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Smart Health Examination Analysis System Based on Medical Knowledge-Base Engine

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ABSTRACT:

At this stage, most physical examination centers have installed health examination information systems, which can print physical examination reports by computer, but only stay in the summary of abnormal indicators (most of them are obscure medical data and descriptions). Influenced by the division of departments, doctors only provide simple and general diet and exercise advice. In order to solve the above problems, we conduct in-depth mining on the physical examination data of the health examination population according to the theoretical system of health management, transform the physical examination data into health information that meets the needs of health management services, and provide services for health management strategies such as health status evaluation, health education, health monitoring, and health consultation for the physical examination institutions. It plays a key role in improving the evaluation quality of physical examination, providing personalized physical examination reports, and extending health management services for health examination institutions.

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I. INTRODUCTION

The knowledge engine based physical examination analysis systemuses modern information technology and relies on leading physical therapy and health care research institutions at home and abroad. Famous medical experts in Zhejiang Province of China were invited to serve as an expert advisory group to provide medical institutions with overall solutions for value-added health examination services such as health examination software, electronic health files, assessment of physical examination results, disease risk prediction, health consultation, and dynamic disease tracking and intervention [1]. With domestic medical experts as the project leader, physical examination analysis systemprovides enterprises and institutions with health management services such as pressure management, health electronic information management, and enterprise health consultants.

Health management service has a history of 20 to 30 years in western countries [2-4], and is gradually changing the original medical service model. It reduces medical expenses by 30% for individuals participating in the health management plan, and effectively reduces health risks. Health management is based on the information technology platform to establish value-added medical care services, and will strive to change the service mode oflack of confidence and lack of interaction in today's traditional Chinese medical care customer relations. It provides a feasible direction for the healthy development of health management in China.

In order to solve the above problems, the Smart Health Examination Analysis System (*SHEAS*) based on the knowledge engine aims at the physical examination data of the health examination population. In accordance with the theoretical system of health management, in-depth mining will be carried out to transform physical examination data into health information that meets the needs of health management services. *SHEAS*provides services for physical examination institutions to carry out health management strategies such as health assessment [5], health education [6], health monitoring [7] and health consultation [8]. It plays a key role in improving the evaluation quality of physical examination, providing personalized physical examination reports, and extending health management services for health examination institutions.
In the past, physical examination was considered as a welfare and a necessary procedure by customers for a long

time. The examination items are mostly set for special physical examination groups, such as enrollment, military participation, job search, retirees, etc. Many people have never heard of the physical examination that really meets the needs of personal health care and designs a physical examination project for individuals and families.At present, the business philosophy and operation mode of most medical examination centers in China will also be affected by the thinking and habits of medical examination in the past. At the same time, testing equipment, testing reagents and testing personnel will also have an impact on it, which will greatly reduce the coverage and accuracy of physical examination items. And the examination items cannot be determined according to your physical condition.

In short, the annual physical examination seems to be in a very passive state. The purpose of physical examination is only to screen for major diseases such as malignant tumors. That is to treat early if you are ill, buy peace if you are not ill. After the introduction of health examination in China in recent years, the concept of health examination and health management is now widely recognized and accepted. Disease prevention, health promotion and improving the quality of life and other health needs have become an important part of physical examination. The current dilemmais elaborated as follows.

(1) Physical examination mode

Most of the physical examiners are clinicians, and the mode and purpose of physical examination continue to use the mode of disease diagnosis. Physical examination process design and service skill training cannot meet the needs of consumer health care.

(2) Information collection

Physical examination information technology is relatively backward, lacking effective information integration, and has not formed an open and complementary information system platform. It cannot meet the requirements of physical examination data storage, data mining, physical examination information interaction and service process. The value of physical examination information is far from being fully utilized.

(3) Management Services

Due to the lack of theoretical research and professional guidance, the physical examination center [9] lacks management experience in project setting, process management, service concept and service content. It cannot meet the multi-level health service needs of customers. At this stage, most physical examination centers have installed health examination information systems that can print physical examination reports on computers. However, they only stay in the summary of abnormal indicators, most of which are obscure medical data and descriptions. Influenced by the division of departments, doctors only provide simple and general diet and exercise advice. With the issuance of the medical examination report, the service to customers is declared to be over. There is no professional consultation and guidance, health maintenance interaction between the physical examination center and customers, and a series of value-added services.The traditional physical examination process is shown in the Fig.1.

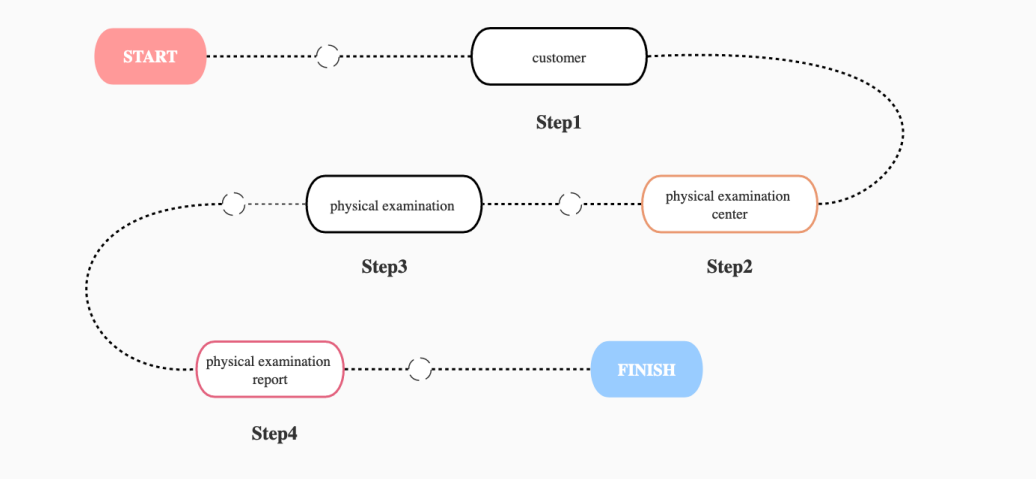

Fig. 1 The current traditional physical examination process

II. THE PROPOSED HEALTH MANAGEMENT MODEL

2.1 *SHEAS* health management project design concept

To tackle the above limitations, the proposed health management model is put forward, which we term *SHEAS* (Smart Health Examination Analysis System).

(1) Based on the original physical examination process, build a health management service chain and expand service capabilities.

SHEAS takes the in-depth mining of customers' physical examination data as the core, and upgrades the traditional physical examination report [10] into a personalized health promotion book. After that, *SHEAS* continues the service by delivering scientific health information. On this basis, *SHEAS*adds service links according to service demand. On the premise of not changing the existing service process of the institution and not increasing the investment in hardware, manpower and software, the connotation and level of institutional services will be rapidly improved.

(2) Take physical examination institutions as the main body to maximize institutional resources and benefits.

As an output carrier of information technology and management services, *SHEAS* is mainly used as an assistant of medical institutions. It could help physical examination institutions integrate existing resources and form service products and service systems. Mining customer demand and adjusting consumption allocation proportion are provided. Use existing resources to improve service capabilities, and obtain more social benefits and profit returns while meeting customer needs.

(3) Personalized health care strategy that focuses on people and meets diversified health needs of customers

The physical examination population will have different health conditions, and the same health conditions will also have diverse consumption needs. *SHEAS* creates a health information management system that conforms to the characteristics of life cycle management by taking advantage of the dynamic balance between health and disease according to customers' consumption habits and behavior patterns. By this way, *SHEAS* forms a triggered health management service network to meet the consumption habits and service levels of different customers.*SHEAS* Health Management Model is described as follows in Fig. 2.

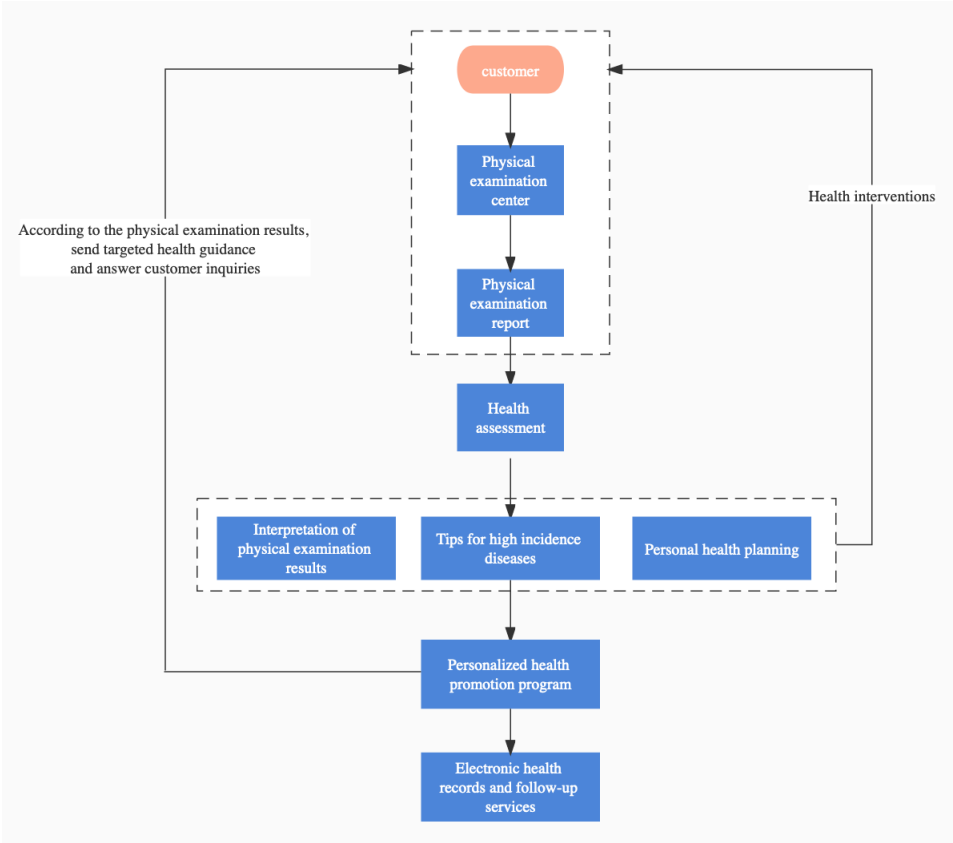

Fig. 2. *SHEAS* Health Management Model

2.2General design principles

(1) Principle of progressiveness technology

Due to the rapid development of information technology, users have a great choice in building information systems. At the same time, users need to rack their brains to find a balance between the progressiveness and maturity of technology when building systems. The technical level of the system should ensure progressiveness and conform to the development trend of computer science today. The technology of system network platform, hardware platform and system software platform should represent the development direction of the current computer technology. At the same time, it has been proved to be practical, stable and reliable. It ensures that the hospital information center has the ability to carry out the continuous development of this product, and can

ensure that this technology is constantly updated and can be successfully upgraded to maintain the progressiveness of the system.

(2) Principle of economic practicability

Adhering to the principle of *spending less and doing more*, we propose a cost-effective scheme to improve the system level and improve the system functions without increasing the investment burden. This is one of the basic bases for our technical design.The current popular software technology, i.e., multi-layer structure system is selected as the core technology of application software system development, which makes the developed application system have very good maintainability and scalability. Under the condition of meeting the management needs, all application software uses graphical interactive human-computer interface, which makes the operation simple and convenient. In addition, it adopts an efficient server, a powerful database system and a general database engine to provide efficient working capacity for various businesses and meet the requirements of large-scale data processing. The application software is developed on a familiar and easy to maintain system platform, and its installation is simple.

(3) Principle of safety and reliability

The system is constructed with mature technology and the world's excellent highly integrated equipment to ensure the high quality, stability and reliability of the system. For the system, such as hardware, operating system, network and database, the fault handling scheme shall be designed as detailed as possible to ensure the rapid recovery of the system. Redundancy technology (redundant equipment, redundant communication link, RAID technology) is adopted to ensure reliable data storage and reliable operation of the network system. The system operation status is observed in real time by means of automatic detection, alarm, monitoring, etc.

The application software system adopts fault-tolerant design to avoid system crash and paralysis and improve system reliability. The fault-tolerant design of the system refers to the design of software that can ensure the correctness of user input and has strong fault-tolerant capability for illegal and destructive input of the system. During the use of the system, when the system restarts after a temporary interruption due to hardware failure or other reasons, it can ensure that the system will quickly recover the original data and continue to run. During the normal operation of the system, the data in the database shall be backed up to the tape drive regularly to avoid the data in the database being too large and ensure the data security.

(4) Principle of expanded openness

With the continuous deepening of hospital information construction, the management mode and business specifications are still improving. Therefore, the current system is required to have a long life.

Componentization: The component-based technology makes use of the object-oriented encapsulation to design the common modules in a unified way. Different parts are designed as independent functional entity modules, and different hooking is carried out according to the specific needs of the physical examination business, which improves the scalability of the system. The componentization generally adopts a multi-layer structure, which fundamentally provides a solid and reliable technical framework for the system, centralizes the business logic in the middle layer for implementation, and is easy to upgrade and change.

Middleware: As the basic platform for constructing the three-tier application system, middleware provides two main functions: one is responsible for the connection and communication between the client and the server. And the second is to provide a three-tier application development and operation platform. The use of middleware ensures the openness of the system and the adaptability to the development of technology.

Dynamic deployment of applications: Use the current application server to provide deployable applications, dynamically deploy new applications to the application server, integrate with the original system, and facilitate users to use and expand.

2.4 Implementation scheme

The knowledge engine based *SHEAS* is an open and extensible Java EE based system. It can generate personalized health promotion books by receiving the physical examination result data from third-party software (such as physical examination management system). In the implementation process of *SHEAS*, because various heterogeneous systems usually use different technologies and architectures to build their own medical information management systems, it is necessary to achieve data docking. On the other hand, *SHEAS* can also realize the entry of physical examination results. For the data exchange problem in health management, *SHEAS* has designed the Health Data Center to effectively solve the collaborative work of different business systems. The definition of physical examination data interface is to complete the exchange of physical examination result data between *SHEAS* and the external management system of the hospital. The purpose of the interface is to transfer the physical examination result data involved in the physical examination management system to the

SHEAS system, so that the *SHEAS* system can correctly receive the data and prepare for the generation of the physical examination report. Finally, personal health promotion book is generated according to the externally imported physical examination result data or own physical examination results.

The first stage: to provide the self-developed health examination analysis system based on the knowledge engine to the hospital. According to the specific needs of the medical examination center of the hospital, *SHEAS*helps the medical examination center to integrate, extend and use existing resources to build a health management service platform with the medical examination center as the main body. To improve the personalized and quantitative content of the existing physical examination report as a breakthrough, through the in-depth mining of the physical examination data [11], the personal health promotion books with hospital characteristics, such as health education, status evaluation, health promotion, health planning, and medical information, will be provided to the physical examination customers. *SHEAS* enhances the intrinsic value of physical examination and rapidly improves customer satisfaction with physical examination.

The second stage: through the powerful health management knowledge base established by the medical examination center of the hospital, electronic health files are used for medical examination customers based on the text health promotion letter. In order to save and check the health examination data of the past years for customers, *SHEAS*provides health information for customers continuously, so that the health examination customers really have a customized health portal.

The third stage: through the effective transmission of information, the gradual improvement of customers' health awareness and cognitive level will produce different health needs and service requirements. *SHEAS* helps the physical examination center to establish a health maintenance platform relying on the hospital's powerful medical resources and taking health information management as the main line. Customers can provide all-round interactive channels through call centers, SMS, mobile devices and other modern communication technologies to satisfy customers. Disease prevention [12], health education, health promotion, health intervention, health services and other health needs make services enter a benign service cycle chain. The physical examination center will change from a single service model to a truly integrated health promotion center.

III. RESULTS AND DISCUSSION

SHEAS is an intelligent system with the core of information technology and management output of the physical examination market through a technical team composed of senior health industry personnel, medical experts and information technology experts. After years of dedicated research and development, it has launched the only health promotion standard system in China, i.e.,*HPS* (Health Promotion System). At the same time, under the guidance of many experts in the health management field, a health information repository *HKP* (Health Knowledge Repository) was established. Based on the results of these two projects, a health examination analysis system based on knowledge engine with independent intellectual property rights was developed. *SHEAS* includes three subsystems, which are health management knowledge base engine system, health examination intelligent analysis system, and dynamic health file management system, respectively.

In the next 2 to 3 years, we will look for medical institutions with common service concepts in major large and medium-sized cities in China. A service and scientific research cooperation system focusing on project cooperation established to jointly carry out health management services. The medical examination institutions will not only win more profits and customers, but also promote the development of domestic health management in breadth and depth. We focus on the continuous improvement of health information knowledge base and the integration and research, development of health management technology. Now, we have reached technical strategic agreements with major domestic health examination software providers, gradually promoting the standardization of software interfaces, and making the use and interaction of health information more smooth.

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