easily maintained, extended or reused.

iii) It is extensible and modular, allowing easy integration of new components in J2EE runtime environment and new plug-in integrated development environment.

It is based on various components of free software (Jboss [5], Struts 2.0 [11], Jquery [6], Hibernate [3], etc…) that have excellent quality and functionality, which enables to participate in mission-critical applications.

iv) It incorporates components and / or mechanisms to facilitate integration with other

systems (security, communications, Reporting tools, etc..).

v) The use of Software Development Frameworks as RichFaces [9], ICEfaces [4] etc…

vi) The use of data mining and process mining software like Weka [12] and Prom [8], as well as a rule based knowledge platform like OpenCDS [7].

The designed software will be validated using one hundred consecutive patients diagnosed with breast cancer and treated between January 2012 and April 2012 at University Hospital Virgen del Rocío (Seville, Spain). This series will be analyzed retrospectively to determine treatment and diagnosis methods. The proposed CDSS, developed by the Virgen del Rocío Technological Innovation Group, in Seville, and based on international CG (National comprehensive cancer network and National institute for health and clinical excellence), will be used to assess the diagnosis and treatment for the selected patients. The results will be compared with those reported in the medical records.

4. Conclusions

Our findings will potentially provide beneficial outcomes by reducing regional variability.

i) [Nationally] The project is articulated between entities in different Spanish regions, which allows spatial diversity, sharing and extending the knowledge and technology among different geographical areas: Madrid, Andalusia, Catalonia, Valencia and the Balearic Islands.

ii) [Internationally] Additionally, the adoption of international standards and international projection of the institutions belonging to the Consortium promotes the convergence of technologies and research in Spain and the international framework.

The predictive model will also facilitate the transition from a conventional CDSS to a dynamic framework where the new knowledge is continuously generated.

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