Integrating Data from EHRs to Enhance Clinical Decsion Making: the Inflammatory Bowel Disease Case

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Abstract

Recent years have witnessed a constant growth of using electronic health records resulting in the availability of enormous amounts of patient information. Clinicians are unable to use this information effectively because of the lack of interoperability and standardization between systems as well as the overwhelming amount of irrelevant information. In this study, we propose a framework to support clinicians decision making by integrating data from different EHR systems in a common data warehouse and applying data mining techniques to retrieve useful knowledge from patients data. This knowledge is then integrated with clinical guidelines in clinical decision support systems to facilitate decision making. Our framework will enhance the use of patients data in decision making and to encourage the use of clinical guidelines and evidence based medicine.

Keywords: Knowledgebase; Integration; CDSS; EHR; Healthcare analytics; Data mining; IBD.

1 Introduction

In healthcare, the use of electronic health records (EHRs) has been widely adopted. This adoption was encouraged by the evident benefits of EHR in enhancing quality of care and reducing cost and medical errors. The use of EHR systems resulted in gigantic amount of patient information estimated to be five hundred petabytes in 2012 [1]. Theoretically, these data should inform clinicians decisions and enhance the use of evidence based medicine. Practically, however, clinicians find it difficult to retrieve the information they need for decision making. This difficulty arises from several factors including: (1) EHR systems have a lot of patient information and not all of this information is useful, therefore, clinicians are overwhelmed by information they do not need; (2) Patient data are usually scattered across multiple EHR systems used by different vendors. These systems lack interoperability and communications, due to lack of standardization and infrastructure, making it extremely difficult for clinicians to have access to all the data they need [2]. In this paper, we propose a solution for the problems of scattered patient data across different EHR systems and the gigantic amount of useless data that may impede the decision taking quality by providing a framework for integrating disease specific data from different EHR sources into a single data repository, applying data mining techniques on these data to create useful domain related knowledge, and integrating this knowledge with clinical guidelines and standards by using CDSS to enhance patient care. We aim at developing an initial design for such a framework for inflammatory bowel disease (IBD) and demonstrating its potential benefits which include: (1) evaluation of current clinical practice with respect to current clinical practice guidelines (CPGs); (2) evaluation of clinical data to identify predictors of clinical outcomes; (3) development of clinical decision support systems (CDSS); (4) identification of practice gaps that need to be met by new prospective research studies or amended CPGs; and (5) identification of regional and national variations in the epidemiology and management of specific diseases.

2 Background

The Division of Gastroenterology & the Farncombe Family Digestive Health Research Institute at McMaster University has implemented an ambulatory care clinic for patients with IBD funded by an innovation grant from the Hamilton Academic Health Services Organization (HAHSO) for the period July 2009 to June 2011. This novel specialty clinic incorporates a multidisciplinary clinic, with multiple healthcare specialties, as well as routine IBD care and is centered on the implementation of OSCAR (an open source EHR) [3]. To date, over 1,000

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patients have been enrolled in the clinical study, which has a roster of 6 gastroenterology specialists with the prospect of including another 12-14 gastroenterologists and their patients. This clinic has also established links with other gastroenterologists in the region (Local Health Integration Network LHIN), with the prospect that other specialists will join the group and contribute to the database. In this study, data will be retrieved from multiple clinics using different instances of EHR systems and collected in a centered warehouse hosted by the ambulatory IBD clinic.

3 Technologies in the proposed framework

In order to implement the proposed framework, we need to use a number of technologies such as data mining, EHR systems, and CDSS systems. We also need to manage some issues related to the use of this framework especially patient privacy and information security.

4 Case Study

In this case study, we walk through the different steps needed to generate and use IBD related knowledge. This case aims at showing the feasibility of a system that utilizes our proposed framework. For this case study, we assume the use of OSCAR EHR system [4].

First, patient data are logged into OSCAR. These data can come from different sources such as clinicians notes, diagnosis, patient entered data through MyOscar personal health record (PHR) system [3], and body sensors logging patients vital signs and symptoms. Next, IBD related Data from OSCAR database is mapped into the IBD specialized data center which is developed and structured to facilitate IBD data mining. This mapping is done using an HL7 integrator that also anonymizes patients data for privacy requirements. Once the data is in the IBD data center, exploratory analytical techniques are applied to this data in order to find useful patterns. These techniques are based on IBD physicians input, literature, and existing guidelines to identify possible relationships between different components of patients data. Following the exploratory techniques, predictive methods (e.g., logistic regression or neural networks) are used to predict future patient outcome and possibly facilitate the diagnosis of IBD which is currently difficult and costly. The knowledge generated by the various analytical techniques is stored and then disseminated to IBD centers using HL7 v3 messaging standards. This knowledge is integrated with guidelines into CDSS at IBD centers using PMML [4]. When a patient approaches to one of these centers, her information is matched with CDSS rules using data matching and natural language processing (NLP) techniques either to predict future flares, classify the patient condition, or suggest a treatment path. One of the benefits of the specialized knowledge integration with CDSS is that physicians will only interact with IBD related data without having to go through pages of unrelated information. This will enhance the efficiency of the decision making process and will likely improve patient satisfaction and quality of life.

5 Discussion and conclusion

In this paper we described a solution for the problem of fragmented patient data found across different EHR systems. Such fragmented data will often limit the ability of care providers, who are the primary users of these data, to effectively apply these data to enhance patient care and safety. Accordingly, we proposed building a specialized data centre that would source and accumulate data from different patient-related systems. This would eventually build a repository of patient data that can be used meaningfully by clinicians. To further enhance the utility and functionality of this data centre, we emphasize the application of data analytics techniques to cluster patient data into more meaningful and related groupings so as to permit the retrieval of established and useful patterns as well as embedding and integrating these patterns into a CDSS system to enhance physicians decision making and patients treatment. Future work includes adding more data sources to the system such as genomic data which have been proposed to influence IBD [5]. The system can also be extended by enabling two way communications between the system and patients. In this case, the system will not only receive data from patients, but it can automatically send medical advice to patients based on the evaluation of their condition.

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