# Development of the Structure of the Ontooriented Database of Information System «Image Therapist»

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**Abstract**

The article is devoted to methods and means of database (DB) design and software implementation based on ontologies. This DB is a main component of the information system "Image Therapist", designed for dissemination, practical development, and research of Chinese Image Medicine within the concept of integrative scientific medicine. The importance of such a DB as a key element of the information system for the collection and management of diagnostic and therapy data by specialists of this folk method treatment and for storing medical data of each patient is substantiated. The structure of a database, its necessary components and the principle of usage are developed. The software tools for the implementation of this database are analyzed.

**Keywords 1**

Diagnostic space, ontology, information system, Chinese Image Medicine, database

## 1. Introduction

Although generally giving a positive assessment of the role of folk and non-traditional medical fields, the WHO Strategy in the field of folk medicine implicitly puts their theoretical and empirical status lower than the corresponding status of Western official medicine, which has a scientific basis. The implementation of the principle of integrativeness and the principle of provability for unconventional medical fields in real medical practice is an extremely difficult problem due to the significant differences between the theoretical and practical foundations of these medical systems, and there are obstacles to this:

1. the vast majority of existing unconventional (folk, traditional) medical fields do not have sufficient theoretical and experimental-clinical justification, in particular, in the field of evidence-based medicine, it forms a skeptical attitude of the academic community to them,
2. for most of the existing unconventional medical areas there are virtually no modern information and analytical tools for collecting, analyzing, systematizing, comparing the results of diagnostic and therapeutic activities of relevant specialists, no information systems to support diagnostic and therapeutic decisions, relevant knowledge bases and e-learning systems,
3. existing information-analytical tools (for example, expert systems, grid-ontology systems for traditional Chinese medicine) are focused on solving narrowly specialized tasks within a single unconventional medical field, rather than solving the problem of unification and integration of theoretical, applied and information-applied resources different medical areas in the form of a single intellectualized information and analytical environment.

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An important component of integrative scientific medicine is Chinese Image Medicine (CIM). That is why, it is important to develop modern intellectualized onto-oriented information systems that would consolidate the CIM therapists efforts and would be available to health professionals all around the world.

The most commonly used by some CIM-therapists information tools are currently a simple text editor and/or spreadsheet to record the symptoms of their patients.

Therefore, CIM-therapists recognize the relevance of intellectualized software solutions and point the functions that would be useful for them in their daily practice. In particular, an electronic patient record (analog of a medical card), remote access to clinical information, support for automatic diagnostics, protection of information data, quick access to information about external organization, assistance in diagnostics and treatment, assistance in human anatomy at acupuncture points, formation of invoices for payment, financial and accounting reporting are main requirements to designed system. [1].

The purpose of this paper is to develop a unified database for the information system "Image Therapist", which will be the only platform for experience exchange between current CIM therapists and experts in official (western) medicine. It will improve the quality of their professional activities, and will be significant step towards international program research of Chinese Image Medicine for 2017-2023 implementation.

## 2. Related Works

Nowadays the integrative scientific medicine is actively forming in the world. It acts as a consolidator of best medical practices and the project of medicine of the future [2, 3]. The World Health Organization (WHO) also supports this initiative and encourages research into folk medicine, what reflected in the WHO Strategy for Folk Medicine 2014-2023. [4].

CIM as a kind of traditional Chinese medicine (TCM) offers a different approach to the interpretation of human life, diseases, their treatment and prevention. Its practical application for diseases diagnosis and treatment has several thousand years of history of its study and successful usage.

At present, CIM is at the stage of active transformation of ancient methods and modern scientific research. It represents a modern, innovative direction of traditional Chinese medicine development [5]. CIM knowledge gained from clinical practice has all the prerequisites to become a significant complementary information source for various disciplines of integrative medicine, as its methods are already recognized by many countries. Moreover, in China CIM is part of the official medical system [6, 7].

Integration of CIM and modern Western medical practice is believed to become the impetus for the development of new treatments for diseases [8, 9].

## *3.* Proposed methodology. Ontology *as the basis of developed database*

Computer ontologies and onto-oriented knowledge bases have been used successfully to solve the problems of ordering, semantic integration of medical-biological knowledge and clinical-experimental data, and transformation of informal knowledge into metadata for reuse in information systems. Their use will allow to transform various unconventional types of medicine and integrate them into integrative medicine, which will fully take into account the physical, mental, spiritual, age, cultural, social, environmental and climatic individual aspects of the patient.

The ontological approach makes it possible to effectively organize, integrate the vast accumulated experience of knowledge of various medical systems, clinical and experimental data, as well as to organize them with high semantic quality.

Therefore, the core of the integrated information-analytical environment of research, professional healing and e-learning CIM (figure 1 shows its generalized scheme), the detailed structure of which was developed in [11], is a computer multilevel ontology of CIM.

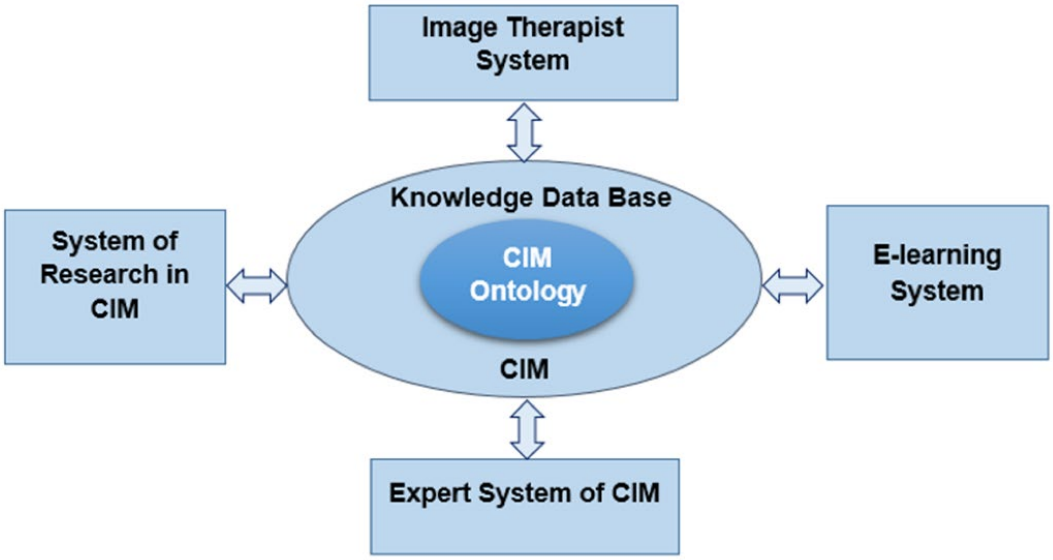


**Figure 1:** General architecture of integrated onto-based information analytical environment of scientific research, professional healing and e-learning of Chinese Image Medicine

The onto-orientation of the integrated information environment will allow unifying and standardizing technologies for presenting information (data and knowledge) in the field of TCM and CIM, which will overcome the problem of semantic heterogeneity of poorly structured and difficult to formalize knowledge in TCM and CIM.

In this case, the use of ontology is the best solution, as it eliminates subjective factors, polysemantics, ambiguity of concepts and images, which explicitly or implicitly operate on CIM therapists in the process of making diagnostic and therapeutic decisions. Also developed ontology and taxonomy are a model of the subject area of CIM (fig. 2, 3).

The ontology CIM is presented as a system of five subontologies:

1. ontology of reality and human CIM and its subontology of the concept of "Image",
2. ontology of health and diseases in CIM,
3. ontology of diagnostic technology in CIM,
4. ontology of therapy technology in CIM,
5. ontology of learning technology, development of CIM-specialist.

These ontological models are described in the OWL language, which has a number of advantages:

- its specification makes it possible to create computer-readable descriptions of classes and relationships between them,
- allows you to set the desired level of expression from simple restrictions to virtually unlimited syntactic freedom,
- determines the way of presenting knowledge and provides an opportunity to draw new conclusions based on current knowledge,

an ontology built for the subject area of CIM can be used for a number of information systems for integrative medicine. This will help reduce the amount of information and avoid duplication.

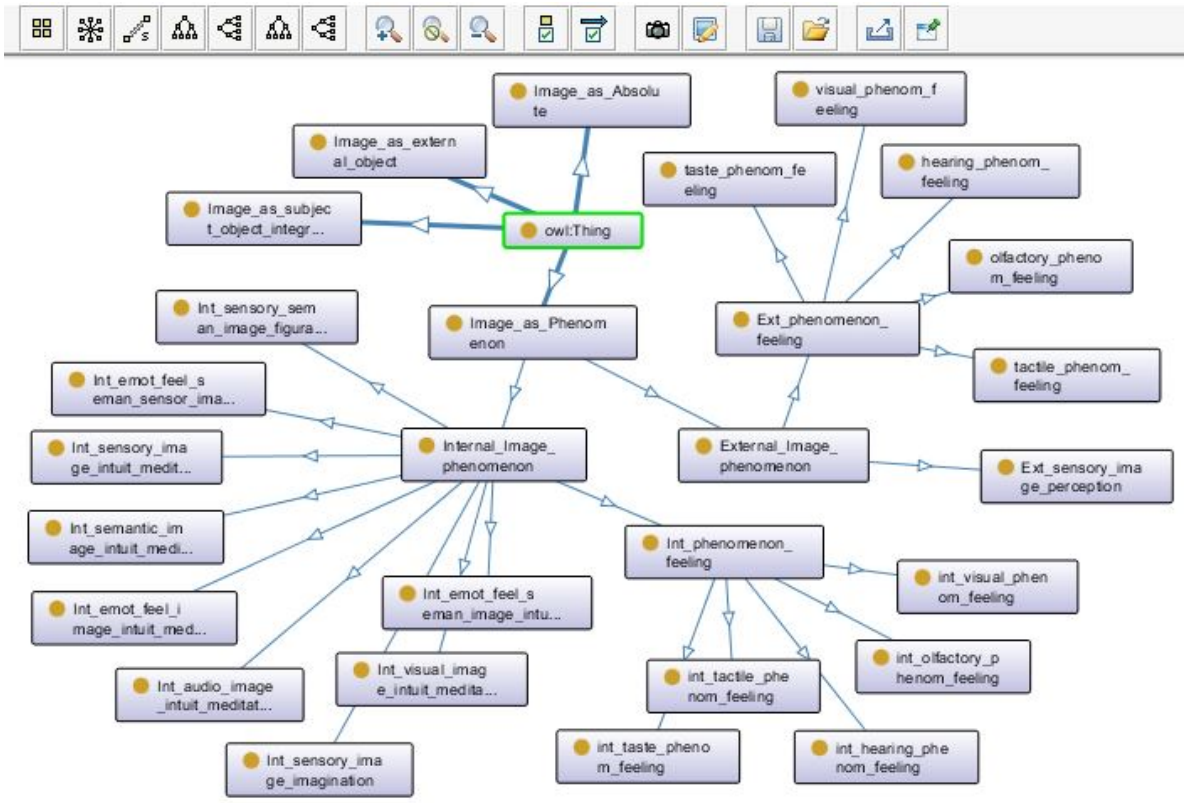


**Figure 2:** A fragment of ontology CIM

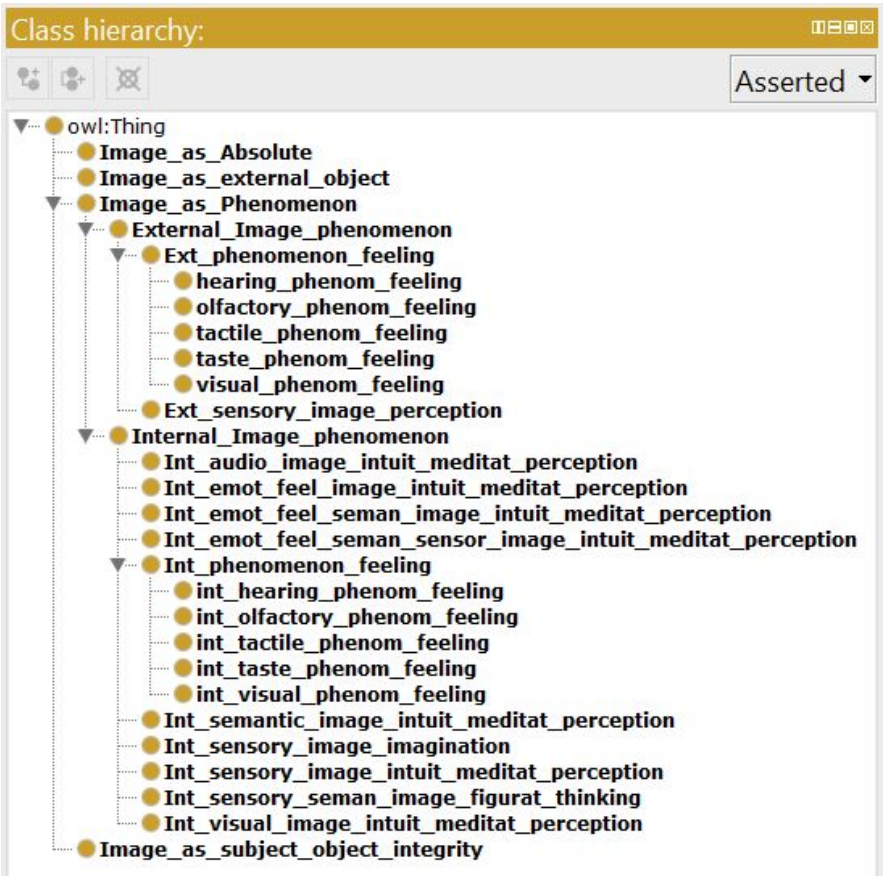


**Figure 3:** A fragment of taxonomy CIM

# 4. Results

## 4.1. Substantiation of database development software

The developed onto-oriented database will become the basis for information system “Image Therapist” and research of CIM. Information in this DB will be collected in real time and will perform two functions: accumulation of diagnostic knowledge of CIM in a standardized form and reuse of knowledge in various combinations of treatment methods.

Such use of the database gives possibility to avoid the redundancy and inconsistency of data that are inherent in this subject area.

Selecting the optimal type of data base is a complex, richly parametric problem and is one of the main stages in the development of IS scientific research results.

Recently, non-relational (NoSQL) databases have been rapidly developing in parallel with relational (SQL) databases, and it is necessary to decide which type is more suitable for our database.

The advantages of relational databases are support for the SQL language (which allows you to perform complex queries and relatively easy to migrate from one relational database to another), a high level of consistency, reliability of storage and access to information. Non-relational databases, in turn, have the advantage of working with big data (BigData), better scalability (which allows you to meet the rapid growth of the load) [13].

Table 1 shows the main characteristics, which show the greatest differences between SQL and NoSQL databases, the needs of the project in these characteristics, as well as the symbol "+" marked the type of database that best meets these characteristics.

**Table 1**

Database characteristics and project needs

| Characteristics of databases | Project need | SQL | NoSQL |
|---|---|---|---|
| SQL language support | Yes | + | |
| Complex queries in the database for research | Yes | + | |
| Consistency, reliability of storage, access to information | Yes | + | |
| Working with BigData | No | + | |
| Scalability | Unlikely | | + |
| Peak loads from users | Possibly (for example, when many users enter experiment results at the same time) | | + |

Based on the data in the table, we can conclude that the needs of the project are better met by a relational database. For example, you can choose MySQL as the most popular open source database [14].

To solve the problem of peak load, we implement data caching based on NoSQL database Redis. Django is used as a web-framework in the project, and Redis is connected as a module. This configuration is shown in Figure 4 as the "General configuration".

If the project needs fast scaling, you can migrate to PostgreSQL (the uniqueness of this SQL database is that it allows you to easily scale horizontally) and perform the necessary scaling on several databases in the cluster (Fig. 4, "Configuration with scaling").

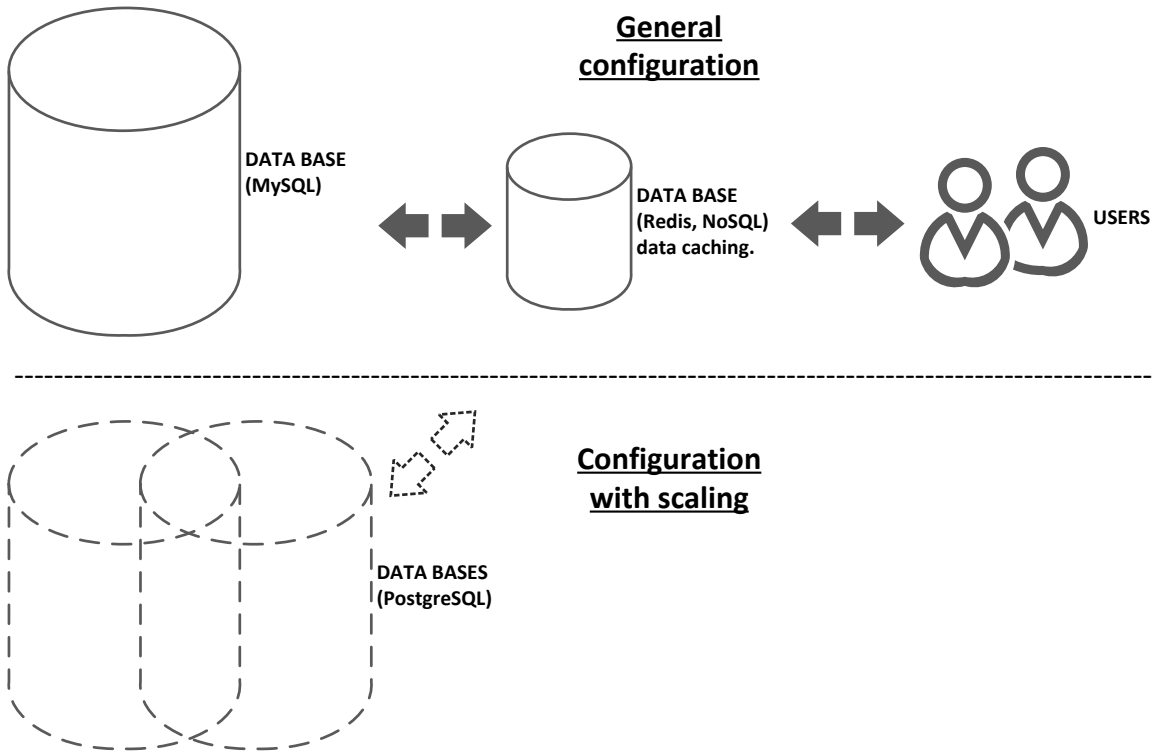


**Figure 4**: Database configuration variants

## 4.2. Development of the structure of the Database for Information System «Image Therapist»

In the IS «Image Therapist» each session will be recorded into the database and can then be used as a separate clinical experiment. The CIM therapist applies the principle of single input and multiple use of data, implementing in such a way the requirements for information system, formulated in [10-12].

Features of the formation of a specific multi-vector CIM diagnosis are described in [15]. There will be two types of logical connections under the formation of the diagnosis process: "many-to-one" – in the case when many different symptoms correspond to one diagnosis (fig. 5, a), and "many-to-many" – in the case when many different symptoms correspond to several possible diagnoses (fig. 5, b).

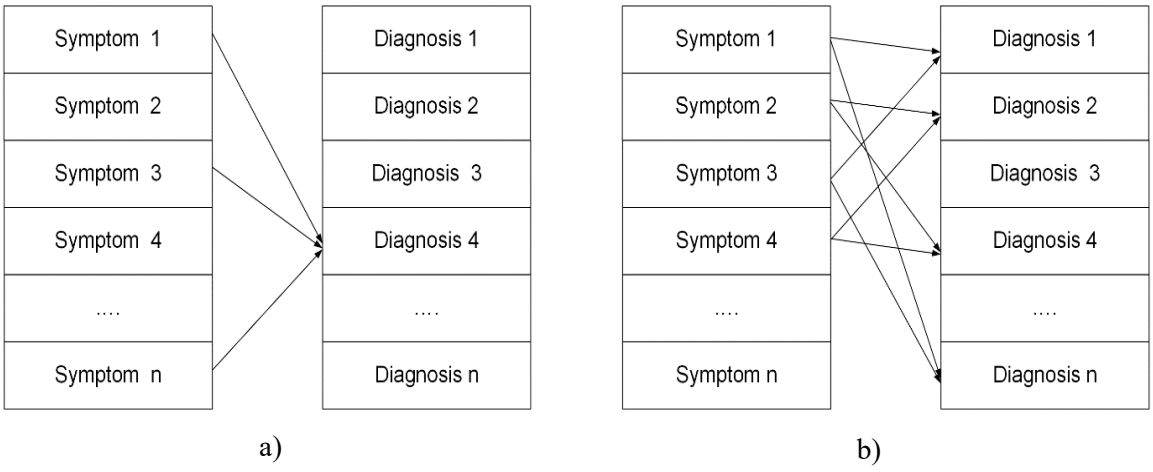


**Figure 5**: Types of used logical connections

In general, the structure of the database for the information system “Image Therapist” can be represented by the following structure – figure 6.

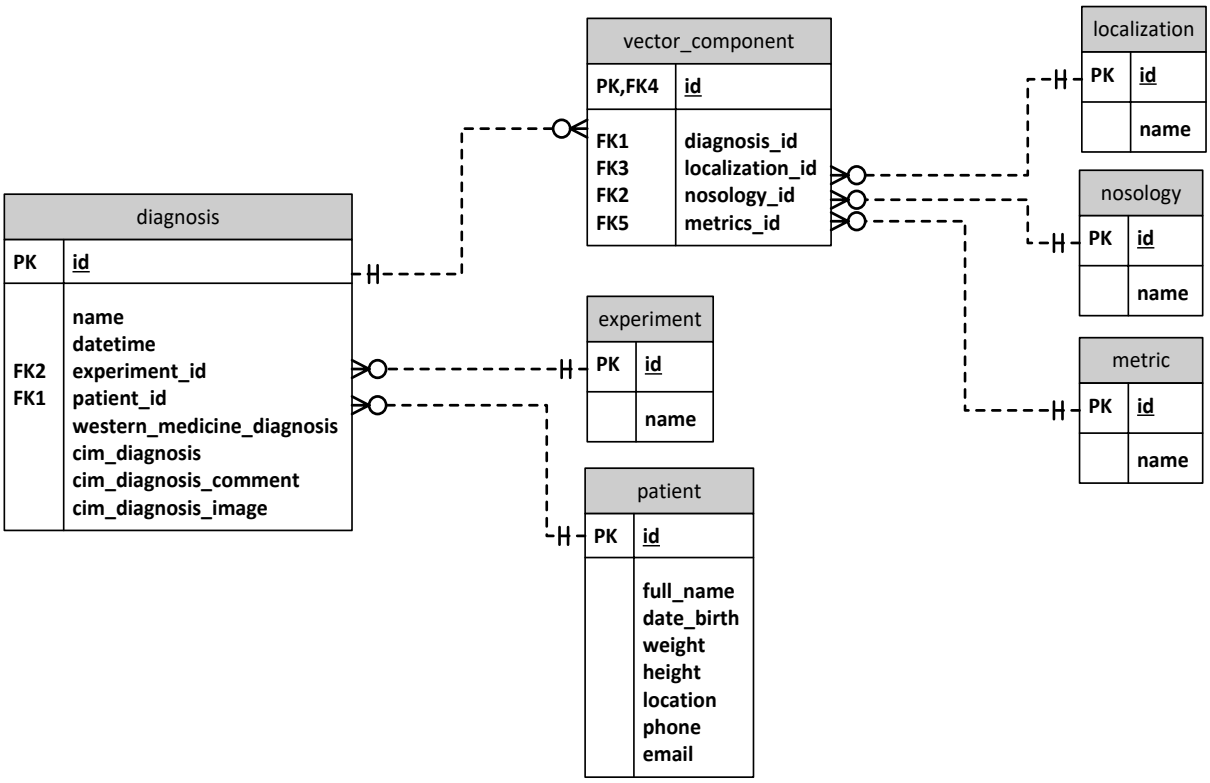


**Figure 6**: Database structure for the information system "Image Therapist" (notations: PK - primary key, FK - foreign key)

To construct the diagnostic space of CIM, a diagnostic ontology of CIM was developed, which includes the following subontologies: nosological ontology of CIM, topological diagnostic ontology of CIM, ontology of diagnostic methods in CIM and ontology of diagnostic metrics and scales in CIM. The topological diagnostic ontology reflects information on the topological localization of diseases in relation to the physical body of man, his energy and information system. Nosological ontology of CIM reflects knowledge of the types (classes) of diseases that are accepted in the diagnostic theory of CIM. The ontology of diagnostic methods in CIM reflects knowledge of methods of obtaining and specifying sensory-diagnostic information in CIM.

The ontology of diagnostic metrics and scales describes the quantitative indicators of the diagnostic space of CIM, which determine the degree of disease and can be set on a certain numerical or non-numerical scale.

The ontology is reflected in the following tables: *localization, nosology, metrics*, which contain the corresponding ontological values. The vector_component table contains information about the components of the diagnostic vector. A vector can consist of several components. The diagnosis table contains information about the patient's diagnosis; it refers to a vector that contains the name, time, date, and second keys for the experiment and the patient. Each diagnosis can be made for only one patient. The diagnosis can be made as part of an experiment, or as a routine diagnostics.

Thus, the patient and experiment tables contain patient data and experiments, respectively.

The system provides for three roles: administrator (with full rights), image therapist (has access only to his patients and diagnoses), scientist (has access to the results of the experiment).

Usually, the process of diagnosis by CIM methods is carried out as a result of clinical consultation and examination.

CIM-therapist examines the patient, asks clarifying questions, while noting the symptoms and their localization from the tables nosology, localization and metrics database. In parallel, new observations made by the therapist, or new symptoms detected during the examination, can be added to the database (this can be information of different types: textual, numerical, graphical). The different sets of symptoms, which will be the basis for the process of diagnosis by an expert system can be formed. Expert system of CIM is also a component of an integrated information-analytical environment, its development is the next step of [10-12]. Expert system will output a diagnosis relevant to a particular set of symptoms and suggest treatment.

However, the construction of expert system for CIM is an iterative process that requires a significant amount of CIM experts efforts to achieve maximum quality, as well as continuous adaptation and improvement of the validity of automatic diagnosis based on their feedback.

A number of experiments on diagnostics have to be carried out in order to form a basis for training of CIM expert system. The database developed in this paper also has the ability to record the results of such experiments.

Another important task that will help to solve such a database is the unification and standardization of semantically heterogeneous, difficult to formalize the knowledge of CIM, eliminating the fuzziness of images and concepts used by image therapists. So, this knowledge will be suitable for use in two more components of the integrated information and analytical environment - in the system of scientific research CIM and in the system of electronic learning CIM.

Implementation of mentioned above capabilities in the developed prototype are provided by the following blocks: Diagnosis, Experiments, Localization, Metrics, Nosology, Patients. References Localization, Metrics, Nosology. They are the components of the diagnostic space of CIM and correspond to the mathematical model of presentation of diagnostic information of CIM, described in [15].

An open-source relational database management system MySQL [16, 17] and a web-framework Django [18-22] were used for software implementation of the database. MySQL provides scalability (can store up to 50 million records), portability (runs on various platforms, including Unix, Linux, Windows, OS / 2, Solaris, Mac OC), security (has a data access control system, provides data encryption during transmission), speed of operation and easiness of operation.

Django is also open-source software written in Python that allows to use a huge number of libraries written in this programming language. One of the advantages of Django is the high speed of development, and this framework also provides object-relational mapping (ORM), built-in administrator interface, security, easy internationalization and localization.

Actually, ORM technology was used to implement our database, the sense of which is that classes and objects of object-oriented programming language are displayed on tables and records in the database. ORM not only provides the creation (editing, deletion) of class-based tables (in Django they are called models) using the migration mechanism, but also constantly maintains data matching at these two levels (models and databases).

Django, using the administrator interface, allows to manage easily users and groups (roles), as well as create various forms (supporting CRUD operations "out of the box") based on models. Figure 7 shows the administrator interface for the system "Image Therapist" and the research system CIM, for the role of "administrator".

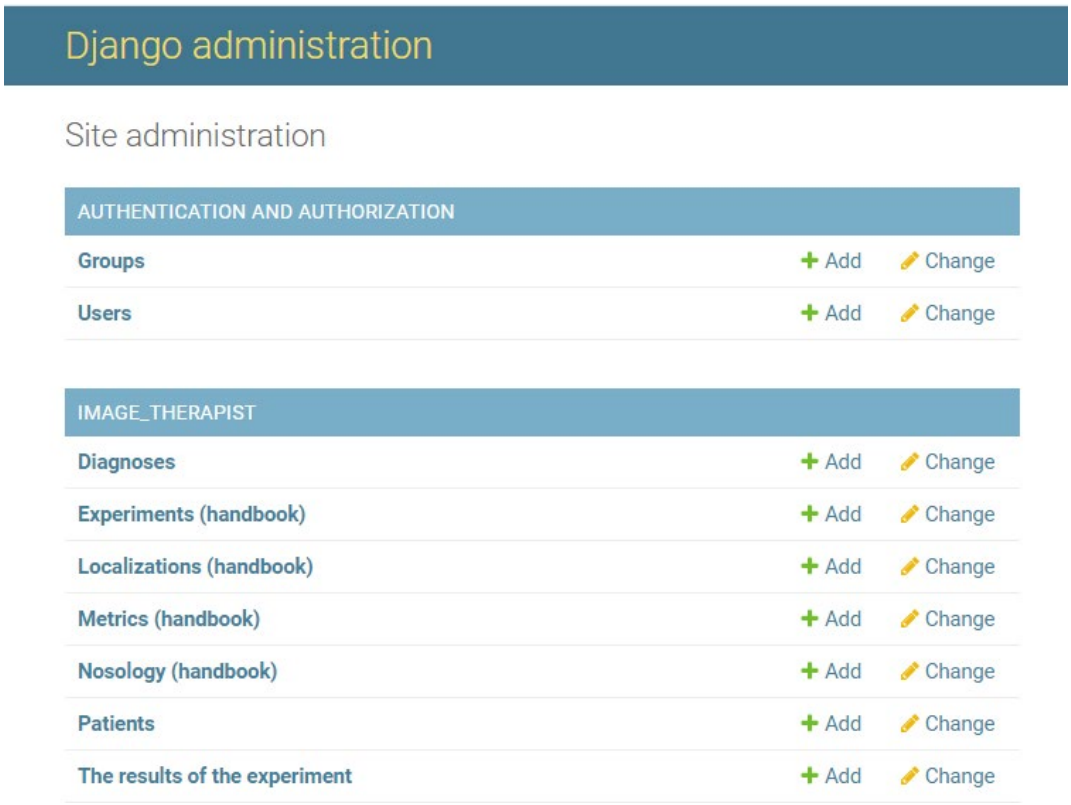


**Figure 7:** Administrator interface for the system "Image Therapist"

## 5. Conclusion

Chinese Image Medicine is officially recognized in an increasing number of countries around the world as one of the components of integrative medicine. This requires the development of information systems of high quality to support the real practice of image therapists and CIM research. The core of such an information system is its onto-oriented database.

The onto-orientation of the database enables direct consideration of the core of knowledge and experience of specialists in this type of folk medicine. Also, the onto-orientation of the developed database enables the filling, clarification and correction of the knowledge base in the field of folk medicine.

The chosen database architecture will allow the project to develop on the basis of SQL DB, to provide its availability at increase of activity of users, and in case of need in fast scaling to pass to other SQL DB. The database developed in this article is the basis for subsequent iterations of design an integrated information and analytical environment for research, professional healing and CIM e-learning.

The use of open-source MySQL database software and Django web framework allows to efficiently implement the system "Image Therapist" and the system of CIM scientific research and thus provide a basis for further research as CIM and implementation of similar systems for other types of folk medicine as components of integrative medicine.

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