
Original Article

Effective Application of Knowledge Management in Evidence-based Chinese Medicine: A Case Study**Angela Weihong Yang, Garry Allan, Chun Guang Li and Charlie Changli Xue**

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Chinese medicine (CM) practice, as a knowledge-based industry, has not embraced knowledge management (KM) techniques widely. However, KM may facilitate the adaptation and promotion of evidence-based CM. A KM framework was introduced to its activities in evidence-based CM through the development of a CM portal. A codification strategy was used to codify and store knowledge systematically in a database. Several approaches were developed and implemented to address specific needs for CM such as centralizing the information, encouraging collective efforts, promoting integration of explicit and tacit knowledge, and developing a flexible technology and support system. Following the established KM framework, the RMIT Chinese Medicine Portal (www.chinese-medicine.com.au) was built up with four major components: organizational knowledge, knowledge workers, KM processes and information technology. Knowledge on Chinese herbs was classified into core, advanced and innovative categories, which involved the development of the monograph template. A working group was organized including CM, pharmacology and information technology professionals to implement this proposal with following sequential development stages: knowledge creation/acquisition, storage/organization, distribution and application. User interface and web language were also defined and accomplished. This case study demonstrates the applicability of KM in evidence-based CM through a multidisciplinary collaboration, such as, an effective collaboration between CM and information technology. The study also shows the potential of KM application in other disciplines of complementary and alternative medicine.

Keywords: Chinese Medicine Portal – codification strategy – database – evidence-based medicine

Introduction

Chinese medicine (CM) has a long history covering thousands of years (1) with extensive literature and clinical applications that play a critical role in Chinese healthcare. Over the past decade, there has been significant growth in the practice of CM outside China (2,3). This trend has also been matched by a growing interest from the research communities in the Western world.

Thus, in recent years, a rapidly growing body of scientific knowledge has developed that demonstrates the efficacy and safety of CM for a number of clinical conditions, such as, adult atopic dermatitis (4), irritable bowel syndrome (5), seasonal allergic rhinitis (6) and dementia (7).

In parallel with this growth, CM education has experienced increasing accreditation and recognition in Western countries including Australia. This has been exemplified at RMIT University, which was the first public university in the Western world to introduce comprehensive CM programs, and undertake extensive teaching and research activities. All RMIT University's CM programs have been approved by the newly established Chinese Medicine Registration Board of Victoria,

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Australia under the Board's 'Guidelines for the Approval of Courses of Study in Chinese Medicine as a Qualification for Registration' (8).

However, the development of CM education, clinical practice and research has encountered significant difficulties as the majority of CM literature is in Chinese, thus limited information is available in the major bibliographic databases such as Medline, BioMed and Embase. Consequently, the ability to maintain, consolidate and share CM knowledge has become a major challenge to CM professionals. A recent review (9) identified some resources in English for herbal medicine, including reference books and web sites. However, these resources have a number of limitations, such as, focusing on Western herbs with the inclusion of a very small number of Chinese herbs, inadequate description of basic characteristics of Chinese herbs and a lack of an evidence-based approach for the production and synthesis of this information. The majority of Chinese herbal medicine (CHM) databases, such as, Herbasin Herb Database (<http://www.herbasin.com/herbs.htm>), Dictionary of Chinese Herbs (http://alternativehealing.org/chinese_herbs_dictionary.htm), RMHI TCM Herbal Database (<http://www.rmhiherbal.org/phar1/a-index.html>), Single Herbs (<http://botanicum.com/english/singad.html>), Traditional Chinese Drug Database (http://www.cintcm.com/content/tcm_database/zhongyao_eng.htm) and TCM Materia Medica (Chinese Herbal Database, <http://www.tcmbasics.com/materiamedica.htm>), only provide the basic information on CHMs, such as, botanical source, properties, actions, indications and dosages. However, systematically organized information related to judicious and safe use of CHMs based on acceptable evidence is lacking. Few of these databases provide information related to identification, chemical constituents, pharmacology, toxicology, adverse drug reactions and cited references. Currently, there is no database available that provides up-to-date information on CHMs from both Chinese and Western medicine perspectives. Thus, establishing a system that provides comprehensive and reliable information on CM has become an imperative to meet their requirements.

Knowledge management (KM), as a business term, first appeared in 1970s (10) with the characteristics of developing, distributing, combining and consolidating knowledge (11). In addition, effective application of a KM system improves efficiency, consistency and cost-effectiveness (12–14). KM has been widely used in many disciplines, including healthcare administration (15). KM has been demonstrated to be suitable for the support of evidence-based medicine development (16). However, it has not been employed in evidence-based CM that has an urgent need to systematically manage its knowledge. As a result, a KM approach has been considered appropriate to be used as a contemporary information-sharing

method because it involves significant use and availability of information technology.

This case study illustrates the process employed by RMIT CM in developing a CM portal. This portal is intended to be a website for making information available to a wide range of different users. RMIT CM aims to provide students, academia, practitioners and researchers with easy access to accurate and reliable CM knowledge through the portal.

Methods

The implementation of KM in evidence-based CM involved three stages: KM strategy decision, design of KM architecture and development of KM system.

KM Strategy

The goal of KM at RMIT CM is to ensure a strong nexus between teaching and research, facilitating clinical practice, and equipping students with the skills for effective information access and utilization. KM strategies were determined by linking CM knowledge and the goal of KM within RMIT CM. CHM was prioritized as the first modality to be adapted as it is the most commonly used CM therapy.

A codification strategy was selected because of its capabilities of codifying and storing information systematically in a database (17). A large amount of information can be processed in a structured way by the database and search engines, whilst providing ready access to content. Several approaches were used to achieve this including managing the information development online whilst ensuring the development team had full remote access to the system, encouraging collaborative efforts, promoting integration of explicit and tacit knowledge and developing a flexible technology and support system, which facilitates a communication network between internal and external members of the development team.

Design of KM Architecture

To facilitate KM in CHM, a four-component KM framework was followed, including organizational knowledge, knowledge workers, KM processes and information technology (18). Knowledge in CHM was classified into core, advanced and innovative categories according to Zack's classification (19), which involved the development of a monograph template. A development team was established to implement this proposal by following sequential development procedures: creation/acquisition, storage/retrieval, transfer and application (20). Moreover, relevant technologies were determined to assist this development, and these are described in 'development of KM system' section subsequently.

Development of KM System

Different KM strategies require different information technology support processes (17), as technology is a driver and enabler in KM networking (21). As the portal has been defined as 'a gateway to a wealth of knowledge' (22) and the most typical tool for KM (23), the RMIT Chinese Medicine Portal was identified as a novel approach for applying KM in CHM. A Microsoft (MS) Access-based database was used to accommodate information on CHM. Hypertext Preprocessor (PHP) was utilized as the key web language, and the portal was presented via a standard Internet browser.

Results

KM Architecture

Organizational Knowledge

Based on the characteristics of single Chinese herbs, the knowledge in CHM was categorized as core, advanced and innovative to meet the requirements from different users such as students, academia, practitioners and researchers.

Core knowledge was defined as the basic knowledge required by all CM students and practitioners, including characteristics of each herb, covering property (nature, taste and channels entered), action, indication, contra-indication and dosage. Advanced knowledge referred to Western medicine description of every herb, consisting of identification, chemical ingredients, pharmacology, toxicology, herb-herb/herb-drug interactions and reported adverse events. The provision of this evidence-based information provides RMIT CM with a leading source of CHMs. Innovative knowledge covered regulatory issues, and recent research and clinical data employing both a critical review and an evidence-based approach. The content was reviewed by the experts in the relevant areas. The quality of the reviewed information significantly differentiates the RMIT initiative from other approaches to the aggregation of CHM information.

Knowledge Workers

The development team supporting the initiative included staff with expertise in CHM, pharmacology, toxicology and information technology. The goal of this group was to provide reliable information for CHM teaching, research and practice through a portal interface.

KM Processes

When developing the portal, CHM knowledge was managed through creation/acquisition, storage/retrieval, transfer and application processes. These processes ensure that the content of CHMs was collected comprehensively and accurately and can be retrieved easily and consistently.

Creation/Acquisition Process. CHM information was gathered from a wide range of sources and methods, such as, searching reference textbooks (e.g. CHM textbooks used in Mainland of China) and existing bibliographic databases (e.g. PubMed and Embase). The information on individual Chinese herbs was refined and structured according to the standard monograph template, consisting of core, advanced and innovative knowledge. There are seven sections in the monograph template: Names, Identification, Chinese Medicine Description, Western Medicine Description, Current Regulations, Recommendations and References. This monograph template was presented in a format that meets the requirements of CM education, clinical practice and research.

Storage/Retrieval Process. An MS access database has been developed for storing and categorizing the data. All other digital objects, such as, image and sound files are linked to this database. The website is organized to show information following herbs, formulae, classifications and chemical ingredients. This database also has search functions, such as, searching by different herb names and traditional classification of herbs, to meet the needs from various users.

Transfer Process. The core of transfer is to transfer the knowledge to the right person at the right location on time. RMIT CM makes CHM contents available to the external users via the standard web browser. A user-friendly interface has been designed to improve retrieving productivity, which further supports decision-making and problem solving. The relevant users can directly access the content through an authorized account. The technology ensures that the users will retrieve the CHM information accurately.

Application Process. When completed, the portal will include commonly used CHM monographs as information resources. The monographs are presented using a standard format, which makes it easy for CHM knowledge to be integrated and applied as requested. The key advantage of the portal is that the herb monograph can have multiple users and be used cost-effectively. Users are able to view the full list of herbs or view specific herb monographs by keywords and herb names. Information technology can support and increase the speed of information integration and application through facilitating the updates of and access to content capabilities.

Information Technology

All user interfaces were HTML/JavaScript based. PHP was selected as the core language for the portal. The data exchange between the database store and the distribution application was via an Open Database Connectivity (ODBC) layer, generic connection strings and SQL

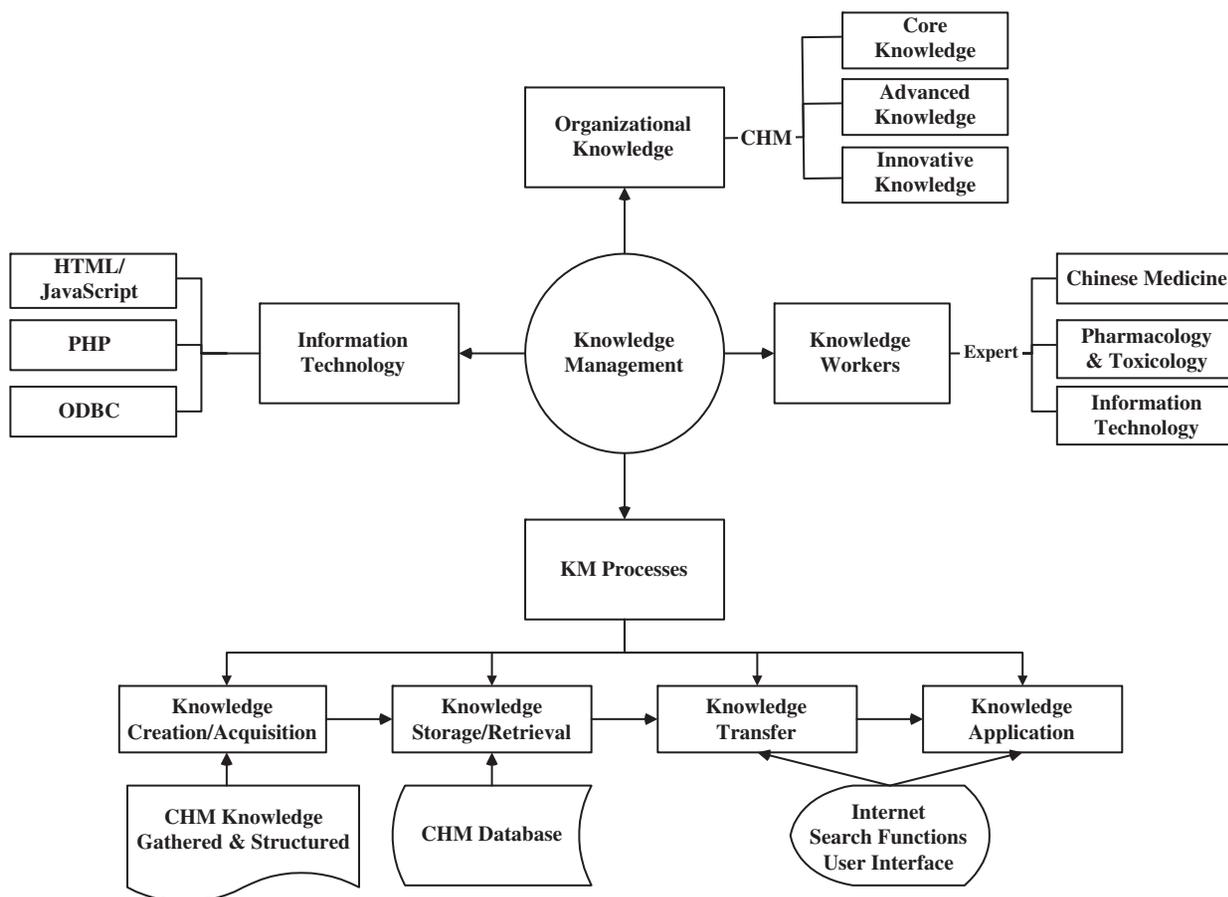


Figure 1. KM architecture for the development of RMIT Chinese Medicine Portal.

statements. Within this system, users were able to provide feedback to the portal administrator for further KM development when interacting with the portal resources.

The KM architecture is summarized in Fig. 1.

RMIT Chinese Medicine Portal

As a result of the strategy and procedures indicated in Fig. 1, the RMIT Chinese Medicine Portal (www.chinese-medicine.com.au) has been developed. All CHM monographs were developed following the template as described in the 'creation/acquisition process' section. Currently, the core knowledge for over 370 commonly used CHMs has also been developed. Three of these herbs, Radix Bupleuri (*Chai Hu*), Radix Angelicae Sinensis (*Dang Gui*) and Radix Aconiti Lateralis Preparata (*Fu Zi*) with the data supported by images and sound files are available online.

Discussion and Conclusions

This article presents our experience in building a CM portal. This study aimed to assist the students, academia,

practitioners and researchers to retrieve, integrate and share CHM monographs via a knowledge-based CM Portal, which will facilitate the development of evidence-based CM.

Within the monograph, information from 'Names' and 'Chinese Medicine Description' can meet the teaching and learning needs of students and academia. Researchers are able to retrieve information on identification of CHMs and laboratory and clinical research from 'Identification' and 'Western Medicine Description'. Clinical practitioners can access the clinical data and receive the recommendation and current regulations for using the relevant CHMs. A reference list is also available for users' information on all citations. By doing so, the application of KM can strengthen the relationship between teaching and research, and facilitate clinical practice as well as provide ready access to students, practitioners and researchers to comprehensive and reliable data efficiently and effectively. This process may improve productivity and facilitate timely decision making.

This Internet-based case study illustrates that KM architecture (Fig. 1) can be applied to evidence-based CM. The literature shows that content management,

effective collaboration and information technology were the three key factors in the implementation of KM (24). This was confirmed in our study. Management of reliable content is a critical factor in KM. In this work, content was systematically structured, in order to meet the requirements of learners from different backgrounds. The content can be searched and presented in a consistent format, making it possible for the users to access the CHM repository efficiently, effectively and consistently, and to exchange knowledge synchronously or asynchronously. Expertise in CHM, pharmacology and toxicology and information technology contributed to the development of the portal through the collaboration of experts in different disciplines.

This case study also demonstrates how KM principles can be applied to organizing CHM information and facilitating access by different users. KM can synthesize CHM information in response to requirements in education, clinical practice and research, analyze CHM information according to an evidence-based approach, integrate explicit and tacit knowledge, and connect users to CHM contents. The application of KM in CM holds the promise of improving the efficiency of knowledge sharing, ensuring consistent outcomes, facilitating the integration of explicit and tacit knowledge and providing an alternative avenue for students, researchers and practitioners to learn CHM from both CM and Western medicine perspectives.

With the growing use of complementary and alternative medicine (CAM) globally, Western medicine doctors and pharmacists are increasingly interested in the proper use of CAM, but at this point, do not have adequate knowledge for CAM practice (25–27). To address this need, reliable evidence-based and readily accessible resources for CAM such as electronic databases, will play a significant role in facilitating this development (27–28). Another effective approach is to incorporate evidence-based information on CAM into medical education (29). Currently, the majority of existing CAM websites are consumer-oriented and developed by commercial entities (30). From conception, our development of a CM portal considered students, practitioners and researchers as the client group. Accordingly, the information was selected and reviewed to meet their requirements. The KM architecture (Fig. 1) used in undertaking this work has the potential to advance knowledge-sharing methods and capabilities in education and practice of other CAM disciplines.

Further study will be extended to three areas. First, full monographs for all CHMs included in the portal will be developed following the standard template. The content will be updated regularly. Second, the portal with full monographs of all CHMs will be evaluated by students, practitioners and researchers by conducting a survey. Feedback from different users will be considered for the improvement of the portal. Third, the concept and

framework of KM will be extended to other aspects of CM such as continuing professional education, research and other modalities of CM therapy, commencing with acupuncture.

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