Web-based: A data warehouse on osteoporosis data warehouse in the osteoporosis community health information management system

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ABSTRACT

Objective: To establish an interactive management model for community-oriented high-risk osteoporosis in conjunction with a rural community health service center. Materials and Methods: Toward multidimensional analysis of data, the system we developed combines basic principles of data warehouse technology oriented to the needs of community health services. This paper introduces the steps we took in constructing the data warehouse; the case presented here is that of a district community health management information system in Changshu, Jiangsu Province, China. For our data warehouse, we chose the MySQL 4.5 relational database, the Browser/Server, (B/S) model, and hypertext preprocessor as the development tools. Results: The system allowed online analysis processing and next-stage work preparation, and provided a platform for data management, data query, online analysis, etc., in community health service center, specialist outpatient for osteoporosis, and health administration sectors. Conclusion: The users of remote management system and data warehouse can include community health service centers, osteoporosis departments of hospitals, and health administration departments; provide reference for policymaking of health administrators, residents' health information, and intervention suggestions for general practitioners in community health service centers, patients' follow-up information for osteoporosis specialists in general hospitals.

Keywords: Community Management; Data Warehouse; Information Management System; Osteoporosis; Remote Management of Osteoporosis

1. INTRODUCTION

Osteoporosis is a multifactorial bone disease in addition to being a noninfectious chronic disease (NCD) that is arousing increased attention-like diabetes mellitus and hypertension. Osteoporosis has definite pathophysiological and social psychological effects in addition to exerting economic consequences [1]. Osteoporosis can increase the incidence of fractures. Among osteoporosis patients, about 30% of females suffer fractures [2]. Osteoporosis has no obvious symptom, thus it is referred to as a "silent" disease. Patients tend not to properly understand treatment nor do they place a strong emphasis upon it. Most elderly osteoporosis patients have a low educational level and therefore do not fully use the services provided by health departments. Therefore, staff in community health centers needs to provide instruction, intervention, and appropriate management prior to disease attack.

Community intervention is an important aspect in promoting NCD management [3]. Active risk evaluation of the population at risk from osteoporosis and appropriate intervention at an early stage of the condition through the community health service are effective in reducing the incidence of osteoporosis and improving patients' quality of life [4].

Since osteoporosis is a multifactorial, chronic epidemic disease, informationization provides important technical support in real-time management and efficient use of human resources [5]. Integration of all procedures is the most important factor in community intervention and management. It involves optimization and assembly of staff, equipment, and desktop application systems to promote cooperation among application users, departments and staff in general hospitals, community health service centers, medical staff overall, community residents, medical institutions, and health administration officials. Most hospital information systems are used to manage the business side of proceedings, that is, one-time integration of information, and they are unable to support full data use.

Thus, there is a need to build a data warehouse that allows full analysis towards strategy development [6].

2. DATA ANALYSIS AND MODEL BUILDING

In cooperation with rural community health service centers, we analyzed data sources towards promoting community health management for osteoporosis by means of a data warehouse.

2.1. Data Research

We invited staff from Yushan Xinglong Community Health Service Center, the Departments of Orthopedics, Gynecology and Obstetrics, and Endocrinology of Changshu Hospital of Traditional Chinese Medicine, Health Bureau of Changshu, and software engineers to compose the group for our data research. The outpatient clinic of Changshu Hospital of Traditional Chinese Medicine was responsible for the organization and communications related to this study, and the data warehouse was constructed for physicians from Yushan Xinglong Community Health Service Center and the indicated departments of Changshu Hospital of Traditional Chinese Medicine and health management institutions. The data warehouse users were provided with basic training with regards to the study concept and required levels of analysis.

2.2. Data Scope

Data source was divided according to subjects and data research to integrate information models of various business systems for macroscopic merge, abstraction, and data scope to confirm that all required data were extracted from business systems and well organized. The data scope was defined as community residents with osteoporosis or at a high risk of osteoporosis; it mainly comprised postmenopausal females and elderly males (older than 60 years). The data of all residents in the data scope were used in the study except those of residents who moved out of the community or died.

2.3. Subject Elements of Community Management for Osteoporosis

The subject elements for community management of osteoporosis included dimension (content of business), subjects (includes data of subjects), particle size (dimension levels to extract data details), and storage limit (of data). Based on a comprehensive analysis of data conducted by physicians from community health service centers and the indicated departments of Changshu Hospital of Traditional Chinese Medicine, several dimensions were confirmed; these included baseline information, osteoporo-

sis-related high-risk factors, bone density, and assessments of interventions. Each dimension was divided into several levels, and particle size was used to confirm and elucidate the dimension levels.

Osteoporosis-related high-risk factors are complex. Among males, 21 high-risk factors have been identified, whereas 26 have been identified among females [7]. We screened the high-risk factors and provided options for data entry, analysis, and mining. Evaluated osteoporosis-related high-risk factors comprised age, body mass, family history, and nutritional factors; intervention measurements included appropriate diet, exercise, sufficient calcium intake, vitamin D intake, and correction of poor lifestyle habits; bone density examination items included quantitative computed tomography, dual energy X-ray absorptiometry, and ultrasound bone intensity examination; treatment measurements included calcium agents, vitamin D, alendronate sodium tablets, calcitonin, Aclasta, and estrogen replacement therapy. The dose and duration of each intervention, examination, and treatment were recorded.

The snowflake model was used to summarize the above multidimensional data relationships; the model consisted of a fact table and a group of dimension tables. This allowed the dimension factors to be further divided; for example, intervention factors included sports, amount of sunlight, appropriate diet, and medication. The "intervention" dimension could be snow flaked, that is, the dimensions could be decomposed in terms of the attributes for sports, amount of sunlight, appropriate diet, and medication to form four-dimension tables. For the "female" dimension, time since menopause had to be recorded as the particle size.

2.4. Dynamic Loading

Community management needs to be continuously updated so as to provide dynamic data loading when constructing a database. Traditional data warehouses store diachronic, resting, and integrated business data, which initially load data and then support business searches. However, data loading with a dynamic data warehouse can load data while simultaneously allowing users to conduct searches. Moreover, dynamic loading does not affect the use of the data warehouse, which allows the immediate analysis of loading data. The intervention measures and bone density measurements of subjects could be continuously recorded.

3. CONSTRUCTION OF DATABASE AND PHYSICAL ACHIEVEMENT

3.1. Fact Table of Data Warehouse

The fact table contains all the osteoporosis health data.

The fact table was the largest table we constructed and its information was updated the fastest in the data warehouse. All attributes for each record depended on the primary key of the fact table, and a series of foreign keys was associated with each dimension table. With regard to the search function of the data warehouse, it is necessary to minimize connection operations among different tables. The fact table was designed as shown in **Table 1**.

4. DESIGN OF RELATED DIMENSION TABLES

For each attribute in the fact table, the dimension information was recorded using a special dimension table to confirm the values of some dimensions [4]. The design of the dimension tables was based on the table name (main key word coding, name), and content in parentheses in **Table 2** represents the field names. The main dimension tables are shown in **Table 2**.

The search function was improved by combining the small dimension tables. For example, the social dimension table is presented in **Table 3**.

Table 1. Design of the osteoporosis health file data fact table.

Field name	Meaning
ID	File compile
Xingming	Name
Chusheng	Birth data
Shequ	Community
Xingbie	Sex
Juejing	Menopause time (female)
Jibing	History of disease
Jiazu	Family history
Gmdff	Measurement method of bone density
Gmdt	Measurement time of bone density
Gmdz	Bone density value
Gmdgk	Bone mineral density
Ganyuss	Intervention diet
Ganyush	Intervention life
Ganyuyd	Intervention exercise
Ganyuyw	Intervention drugs
Beizhu	Remarks
Lrname	Name of data entry staff
Lrrq	Date of data entry
Guidang	Filing or not (1: filing; 0: not)

Table 2. Design of the main dimension tables.

Structure of dimension table	Instruction
BASIC (basic information)	Dimension table of basic information
FACTORS (risk factors with osteoporosis)	Dimension table of risk factors for osteoporosis
BMD (bone mineral density)	Dimension table of bone mineral density
IM (intervention measures)	Dimension table of intervention measures

Interactive Data Distributed Structure

System management was achieved through interactive management of physicians from the community health service center and general hospital and health administration departments. Therefore, we used an interactive data mart structure. Although different data marts were achieved in specific departments, they were integrated and interlinked to provide a comprehensive data view for business scope. The administrator assigned different permissions for different grades of users. The user had to register the database for data entry, correction, export, and analysis, that is, the data warehouse for business scope. For example, the staff of different community health service centers could enter different data relating to their own communities.

User management is also a special dimension table. The user management was built as presented in **Table 4**.

5. PLATFORM DEVELOPMENT AND DATA WAREHOUSE

Hypertext Preprocessor was used to develop web application programs. The Linux operating system was employed as the server operating system, equipped with the Apache 2.0 operating platform. The MySQL 4.5 relational database was built and is accessible on the internet. The user can input http://www.cszlf.net/sycweb/ in the web browser, and the log-in page appears as seen in **Figure 1**.

The data entry interface appears after inputting the user name and password **Figure 2**.

The system provides online analysis for real-time and online analysis of data in the data warehouse, including individual case analysis, group analysis, and global analysis. For individual case analysis, the user can search the target records through a conditional search and click the "analyze" button on the interface to obtain the individual case analysis by system and primary diagnosis and treatment suggestions; these do, however, require the confirmation of clinical physicians. This process achieves computer-assisted diagnosis and treatment **Figure 3**.

Table 3. Social dimension table (expression of patients in the community).

Id	Community no.
Sqmc	Community name

Table 4. Users table (system administrator list).

Id	User encoding
Name	Logging name
Pass	Logging password
Xinming	Real name
Level	Management level (0: system administrator; 1: common administrator)
Last	Last logging time

Figure 1. Log-in screen of Changshu osteoporosis remote management system.

Figure 2. Data entry interface of the Changshu osteoporosis remote management system.

Figure 3. Online analysis interface of the Changshu osteoporosis remote management system.

6. DISCUSSION

There is a common lack of appropriate tool software and unified ordered organization in community public health service management, [8] and it is difficult to analyze daily working data or to further community health management. Although some information management systems for osteoporosis have been developed and used, most of them use databases rather than data warehouses; thus, they do not support data analysis functions or data mining [9]. We have been collecting data since 2010, and we have combined basic principles and methods for a data warehouse with community intervention in constructing such a warehouse that achieves dynamic loading. This data warehouse has several positive features: It effectively organizes data sources, and provides deep-level data mining and online analysis. In addition, users can include community health service centers, osteoporosis departments of hospitals, and health administration departments. In this way, it is possible to provide strategic evidence and support for health administration departments, provide complex computer-aided diagnosis and treatment for community health service centers, provide patients with follow-up data, and provide raw scientific research data and real-time health statistics for hospital-based physicians. The system can be used for data management, data query, online analysis, etc. for specialist outpatients for osteoporosis in community health service center and health administration sectors [10]. The web-based network environment eases data searches, and online analysis of the data warehouse in combination with data-mining techniques can analyze the data distribution and dynamic changes of each variable, support research and strategy, and provide evidence for clinical research and community NCD [11].

7. ACKNOWLEDGEMENTS

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