Research and Implementation of Regional Health Information System for Smart Healthcare

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Abstract:
Objective: This article discusses the development of medical information models by integrating the practice of smart medical information construction both at home and abroad, and accumulates a technology for building distributed, cross-domain smart medical models, and seeks feasible solutions.

Methods: Through the analysis of business requirements and status quo, using the UML Unified Modeling Language definition view, a model for smart medical information platform is established from various aspects to guide the design of the architecture and functional design.

Results: The smart medical information platform is the core system of regional healthcare informatization, and more intelligent medical and health services are new ideas for the development of medical informatization. The comprehensiveness, accuracy and timeliness of business data based on health records on the platform play a crucial role in the effective provision of medical and health services. In the entire “Smart Healthcare” building process, the use of Internet of Things technology to intelligently collect residents’ health data, build a smart medical information platform and electronic medical records resources database, health records resources database, medical professional knowledge base, to promote the integration of residents health card applications, to accelerate the construction of such projects as telemedicine, mobile medical care, appointment registration, health management, and smart community health services, to realize information sharing and exchange among departments of health and medical insurance, drug administration, family planning, public security, and civil affairs, and to establish cross-system cross-institutional regional health information system, relying on big data technology to conduct smart big data intelligence analysis, to allow residents to enjoy more convenient, efficient, high-quality, continuous medical services and health management, and to enhance residents’ sense of enjoying medical reform.

Keywords: smart healthcare, HL7RIM, access control, cross-domain

Health is the foundation for people’s all-round development. If the health of the people is not guaranteed, we will not be able to modernize and realize the great rejuvenation of the Chinese nation. Therefore, the level of medical care is related to the vital interests of the people and the long-term development of the country.

In order to solve the problems of the people’s difficulty in seeing a doctor and the difficulty in seeking medical care, and promote the reform of medical care, medical insurance, and medicine, in mid-2015, the General Office of the State Council issued the “Implementation Opinions on Pushing the Comprehensive Reform of County-level Public Hospitals Comprehensively” (hereinafter referred to as “opinions”). The “Opinions” pointed out that we must adhere to protecting the basics, strengthening the grass-roots level, and building a mechanism that will benefit and have fair access to the people as a starting point and point of departure to achieve a systematic, overall, and coordinated development of the reform.

The “Opinions” proposes strengthening the construction of health information. To establish a standard medical and health information system, it is imperative to promote the informatization of medical treatment, public health, medicine, medical insurance, and financial supervision, and establishing a practical and shared medical and health information system so as to achieve a unified, efficient, and interoperable public service information platform is the important task of the new medical reform.
In order to meet the development needs of our country’s health care, a regional health and medical information platform must be established. The regional health and medical information platform unifies health care and hygiene, including community health services\textsuperscript{[1]}, hospitals in the medical reform area, disease prevention and control, maternal and child health care, health management departments and other health information. The promotion of regional health informatization plays an important role in the sharing and integration of information between health care and health. It also plays an important role in realizing the interlinking of data resources in medical and health departments and the efficient and high-quality treatment of medical and health services.

Based on the above facts, this paper will focus on regional health information systems for smart healthcare ("Smart Healthcare" is about open standards for information, health information, electronic health records, information sharing, resource integration, and establishment of public health systems, etc.). In order to realize the mutual-communication of medical information, we will explore the establishment of a smart, standardized, top-down medical and health informatization strategy and framework, integrate medical and health services, operations, processes, and management, and develop new medical and health intelligence technologies.

1 Research sample

This paper discusses the construction of the regional health information system for "smart medical" in the medical and health industry as a research object, in order to seek a general solution and provide reference for the development of industry informatization.

2 Research methods

2.1 SOA Analysis and Design Method

For the characteristics of smart healthcare and the business goals of policy decision-making in the health industry, in accordance with the requirements of compliance, abstraction, and unity, under the framework of iterative and business-driven design principles, a service-oriented technology architecture (SOA) needs to be adopted\textsuperscript{[2]}.

2.2 J2EE Technology

This paper uses the typical three-tier architecture of J2EE B/S/S to divide the smart healthcare system into portal access layer, business process layer, service integration layer, data resource layer, and infrastructure layer. Therefore, developers who are responsible for each level only need to understand their own related technologies without having to know all the technologies, making the division of labor of the technicians more clear, and the business personnel only need to be responsible for the realization of the business logic, thereby reducing the technical personnel costs. Combined with the characteristics of the smart medical system business system, it is considered that the Rich Client architecture mode is mainly used in some tools and offline data acquisition functions, while other parts are recommended to adopt the B/S/S architecture mode. The J2EE-based B/S/S architecture is one of the most mainstream architectures today. It is characterized by zero client maintenance, strong extensibility, and cross-platform, and has been recognized in the industry.

2.3 Web Service Technology

Web Service uses a standardized application method, object-oriented, and uses many technologies such as XML, has excellent compatibility and versatility, and can do cross-platform operation, thus achieving distributed integration, using a more loosely coupled integration mode. This article adopts a Web Services development and application support platform based on the XML-based standardized interface. The Web Services used have the advantages of consistency, value preservation, and flexibility.

2.4 ESB Technology

The concept of an Enterprise Service Bus (ESB) which evolved from a service-oriented architecture (SOA). SOA describes an application integration model for IT infrastructure in which the soft component sets are coupled with a well-defined hierarchical structure. The ESB is a pre-assembled SOA implementation that includes the basic features required by the SOA layered objectives. The ESB technology has been developed in conjunction with related technologies such as Web Services, XML, and traditional
 middleware technologies. The current program uses the open source product OpenESB.

### 2.5 Message Middleware Technology

In order to adopt a loosely-coupled and flexible approach to integration, we use message-oriented middleware (MOM) to develop applications and communicate among related programs via middleware (MOM) to implement inter-asynchronous data transmission among applications based on storage and delivery. MOM tries to achieve that the technician does not need to know the details of remote procedure call (PRC) and network/communication protocols when the message is sent.

### 2.6 ETL Technology

Currently, the program adopts some function modules such as Kettle in the open source Pentaho to implement the ETL (Extraction—Transformation—Loading) function. Kettle designs ETL processes for data extraction and conversion, and then publishes ETL process script files to the Kettle-based J2EE projects. Eventually, Web operations are used to control the startup, shutdown, and operation monitoring of ETL scripts to achieve data extraction, conversion and loading.

### 2.7 XML Technology

XML technology can be widely stored and can be divided into the following three types according to its source:

The most basic source is an XML plain text document, which is the simplest. Or directly put the data into a file for storage, so that it is also very convenient to read; or be in the form of style information, and displayed in the browser; or use DOM interface programming, connect other applications. In order to further develop the convenience of various dynamic applications, the first source is used to expand. First, the data is managed in the database management system, and then the server-side applications are used for dynamic storage and retrieval. This approach is most effective for the most advanced application development based on three-tier structure.

Compared with the first two sources of data, the third category is more extensive and therefore requires specific treatment. The MIS system and the data exchange platform within the business department are connected through the data interface, but the data exchange between the business departments is usually in the form of a file. Therefore, the data sources we access using XML technology are mainly the first two. First, the XML data is parsed using the data interface, and the resulting data is generated as an XML-only text file, and second, it is transmitted through the data exchange platform.

### 2.8 PKI Technology

Public Key Infrastructure (PKI), which integrates software, hardware systems, and security policies, provides a complete security mechanism. Even if the user does not know the identity of the merchant, or when the same merchant has a lot of distribution, he can still communicate through the certificate (basis) and numerous trust relationships so as to continue e-commerce transactions.

### 3 Results and Discussion

#### 3.1 Overall Design and Implementation of the Platform

Through the SOA architecture technology, a smart medical information platform with a wide range of medical data centers and a centralized coverage is established. And this platform is based on electronic health records, and then readjusts and generates business applications that meet the national or regional health standards. The system finally generates an interconnected business collaboration network.

#### 3.2 Design and Implementation of Network Topology Architecture

After the establishment of the medical information private network, a special information network covering four levels of cities, districts, blocks, and communities will be established, and the residents will be able to interact through the Internet. In order to ensure the smooth flow of the network, it is recommended to adopt the following standards to configure the network: the network speed of arrival at health data centers and hospitals should not be less than 100 M, and the network speed of arrival at service agencies such as MCH, community health service centers (township hospitals), CDC, health supervision offices, should not be less than ten M, and the speed of reaching the village clinics or health clinics should not be less than 4M.

#### 3.3 Design and Implementation of Platform Service
3.3.1 Registration Services

For the smart medical information platform, the registration service is one of the most important services of the enterprise service bus (ESB) in the platform. One of its main tasks is to realize the business system on the connected and smart medical information platform. The registration function of the platform-based application support system provides the most basic guarantee for the system integration, interoperability and business collaboration of the smart medical information platform. The registration service supports the IHE ITI PIX related regulations, and personal registration services are used to meet the need for uniqueness identification of residents for various types of medical certificates such as identity cards, social insurance (medical insurance), new rural cooperative medical service, and medical service cards.

For business systems connected to smart medical information platforms, such as comprehensive business systems of medical institutions, public health business systems, and hospital information systems based on electronic medical records, information on these services (such as various business systems) is registered through the platform’s registration service. The provided service information and required service information are registered on the smart medical information platform and describe the business system through the WSDL language.

For application systems such as health file sharing services, two-way referral services, and other smart medical information platforms, the service information of these applications (such as the external service information and required service information) can be provided through the registration service of the platform, and registered on the smart medical information platform and described the business system through WSDL.

3.3.2 Health File Storage Service

Health file storage services include load data services (implementation components, one for File_ELs (file system EL service), one for DB_ELs (database EL service)), and primary key management for NIIE services (3E aims to give a unique system number). integrate data services and store health records services. This section presents data integration methods for prescription information, inspection and examination, electronic medical records, and health examinations based on registration service information.

3.3.3 Full Health Records Service

The full health records service is responsible for analyzing information from external resources, properly storing these data in a repository according to their status, and archiving, filing and updating health records, and responding to retrieve, aggregate, and return data in external health service in reverse.

3.3.4 Information Interface Service

Information interface services mainly include two types: communication bus services (supporting data storage services, business management, auxiliary decision-making, and underlying communication with basic business systems and data browsers. The main service components include message services and protocol services) and platform public services (services such as context management, application auditing, security management, and privacy protection included in software system management).

3.3.5 Data Exchange and Transformation of Medical Institutions

(1) Data acquisition content
(2) Hospital system reform
(3) Information Resource Directory Operation

3.3.6 Data Warehouse Services

The data warehouse can make supplementary decisions for NCMS or medical insurance management, clinical management and other types of business. At present, in addition to providing support for the above businesses, assistive decision making can also use data warehousing platforms to meet the needs of the public health monitoring business domain. The public health domain needs to support some processes to discover potential outbreaks of infectious diseases or to run other types of public health procedures through operational research and analysis.

3.3.7 Data Security and Privacy Services

The smart medical information platform adopts different data access strategies based on the privacy level of the health record data.
3.3.8 Health File Browser

The goal of building a health file browser is to implement a Web-based health file browsing page that is compatible with multiple types of doctor workstations, providing tools for cross-organizational information sharing access.

3.4 Design and Implementation of Information Acquisition and Exchange System

The information acquisition and exchange system will collect data from various data sources such as hospital health systems at various levels, and provide the necessary information to the smart medical information platform. Including data acquisition, data conversion, data upload, and data exchange with service bus, and data cleaning, conversion, modeling, dictionary comparison, release, data reporting quality control, configuration management system, authorization management, etc. of reporting information to meet the needs of data sharing services such as data collection and transmission, health file retrieval, and medical collaboration at all levels of medical institutions.

3.5 Design and Implementation of Data Quality Management Functions

First, the data is full, complete, and not missing; second, the data is the entity complete, referential integrity, and the retention domain intact; finally, the data is secure, auditable, protected from tampering/stealing/resetting, and not authorized access and store.

4 Conclusion

Choosing a regional health information system for “smart medicine” as the research topic, mainly because the medical and health informatization is one of the key tasks of China’s healthcare system reform, and it is also increasingly playing an important supporting role, just as the Vice Chairman of the National People’s Congress and former Minister of National Health Chen Zhu said “to use information to solve the difficult problems of medical reform.” The smart medical information platform is the core system of regional medical and health informatization, and more intelligent medical and health services are new ideas for the development of medical and health informatization. The comprehensiveness, accuracy and timeliness of business data based on health records on the platform play a crucial role in the effective provision of medical and health services. In the entire “Smart Healthcare” process, the use of Internet of Things technology to intelligently collect residents’ health data, build a smart medical information platform and electronic medical records resources database, health records resources database, medical professional knowledge base, promote the integration of residents health card applications, to accelerate the construction of such projects as telemedicine, mobile medical care, appointment registration, health management, and smart community health services, to realize information sharing and exchange among departments of health and medical insurance, drug administration, family planning, public security, and civil affairs, and to establish cross-system cross-institutional regional health information. The system, relying on big data technology to conduct smart big data intelligence analysis, allows residents to enjoy more convenient, efficient, high-quality, continuous medical services and health management, and enhance residents’ sense of enjoying medical reform.

This paper focuses on the establishment of residents’ health records model as the main research object, and combines the current development trend of medical and health informatization, and puts forward the specific implementation path of the smart medical information platform (system).

First of all, the paper has studied the domestic and foreign medical informatization practical experience and the current status of smart medical technology, and compared its advantages and disadvantages. At the same time, the relevant technical principles involved in the paper’s research are discussed, including smart medical technology, cross-domain access principles and distributed systems. These efforts are mainly to seek solutions based on the research objectives and to make technical preparations for the design of cross-domain smart medical models.

Secondly, the paper analyzes the current status of the medical industry, uses the RIM unified modeling language to model from the business model, system requirements, and system architecture, extracts a distributed, crossdomain smart medical model, and proposes the goals of the model:
In the cross-domain environment, the existing application systems are integrated to realize the unified management of all kinds of medical and health business information by the smart medical system at the minimum cost of transformation.

Finally, according to the requirements of the smart medical regional information system platform, the correctness and feasibility of the model are verified. Through the function test and performance test of the system, it shows that the system meets the design requirements in both function and performance. During the operation, the system showed good security and stability, and user satisfaction also improved. This shows that the construction of a smart medical regional information platform is entirely feasible.

References


