INTERNATIONAL JOURNAL OF MEDICAL INFORMATICS 79 (2010) 611–622

journal homepage: www.intl.elsevierhealth.com/journals/ijmi

Design and implementation of a standards-based interoperable clinical decision support architecture in the context of the Korean EHR

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ARTICLE INFO

Article history:
Received 4 December 2009
Received in revised form 5 June 2010
Accepted 5 June 2010

Keywords:
Clinical decision support systems
Electronic health records
System architecture
Systems integration
Knowledge bases

ABSTRACT

Background: In 2000 the Korean government initiated efforts to secure healthcare accessibility and efficiency anytime and anywhere via the nationwide healthcare information system by the end of 2010. According to the master plan, electronic health record (EHR) research and development projects were designed in 2005. One subproject was the design and implementation of standards-based interoperable clinical decision support (CDS) capabilities in the context of the EHR system.
Objective: The purpose of this study was to describe the challenges, process, and outcomes of defining and implementing a national CDS architecture to stimulate and motivate the widespread adoption of CDS services in Korea.
Methods: CDS requirements and design principles were established by conducting a selective literature review and a survey of clinicians, managers, and hospital and industrial health information technology engineers regarding issues related to CDS architectures. The previous relevant works of the American Medical Informatics Association, the Healthcare Information and Management Systems Society, and Health Level Seven were used to validate the scope and themes of the service architecture. The Arden Syntax, Standards-Based Sharable Active Guideline Environment, First DataBank, and SEBASTIAN approaches were used to assess the coverage of the application architecture thus defined. A CDS prototype of an outpatient hypertension management system was implemented and assessed in a simulated experimental setting to evaluate the feasibility of the proposed architecture.
Results: Four CDS service features were identified: knowledge application, knowledge management, audit and evaluation, and CDS and knowledge governance. Five core components of CDS application architecture were also identified: knowledge-execution component, knowledge-authoring component, data-interface component, knowledge repository, and service-interface component. The coverage and characteristics of the architecture identified herein were found to be comparable with those described previously. Two scenarios of deployment architecture were identified in the context of Korean healthcare. The preliminary feasibility test revealed that the architecture exhibited good performance and made it easy to integrate patient data.

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1386-5056/$ – see front matter
doi:10.1016/j.ijmedinf.2010.06.002

We have described the efforts that have been made to realize CDS service features, core components, application, and deployment architectures in the context of the Korean EHR. These outcomes showed the potential to contribute to the adoption of CDS at the national level.

1. Introduction

Clinical decision support (CDS) is not only a good idea but also an essential and core function of electronic health records (EHRs). The current widespread use of EHRs emphasizes the potential for improving the quality of healthcare by providing timely access to patients' health information, tracking patients over time to ensure that they receive guideline-recommended care, and offering decision support mechanisms to reduce treatment errors. Institute of Medicine reports published in 2001 and 2003 strongly recommended the development of automated information systems that provide clinicians with immediate access to CDS tools [1,2]. One recent statewide survey in the United States concluded that to improve the quality of care, it is not sufficient to simply implement an EHR; rather, this tool needs to be coupled with other systems, such as decision support [3].

Several studies have demonstrated that decision support delivered via EHRs can improve the quality of care, especially in specific domains such as preventive care and the care of certain chronic conditions. However, there has been limited adoption of effective CDS capabilities, including in the United States [4]. Zhou et al. [3] reported that the usage of decision support among EHR users was quite low, at only 23.5% in 2005, compared to its availability, which was 65.0% among those with an EHR. Greenes [4] pointed out the difficulties of implementing robust and sustainable CDS services from a long-term maintenance and update perspective, which relate to (1) frequent changes in the knowledge assets underlying CDS, (2) the various forms used to represent the knowledge, and (3) the lack of tools to support the sharing and leveraging of medical knowledge.

Korea has had more than 20 years of experience in health information technology (HIT), but only a few tertiary teaching hospitals utilize home-grown CDS services [5,6]. These systems are embedded in a computerized physician order entry (CPOE) and/or an electronic medical record (EMR, an institutional EHR) system that is ultimately customized and highly dependent on the specific applications, which makes it difficult to share CDS capabilities between applications and institutions. Moreover, there is a degree of redundancy in development cost and efforts, as well as limitations to those who are able to access hospital CDS services due to them having insufficient resources or experience in developing CDS systems (CDSSs). As a result, they do not even attempt to use the CDS services, and so relevant medical knowledge is not always available or used when making many healthcare decisions.

The Korean Ministry of Health and Welfare (MOHW) developed the master plan for National Healthcare Information and Communication Technology (NH-ICT) between 2000 and 2010. The vision of this program was to secure healthcare accessibility and efficiency anytime and anywhere via the nationwide healthcare information system by the end of 2010. Based on this program, a center of interoperable EHR (CiEHR) was established, which directed the long-term research and development plans to support the NH-ICT initiatives both technically and strategically [7]. We have worked to develop CDS service architecture and components in harmony with other EHR activities by defining an EHR architecture at the national level, developing a common clinical content model and healthcare terminologies, and identifying a health information exchange infrastructure under the vision of the CiEHR. The purpose of the present paper is to describe the process, challenges, and outcomes of defining the CDS architecture at the national level in order to stimulate and motivate the widespread adoption of CDS services in Korea. This process ultimately led to the implementation and evaluation of a prototype CDS service for hypertension management in ambulatory care settings. This process has been followed by several pilot demonstration projects in three hospitals in Seoul and the Gyeonggi province. These projects aimed at systematically assessing the feasibility of implementing the CDS architecture outside of the CiEHR, which could drive improvements in health outcomes and allow the process to be readily deployed in diverse healthcare settings.

2. Background

In 2005, Health Level Seven (HL7) initiated the Healthcare Services Specification Project (HSSP) together with the Object Management Group to standardize the functionality and interfaces of software services that are considered important to the healthcare industry. One of the HSSP services is a CDS service that uses patient data to make machine-interpretable inferences regarding patients. The HSSP CDS service project aims to define a common service interface to fulfill a core functional requirement shared by all CDSSs. The American Medical Informatics Association (AMIA) released "A Roadmap for National Action on Clinical Decision Support" [8] to realize the vision of a United States healthcare system in 2006. The report identified core pillars for realizing the promise of CDS. Kawamoto and Lobach [9] proposed a service-oriented architecture (SOA) framework based on the HSSP approach and AMIA recommendations, and identified core elements.