The ontology as the core of integrated information environment of Chinese Image Medicine

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Abstract. The article is devoted to the improvement of modern onto-oriented information tools for Integrative Medicine (IM), in particular, for its component - Chinese Image Medicine. The architecture of the components integrated onto-oriented information and analytical environment for scientific research, professional healing activities and e-learning of the Chinese Image Medicine is presented. The onto-orientation of the developed environment provides the ability to maintain the necessary level of integration, integrity of knowledge and data in the CIM for various information technologies and systems. The structure of the ontology of Chinese Image Medicine are detailed. Namely, the separate structure of the ontology of CIM is specified. The axiomatic-deductive strategy of organizing the knowledge space of the Chinese Image Medicine is proposed. Developed diagnostic ontology of Chinese Image Medicine, which includes the nosological ontology, the topological diagnostic ontology, the ontology of the diagnostic methods and the ontology of the diagnostic metrics of CIM.

Keywords: ontology, e-learning systems, expert systems, axiomatic-deductive strategy, Integrative Medicine, Chinese Image Medicine.

1   Introduction

According to the strategy of the World Health Organization (WHO) in the field of folk medicine [1], an important strategic problem is the development of a scientifically sound approach to the implementation of alternative and complementary medicine in the field of official medicine, both internationally and nationally. Today, in most countries of the world, in particular, in the USA, China, Japan, Korea, Russia, many countries of Europe, Brazil there is a significant revival in the scientific study of non-conventional (alternative, complementary) methods of human health improvement and treatment, which contributes to the formation of such a perspective the direction of medicine as an integrative (integral, holistic) medicine [2-4]. Integrative (holistic) medicine develops all over the world, dating back to the 90s of the twentieth century. The Academic Consortium for Integrative Medicine and Health, the National Center for Complementary and Integrated Healthcare (NCCIH) were founded in the United States, and in 2001, the Institute for Integrative Medicine was opened in Harvard. In

some countries of the world there are higher education institutions that train specialists in the field of Integrative Medicine, and many national and international public organizations (associations) have been established, whose activities are aimed at the development of Integrative Medicine around the world. There is a large number of prestigious international journals dedicated to Integrative Medicine. In 2017, Berlin hosted the first World Congress of Integrative Medicine. As well a Program for the researches of Chinese Image Medicine for 2017-2023 (Program) was developed [5]. The Program is aimed at conducting comprehensive scientific researches of Chinese Image Medicine in order to create theoretical and experimental scientific basis for CIM. According to the information-analytical direction of the CIM research program, the actual scientific and applied problem is the creation of an integrated onto-oriented information and analytical environment for scientific research, professional healing activities and e-learning of the CIM.

2   Related Work

In [2-4], an overview of the current state, research and further promotion of Integrative Medicine is given. Since traditional Chinese medicine (TCM) is one of the important components of IM, the authentic methods and means of TCM actuvely are studied, distributed and developed, as evidenced by a series of papers [6-12]. At the same time, in the field of CIM there are no complex theoretical and experimental research, therefore, at present, one can state the shortage (lack) of scientific works on this subject. Given this state of affairs, a Program for the researches of Chinese Image Medicine for 2017-2023 (Program) was developed [5]. The Program is aimed at conducting comprehensive scientific researches of Chinese Image Medicine in order to create theoretical and experimental scientific basis for CIM, which will promote the disclosure of the deep causes and mechanisms of human diseases and will help to create effective methods for their prevention and treatment. The first works in this direction [13-18] contributes to its further intensive development.

3   Results and Discussion

The Integrative Medicine, synthesizing the best experience of Western, Oriental and traditional medicines, is the key to health in the XXI century. Integrative medicine holistically involves different directions of non-traditional types of medicine. Some methodological experience of integrative medicine has already been gained, but it needs further conceptualization and algorithmization. Figure 1 presents a conditional scheme of the strategy for the formation of IM from a set of well-known medical areas, through the scientific selection of qualitative knowledge and methods of each of them and the synthesis of these selected components of Integrative Scientific Medicine.
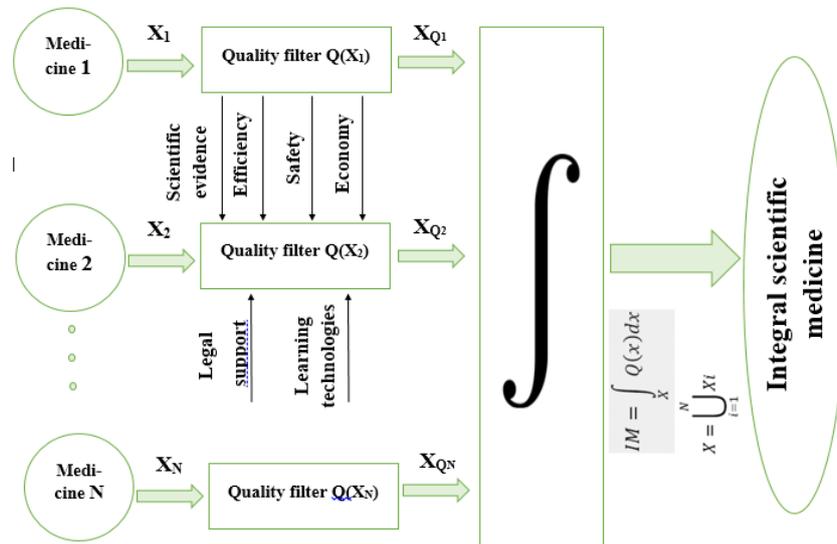
Fig. 1. Conditional scheme of the strategy of formation of Integrative medicine from a set of well-known medical directions

In China, IM has become an integral part of public health successfully combining the achievements of Western medicine and traditional Chinese medicine. TCM is rooted in the ancient historical reality and includes naturopathy (treatment with products of natural origin, phytotherapy), qigong, meditation, massage, special diets, acupuncture. The methods and means of Chinese Image Medicine (CIM), which is a part of TCM and its historical roots reach the antiquity of Chinese civilization, are of great interest of scientific research. Nowadays CIM gained a new powerful impetus for its distribution and development worldwide, including the USA, Canada, Germany, Switzerland, China, Russia, Ukraine, Belarus, Brazil, Latvia, Estonia, Czech Republic, Slovakia and Hungary. A world famous centre for studying and research in Chinese Image Medicine is Beijing Medical Research Institute "Kundawell" (China). Unlike TCM, for which a number of large-scale clinical trials, theoretical scientific substantiation and a range of relevant information and analytical tools (ontologies, expert systems, grid systems for TCM [6-12]), for Chinese Image medicine (CIM) has almost no similar research and relevant information and analytical tools. The absence of the comprehensive theoretical and experimental researches of the CIM, as well as the lack of technical information and analytical decisions in the field of CIM, is a significant barrier to the creation of a complete scientific CIM paradigm in medical science, as many of the theoretical and experimental aspects and regularities of this area of folk medicine remain unclear.

According to Program, the creation of the scientific direction of the CIM is appropriate to realize in four interrelated areas: the theoretical direction, the experimental direction, the direction of clinical researches and the information-analytical direction (see Table 1).

**Table 1.** Directions of scientific researches of CIM

DIRECTION	DESCRIPTION OF THE DIRECTION
THE THEORETICAL DIRECTION	Relates to the development of scientific concepts, models, methods, theories of CIM using the theoretical and methodological approach of modern science
THE EXPERIMENTAL DIRECTION	Relates to the organization and conduct out of comprehensive objective instrumental, laboratory and statistical studies of the physical and physiological (biophysical, biochemical, bioinformational) processes in the human body under the influence of the CIM-therapist and the individual practice of ZYQ.
DIRECTION OF CLINICAL RESEARCHES	Relates to the development and implementation of clinical research programs for CIM and ZYQ methods in accordance with the requirements and standards of modern evidence-based medicine.
INFORMATIONAL -ANALYTICAL DIRECTION	Relates to the development and support of an integrated information and analytical system of scientific research, professional healing activities and training of the CIM, which serves for the organization and coordination of the activities of researchers, CIM-therapists and instructors, the collection, automated statistical and intellectual analysis of the results of treatment by the methods of CIM and the results of ZYQ practice, the creation of a unified database of all theoretical, experimental and clinical research in the field of CIM and ZYQ, the development of the web-oriented system of e-learning of the CIM-specialists, the expert system of support for the adoption of diagnostic and therapeutic decisions in the field of CIM.

The actual scientific and applied problem is the creation of an integrated onto-oriented information and analytical environment for scientific research, professional healing activities and e-learning of the CIM. The purpose of developing this information-analytical environment is:

1. Improving the quality (evidence, effectiveness, safety, controllability, reliability, cost-effectiveness, intensity) of professional activity and the exchange of experience of CIM-therapists.

2. Providing effective organization and coordination of the functioning of the CIM-therapists, the researchers of the CIM, the persons studying the CIM.

3. Providing at high scientific, technological and infrastructural levels of collection, automated statistical and intellectual analysis of the results of diagnosis and treatment of CIM methods.

4. Creation of a unificated database and knowledge base for theoretical, experimental and clinical research in the field of CIM.

5. Formation of modern intellectualized information resources in the field of folk, complementary and integrative medicine on both at the national and international levels.

The proposed work is devoted to the development and further structuring of the CIM ontology and integrated onto-oriented information and analytical environment for scientific research, professional healing activities and e-learning of the CIM.

Architecture of the components of the environment integrated onto-oriented information and analytical environment for scientific research, professional healing activities and e-learning of the CIM. General architecture of integrated onto-based information analytical environment of scientific researches, professional healing activities and e-learning of Chinese image medicine is presented in Figure 2 [14].
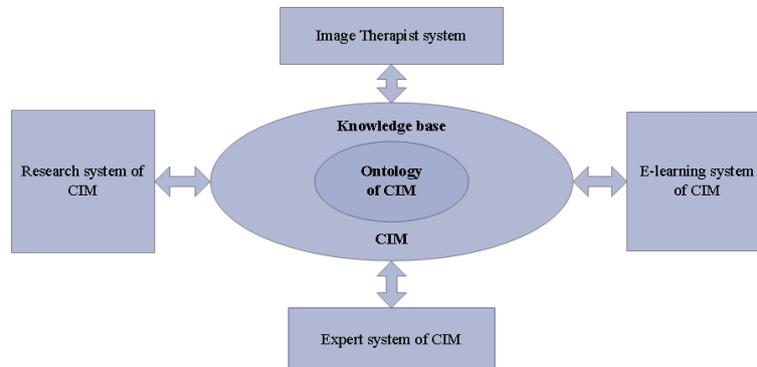
Fig. 2. General architecture of integrated onto-based information analytical environment of scientific researches, professional healing activities and e-learning of Chinese image medicine

Information system of professional healing "Image Therapist" is designed for centralized organization, upgrading (efficacy, safety, controllability, reliability, efficiency, intensity) of professional activities and experience exchange of the existing CIM therapists. General architecture of information system of professional healing "Image Therapist" is presented in Figure 3 [14].
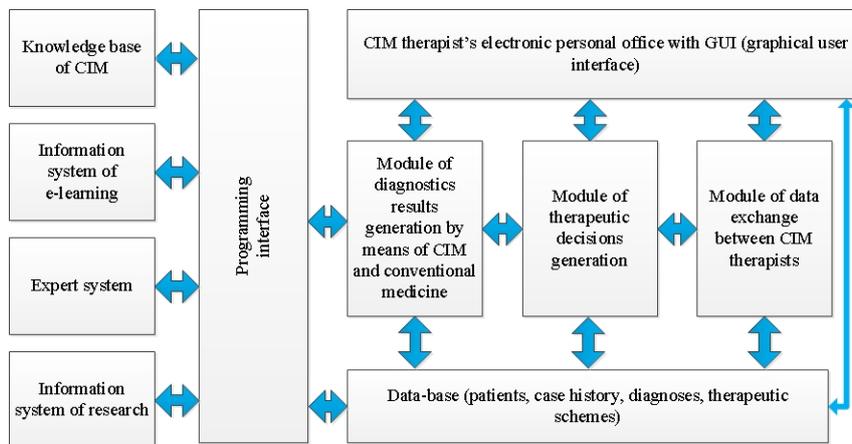
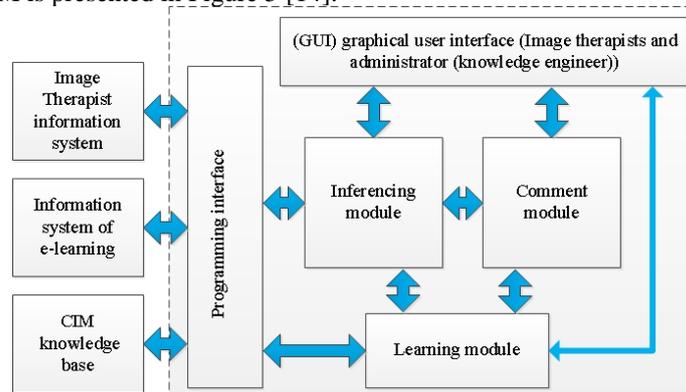**Fig. 3.** General architecture of information system of professional healing "Image Therapist"

An important part of the integrated information analytical environment is CIM information system of e-learning. Development of such e-learning system will considerably simplify, intensify and improve quality and availability of educational process in CIM. For implementation of e-learning information system evidence-based standards of CIM learning should be developed firstly; they include educational and professional program for a CIM therapist, educational qualification of a CIM therapist, curricula and steering documents in disciplines, lecture and practice-oriented learning materi-

als, methods of testing and self-assessment testing of CIM specialists. General architecture of the e-learning information system for CIM therapists is presented in Figure 4 [14].
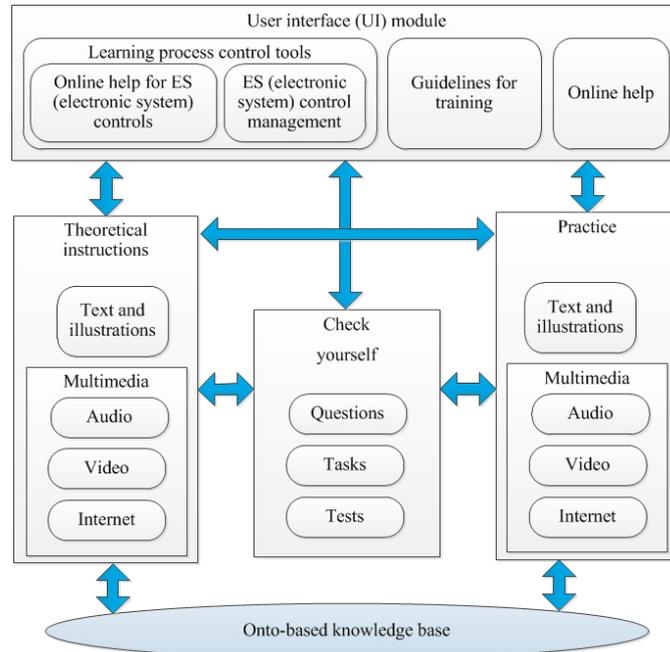
Fig. 4. General architecture of the e-learning information system for CIM therapists

An important part of the developed information analytical environment is the expert system for diagnostic and therapeutic decision-making support in CIM, which will help to improve the skills of CIM therapists. Expert system will issue diagnostic recommendations and personalized patient care scheme by means of CIM, based on data (personal and clinical) about a patient and CIM knowledge-base content. General architecture of the expert system for diagnostic and therapeutic decision-making support in CIM is presented in Figure 5 [14].

Fig. 5. General architecture of the expert system for diagnostic and therapeutic decision-making support in CIM

Chinese Image medicine ontology. The main stage in the development of CIM informational environment, creation of CIM scientific paradigm includes the development of its computer ontology. Besides, CIM ontology development is aimed at the necessity of a comprehensive solving of a range of important tasks of theoretical, clinical, experimental as well as informational and analytical areas of International Research Program, such as: 1) the unification, standardization of information presenting technique (data and knowledge) in CIM, which allows overcoming the problem of semantic heterogeneity of poorly structured and difficult to formalize knowledge of CIM 2) the working out a high-quality dictionary (glossary) and knowledge data-base (thesaurus) in CIM that would have such properties: completeness, consistency, interpretability, unification, integration with other subject areas, including integrative medicine; 3) the multiple reuse of CIM knowledge in various information systems and applications; 4) the necessity of intelligent CIM information search on the Internet in terms of WEB 2.0 semantic search technologies, which ensures a high relevancy and pertinence of the information wanted [15, 16].

Consider the structure of the CIM theory, which defines the general structure of the CIM onology. It is proposed to divide the scientific theory of CIM into two large parts: 1) General Scientific Theory of Integrative Medicine; 2) Special Scientific Theory of Chinese Image Medicine. As the general CIM theory, and the special CIM theory is divided into five of its main sections: 1) the theory of reality and human; 2) the theory of health and diseases; 3) the theory and technology of diagnostics; 4) the theory and technology of therapy; 5) the theory and technology of learning, the professional development of therapists. The sections of the general and special parts of the CIM theory was developed (see Table 2).

Table 2. The sections of the general and special parts of the CIM theory

SECTIONS OF THEORY	DESCRIPTION OF SECTION CONTENT
The theory of reality and human in IM and CIM	Describes the basic concepts and ideas of the IM (CIM) and serves as a practical-philosophical foundation for the rest of the IM (CIM) sections
The theory of health and diseases in IM (CIM)	Describes the basic concepts of health and diseases in IM (CIM); diagnostic standards of health and diseases for their evaluation by various methods of diagnosis of IM (CIM); the classification and definition of the types of diseases in the IM (CIM)
The theory and diagnostics technology in IM (CIM)	Describes and formalizes theoretical foundations, methods and means of obtaining diagnostic medical information by the methods of the IM (CIM), as well as methods of its interpretation.
The theory and technology of therapy in IM (CIM)	Describes and formalizes theoretical foundations, methods and means of conducting therapeutic procedures in the IM (CIM), as well as their interrelations with the corresponding diagnostic information.
The theory and technology of training, development of the IM-specialist (CIM-specialist)	Describes educational theoretically and practically oriented content, as well as technologies for its implementation into the educational process for the preparation and improvement of the qualification of the IM-specialist (CIM-specialist)

The development of CIM semantic space should be based on the axiomatic-deductive scheme of CIM theory development that satisfies the requirements for its semantic

quality [17]. The first component of the strategy is the deductive-axiomatic strategy of CIM terminology-conceptual apparatus development that involves: 1) the definition of fundamental concepts of CIM theory; this enables the presentation of these data in a format accessible for computerised processing in the form of a hierarchy of classes and relations between them, and further computerised processing of the semantics of the defined informational units by the developed ontology; 2) the definition of derivative concepts of CIM theory, basing on its fundamental concepts. The second component is a deductive-axiomatic strategy for establishing the true statements of CIM theory; it involves: a) the definition of true statements-axioms, the truth of which is accepted with no proof; b) the development of rules for logical derivation of all statements of the theory from its axioms. To unify the conceptual apparatus of CIM, the use of a 'top-down' method with a plurality of iterations following the general model of quality data stored in the structured format of computer system according to the ISO/IEC 25012 international standard would be the most effective.

Consider in more detail the diagnostic ontology of CIM. The diagnostic CIM-ontology includes the nosological ontology of CIM, the topological diagnostic ontology of the CIM, the ontology of the diagnostic methods of the CIM and the ontology of the diagnostic metrics of the CIM (see Table 3).

Table 3. Components of the CIM diagnostic ontology

Components of the diagnostic ontology of CIM	Description of components of diagnostic ontology CIM
Nosological Ontology of CIM	Nosological CIM ontology reflects knowledge about the types (classes) of diseases that are taken in the diagnostic theory of CIM
Topological diagnostic ontology of CIM	Topological diagnostic ontology CIM reflects the data on the topological localization of diseases related to the physical body, the energy system (field system, Chi system) and information systems (psycho-mental-spiritual system, Shen system), in particular, contains information about body parts, organs , tissues of the physical body, information about bioactive points and energy channels of the human energy system, information about information, psycho-emotional, mental and spiritual topological aspects of a person.
Ontology of diagnostic methods of CIM	The ontology of diagnostic methods in the CIM reflects the knowledge about the methods (channels) of obtaining and the specifications of sensory diagnostic information in the CIM.
Ontology of the diagnostic metric of CIM	Describes the quantitative characteristics (indicators) of the diagnostic space of the CIM, which determine the degree of manifestation of a particular disease and can be given on a certain number (for example, 1 to 5) or non-numeric (eg, very weak, weak, medium, strong, very strong) scale.

For development and specification analysis of conceptual model description of CIM the OWL language was chosen [15]. A fragment of the ontology of CIM diagnostic methods developed in the Protégé environment using the OWL ontology description language is presented in Figure 6.
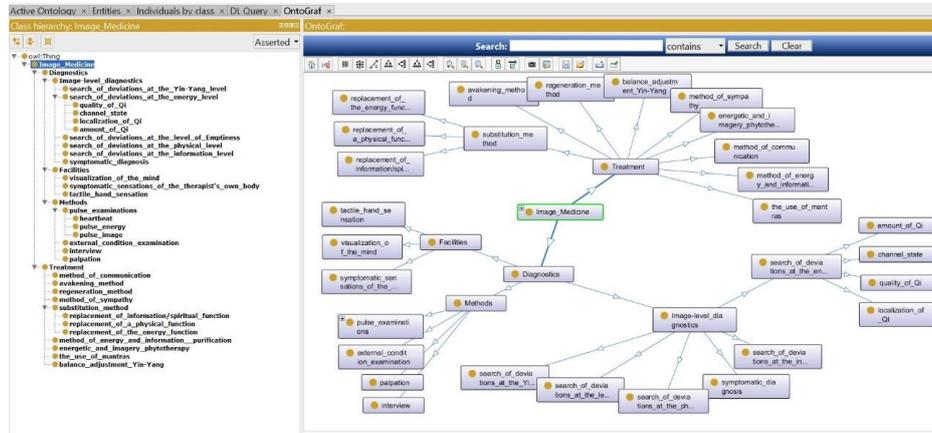
Fig. 6. A fragment of the ontology of CIM

4 Conclusions

The construction of ontology CIM will make possible to unify, standardize the technologies of presentation of information (data and knowledge) in the field of CIM, which will make it possible to overcome the problem of semantic heterogeneity of less structured and difficult formalized knowledge in the field of TCM and CIM, since the use of ontologies eliminates subjective factors, polysemantics, fuzziness of concepts and images that are used explicitly or implicitly by the CIM therapists in the process of diagnostic and therapeutic decision making. Ontology CIM will make it possible to standardize the conceptual-terminology apparatus of the CIM, which will significantly facilitate the CIM-therapists to exchange and accumulate their knowledge and experience in unificated way in an integrated information environment. In addition, the onto-orientation of the developed environment provides the ability to maintain the necessary level of integration, integrity of knowledge and data in the CIM for various information technologies and systems, as well as the possibility of multi repeated use of knowledge in the CIM for various information systems and applications.

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