© 2019 Journal of Pharmacy & Pharmacognosy Research, 7 (4), 246-259, 2019
ISSN 0719-4250
http://jppres.com/jppres

*Review | Revisión*

# Progresses and challenges in the traditional medicine information system: A systematic review

[Avances y desafíos en el sistema de información de medicina tradicional: una revisión sistemática]

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**Abstract**

*Context*: Traditional medicine information system (TMIS) is a substructure founded on the targeted application of technology. It also serves as a tool supporting the decisions in traditional medicine (TM). However, due to following a different approach in the treatment process, the TM has faced some challenges.

*Aims*: To review the universal progresses and challenges in TMIS.

*Methods*: This study was conducted using systematic search and review. The resources were retrieved through searching the key words related to the TMIS in the available databases including Science Direct, WOS, ProQuest, PubMed and IEEE. The findings were classified in to two distinct categories of progresses and challenges relating to the TMIS.

*Results*: As many as 28 studies conducted from 2000 to 2017 were included in this research. The majority of the studies were related to 2010 or after 2010 conducted in China. Progresses identified in this TMIS were categorized into four types including the development of the database, universal standardization of the TM, development of the clinical data warehouse, and application of information technology in the TM. The challenges were classified into four distinct categories, namely the lack of treatment protocols in TM, the necessity of developing a universal unified terminology, the necessity of creating a medical ontologies and the necessity of ensuring the data quality.

*Conclusions*: Information technology forms a significant aspect of the TM modernization. To develop both the TMIS and the knowledge sharing tools, it is necessary to remove the problems and challenges involved in the data record process in the TM.

*Keywords*: challenges; herbal medicine; information systems; opportunity; traditional medicine.

**Resumen**

*Contexto*: El sistema de información de medicina tradicional (SIMT) es una subestructura fundada en la aplicación específica de la tecnología. También sirve como una herramienta de apoyo a las decisiones en medicina tradicional (TM). Sin embargo, debido a seguir un enfoque diferente en el proceso de tratamiento, la TM ha enfrentado algunos desafíos.

*Objetivos*: Revisar los avances y desafíos universales en SIMT.

*Métodos:* Este estudio se realizó mediante búsqueda y revisión sistemática. Los recursos se recuperaron mediante la búsqueda de las palabras clave relacionadas con el SIMT en las bases de datos disponibles, incluidas Science Direct, WOS, ProQuest, PubMed e IEEE. Los hallazgos se clasificaron en dos categorías distintas de avances y desafíos relacionados con el SIMT.

*Resultados*: Hasta 28 estudios realizados desde 2000 a 2017 se incluyeron en esta investigación. La mayoría de los estudios se relacionaron con 2010 o después de 2010 realizados en China. Los avances identificados en esta SIMT se clasificaron en cuatro tipos, incluido el desarrollo de la base de datos, la estandarización universal de la MT, el desarrollo del almacén de datos clínicos y la aplicación de tecnología de la información en la MT. Los desafíos se clasificaron en cuatro categorías distintas, a saber, la falta de protocolos de tratamiento en MT, la necesidad de desarrollar una terminología unificada universal, la necesidad de crear ontologías médicas y la necesidad de garantizar la calidad de los datos.

*Conclusiones*: La tecnología de la información constituye un aspecto significativo de la modernización de la MT. Para desarrollar tanto el SIMT como las herramientas de intercambio de conocimientos, es necesario eliminar los problemas y desafíos involucrados en el proceso de registro de datos en el MT.

*Palabras Clave*: medicina tradicional; oportunidad; retos medicina herbaria; sistemas de información.

ARTICLE INFO
Received: February 24, 2019.
Received in revised form: June 11, 2019.
Accepted: June 11, 2019.
Available Online: June 15, 2019.
Declaration of interests: The authors declare no conflict of interest.
Funding: The authors confirm that the project has not funding or grants.

## INTRODUCTION

Traditional medicine (TM) is a collection of knowledge, skills and practices that the health maintenance as well as prevention, diagnosis, improvement or treatment of the physical and mental diseases" (Benzie and Wachtel-Galor, 2011; Smith et al., 2014). Herbal drugs form the main part of the TM system (Benzie and Wachtel-Galor, 2011). According to the WHO's report, 70% to 95% of the people across the world use the herbal drugs for their primary healthcare purposes (Carmona and Pereira, 2013; Bonifácio et al., 2014). Herbal drugs are currently the oldest and the most frequently used medicine system in the world (Ogirima et al., 2015). A large portion of the population in the developing or developed nations still relies on the TM and herbal medicine for their primary healthcare (Jivad et al., 2016; Parsaei et al., 2016; Rouhi-Boroujeni et al., 2016). More than 90% of the people in Africa, 70% in India, 70% in Germany, 48% in Australia, 70% in Canada, 42% in America, 39% in Belgium and 76% in France use herbal drugs for meeting their healthcare requirements (WHO, 2004; Sen et al., 2011; Mafuva and Marima, 2014; Sen Chakraborty, 2017). Currently, nearly 80% of the drugs used for the body immunity, cardiovascular systems and anticancer drugs are of plant origin (Fang et al., 2005).

As a growing practice around the world, TM is experiencing its rapid advancements era based on health information technology. The modern and technology-based techniques are vital for controlling and maintaining the quality of the herbal drugs (Sen and Chakraborty, 2017). The creation of a database for storing a large portion of the data and their transformation in to useful data has effectively contributed to the progress of the TMIS (Noraziah et al., 2011; Ogirima et al., 2015). China's Comprehensive Herbal Medicine Information System for Cancer (CHMIS-C) has served as an appropriate information resource for the TM researchers (Fang et al., 2005). In the same way, Web-based Decision Support System for Prescription in Herbal Medicine in Nigeria has played a significant role in controlling the quality of the herbal drugs prescription (Ogirima et al., 2015). Developed for consulting with the patients in the e-health system, E-health Record System (EHRS) in Australia has successfully assisted the TM's practitioners in the treatment management (Bjering et al., 2011).

Compared to the non-traditional medicine, the TM follows a different approach in the treatment process (Hasanpour-Dehkordi et al., 2017; Solati, 2016; 2017). The TM's clinical data have peculiar informational content including the disease signs and symptoms, the diagnosis pattern and herbal drug's chemical formula (Ansani et al., 2003; Kim et al., 2013; Carvalho et al., 2014). Hence, the structured information system effectively records the TM's data. In this way, it prevents reworks, lack of coordination and conflicting reports and allows data analysis and learning from the available data (Wiesner and Knöss, 2014; Walker, 2015). Despite the high consideration given to the TM practice around the world, it seems to face remarkable challenges. The most important recognized challenge is the lack of a reference standard for determining the proper dosage of the herbal medicine for the patients. This in turn has resulted in the creation of incorrect and incomplete information about the herbal drugs (Aghebati et al., 2014; Ogirima et al., 2015). Lack of quality assurance instructions, lack of a universal unified terminology, lack of evaluation of the safety as well as the lack of patient information system in the TM-centered clinics or hospitals are among the other challenges (Evans, 2008; Zhou et al., 2010; Janamian et al., 2011; Niemeyer et al., 2013; Snow, 2016). Unfortunately, the herbal drugs are not covered by the health insurance in many he member states of the EU. These countries seem to have low motivation for investment and conducting clinical and non-clinical research in this domain (Wiesner and Knöss, 2014). The herbal drugs are commonly believed to have no side effects so that many consumers regard them healthier than the chemical drugs. It is important to know that the irrational use of these medicines would be associated with increased risks endangering the treatment process success (Mukherjee et al., 2015). The effectiveness

of TM as a complex system have been convincingly tested and validated in numerous scientific studies. The TMIS in fact provides a substructure for managing the health services within the TM domain. This system has brought in some positive consequences including healthcare quality promotion and costs reduction. Taking all these into account, this study was an effort to review the recent researches on the TMIS and the effect of information technology on the TM progress. It was also tried to identify the challenges in the development of the information system software used for the TM. To do so, the relevant articles published in 17 recent years were systematically searched and evaluated from different aspects.

## METHODOLOGY

### Study design

This research was conducted based on systematic search and review methodology covering the following four stages: identifying the research questions, locating the relevant studies, selecting the studies and finally charting the data and collating. For the purpose of this research, the foregoing four stages were organized as follows (Fig. 1):

*Stage 1*

The research questions and objectives were structured based on the study of TMIS and its respective progresses and challenges.

*Stage 2*

The respective resources were identified and retrieved through searching the key words relating to the TMIS from various available databases such as Science Direct, ProQuest, PubMed, WOS, IEEE and search engines Google scholar. The respective queries have been presented in Table 1.

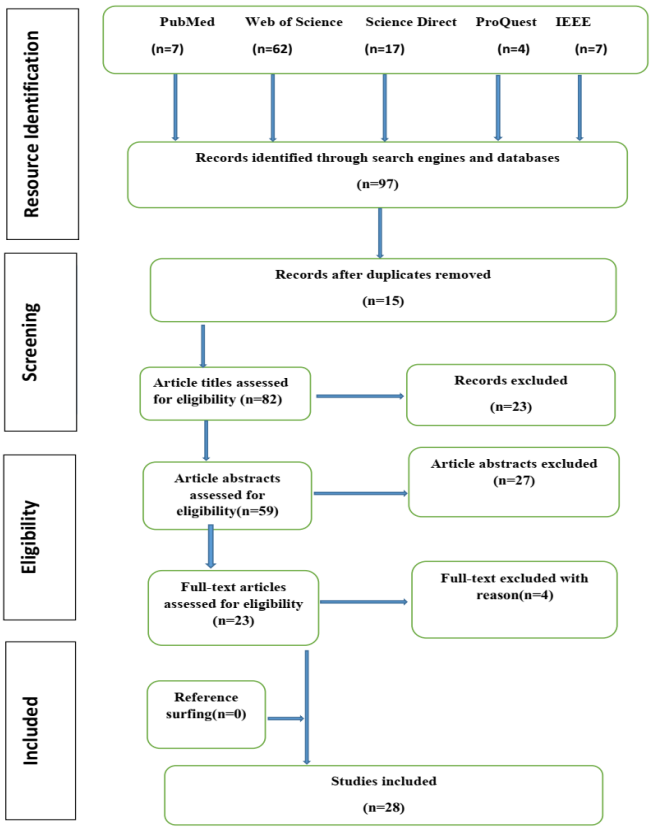


**Figure 1.** PRISMA flow diagram of the study.

*Stage 3*

To select the articles, the PRISMA chart was used. Using the queries represented in Table 1, 97 articles were identified in total. In the next step, the identified articles were put in to the Endnote software. The produced list was then independently checked by two raters in terms of title, abstract and the content given the inclusion and exclusion criteria (Table 2). In this way, 28 articles were finally included in the study. The cases of inter-rater disagreement were resolved by holding a mutual meeting. Furthermore, the inter-rater agreement estimated by using kappa coefficient (κ) was found to be 0.81 (statistically significant at $p<0.001$). The Fig. 1 represents the protocol prepared for selecting the article.

**Table 1.** The search strategy of the research.

| **Search Strategy** | |
|---|---|
| Search engines and databases: PubMed, ISI web of science, Science Direct, Google Scholar | |
| Limits: Language (only resources with at least an abstract in English) | |
| Time: 2000 to present | |
| Date: up to 2018, March, 01 | |
| Strategy: #1 AND #2 AND #3 AND #4 | |
| #1 | (traditional OR Herb*). [TI]. |
| #2 | (medicine*).[TI]. |
| #3 | ("information system" OR "information systems" OR "data system" OR "data systems" OR "health system" OR "health systems" OR "Support System" OR "Support Systems" OR DSS OR knowledge systems). [TI-Abs-Key] |
| #4 | (information techno*).[TI-Abs-Key]. |
| #5 | (challenge OR barrier). [TI-Abs-Key]. |
| #6 | (progress OR opportunity). [TI-Abs-Key]. |

**Table 2.** Inclusion and exclusion criteria for articles.

| **Inclusion criteria** | **Exclusion criteria** |
|---|---|
| Journals and conference proceedings published between 2000 and 2018. | The articles published in languages other than English were excluded. |
| The articles that have been published with abstract and full text. | The articles whose full texts were not available were excluded. |
| The articles that have used the TM or herbal information systems. | The newspapers, letters to the editor, workshop, poster and short reports were excluded. |

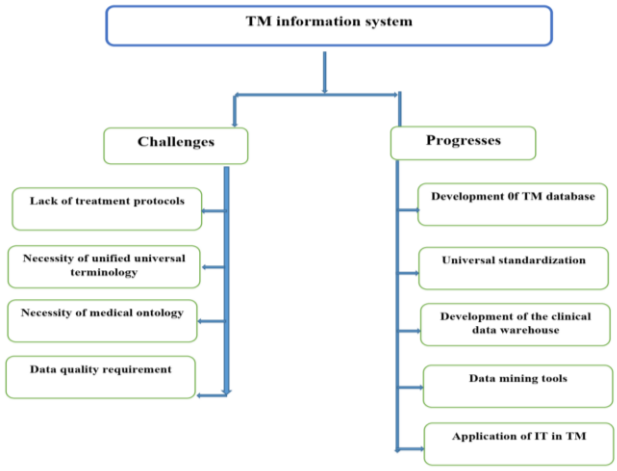


**Figure 2.** Challenges and progresses in TCM.

## RESULTS

As discussed earlier, 28 studies conducted between 2000 and 2018 were included in this review. It is worth mentioning that the articles related to 2010 and after were mainly from China, Malaysia, Japan and Australia. The findings of the study were sorted into two main categories, namely progresses and challenges in TMIS. The former focused on the information technology, software and technical systems used in TM while the later tried to identify the challenges and problems in the development of TM-specific information systems and information technology software (Fig. 2).

### Progresses in TMIS

*Design & development of traditional medicine database (TMDB)*

The creation of TMDB is one of the main progresses achieved in the field of TM. Being common in China and India, this system has specifically designed to support the decision-making system and data mining and processing (Chen et al., 2006; Noraziah et al., 2011; Ikram et al., 2015; Ogirima et al., 2015). There are a lot of databases in TM (Mukherjee et al., 2015). Traditional Chinese Medicine database (TCMID) is the most comprehensive database in use in China representing remarkable advances in information integration (Xue et al., 2012). Besides the combinations of the herbs, this database provides the three-dimensional structures of the herbal combinations for research use (Zhang et al., 2013).

*Universal standardization of TM*

Nowadays, different nations have recognized the critical function of the standards in promoting the levels of quality, safety, validity and efficacy. These factors form the underlining of TM policies and plans (WHO, 2007; 2013). As a result, some nations have made effort to take effective steps towards the development of the TM knowledge base through sharing the information on the regulatory strategies (Claeson, 2014). In this line, for the universal standardization of the TM, the International Organization for Standardization (ISO) passed the ISO/T249 in 2009 (Ozaki et al., 2017). The herbal products standardization rules follow the international standards (Mukherjee et al., 2015). In the European Union, a complex regulatory framework for the management of the herbal medicinal products has been incorporated into the guidelines of EC2/83/2001 and EC/63/2003. According to these guidelines, all the herbal medicines should be in conformity with the good manufacturing practices and pattern (Bouin and Wierer, 2014). This pattern shall provide some insight regarding what information to be recorded in the herbal medicine prescription as well as its medical function (Carvalho et al., 2014; Wiesner and Knöss, 2014; Zhang et al., 2016). To meet the

quality standards governing the herb monographs, some information such as the complete scientific name of the herb, its ingredients and identity number must be provided. The identity number is required to be presented to the pharmacy (Zhang et al., 2016). To improve the regulatory framework for the record of the herbal drugs, the find has certified the applied RDC 26/2014 standard. As per this standard, the herbal medicines must be recorded prior to mass production and drug distribution among the consumers. The drugs records will be legally valid for 5 years (Souza et al., 2014).

*The development of the clinical data warehouse (CDW) in TM for knowledge discovery and medical decision support*

As one of the most significant TM information resources, CDW is a technical strategy used for storing, managing and processing the mass data (Zhou et al., 2010). CDW integrates the data of the structured electronic medical record (SEMR) to be used for both the medical knowledge discovery and clinical decision system (CDS) in TM (Zhou et al., 2010; Ogirima et al., 2015). In 2002, China government has created the TCM Electronic Medical Record (EMR) (TCM-EMRD). This database contains more than 3500 electronic medical records relating to the in-patients. In fact, it includes the data of TCM clinical practice on the inpatient including the TCM diagnosis and the description of the concepts, symptoms and formula of the herbal medicines (Feng et al., 2006).

*Discovery tools for the TM modernization*

As a strong tool for knowledge acquisition from the data repository, data mining has found application in nearly all the TM areas. Technically, it serves as a support for the TM modernization process. Discovering the relations in the TM features based on data mining not only may promote the quality standard but also may facilitate the discovery of the TM principles (Wang and Miao, 2012). To analyze the improper drug prescription, a collection of 1920 prescriptions retrieved from Taiwan National Health Insurance Research Database were analyzed. According to the analysis results, 19.5% of the prescriptions contained wrong medicines (Yang et al., 2016). In the same vein, the MeDisco/3T text mining system (medical discoveries in the TM) has mainly developed so as to extract the knowledge from the Chinese Traditional Medicines (CTM's) texts. This system derives the data on the structured formalization of the TM. These data include the nomenclatures of the medicinal herbs, the combinations and ingredients available in the TM practice and their description (Lukman et al., 2007).

*Application of information technology in TM*

IBM Corporation is developing a technology that will assist the hospitals in standardizing the patient records for a group of hospitals located in Guangdong province in Southern China. Such technology will enable using the patient's records for the treatment analysis through CTM. Information technology is widely used in TM (Jokiniemi, 2010). The medical informatics includes the electronic health records, traditional knowledge digital libraries, image processing systems, telemedicine, clinical decision support systems (CDSS) and access to the health information. All these are founded on the information technology infrastructure (Ikram et al., 2015; Sen and Chakraborty, 2017). Two cases of the application of information technology in TM realized during the last decade are Information-based multidimensional High-Performance Liquid Chromatography (HPLC) and intelligent mobile platform. Developed in Chain, the former is used for evaluating the TM and herbal medicines (Yang et al., 2013) while the latter has been designed for identifying the herbal medicines in China (Souza et al., 2014). According to the systematic review, the development of expert systems and knowledge sharing systems and the expansion of disease diagnosis tools using computer in TM are among the major functions provided by TCM IT applications. These systems will improve the quality and safety of the healthcare in the TM (Jokiniemi, 2010; Celik, 2015). It is noteworthy that the IT substructures like HIS and Telemedicine system have not still been applied and strategized for supporting the TM (Chen et al., 2006; Ikram et al., 2015).

## Challenges in TMIS

*Lack of treatment protocols in the TM*

Policy making and standardization are deemed as the most difficult challenges faced by TMIS (Zhou et al., 2005; Telles et al., 2014; Ikram et al., 2015). This difficulty results from the remarkable differences in the methods applied for each type of intervention as well as physician education. Some TMISs tend to focus on the physical aspects of the treatment systems while some other give more consideration to the spiritual and metal aspects (Ikram et al., 2015). The lack of treatment protocols and standardization is the main problem investigated in TM in 20th century. This has brought in a huge information gap between the TM practitioners and consumers (Lai et al., 2014). The WHO "Traditional Medicine Strategy 2014–2023" published by WHO reports that TM has been launched in more than 100 nations across the world. This has transformed TM into an international industry (Wang et al., 2016). However, the lack of well-established treatment standards has weakened this type of medicine influencing its international advance, negatively (Ansani et al., 2003; Wang et al., 2016).

*The necessity of a unified universal terminology*

Sometimes, one medicinal plant happens to be named differently using the general, Latin, local or commercial names. In contrast, some other of different species take similar names. This becomes more complicated given the prevalence of the terminology specific to different world languages (Mukherjee et al., 2015). Currently, there is no universal terminology and a unified coordinated regulatory attitude (Wiesner, 2014). To standardize the structured clinical data, an integration of the systematic terminologies is required (Liu et al., 2012). Accordingly, in line with the information standardization projects such as International Classification of Traditional Medicine (ICTM), a new project for the compilation of an international standard terminology has been incorporated into the recent ICD-11 revision (WHO, 2007; Gao and Watanabe, 2011; Katayama et al., 2012).

*The necessity of medical ontology and unified traditional Chinese medical language system (UTCMLS)*

The huge volume of the ambiguous terms and multiple meanings is a common problem experienced when searching in different databases. Due to this problem, it is necessary to construct the ontology in the TM-related IT software (Jokiniemi, 2010). The TM clinical data is involved with numerous aspects and heterogeneous informational components. Accordingly, a large-scale data analysis is required for ensuring the achievement of valid analytical data. The automatic extraction of structured data from the free texts is challenging due to involving with different terms, synonyms and concepts used in the medical texts (Liu et al., 2012). To remove the obstacles, a standard terminology system of appropriate hierarchical structure is required. This system would allow reaching logical results from data extraction process (Lukman et al., 2007). Initiated in 2001, UTCMLS project was mainly designed so as to construct a reusable and modifiable ontology. This ontology is required for integrating and adjusting the whole complex set of TM knowledge. Similarly, other terminologies such as Systematized Nomenclature of Medicine_ Clinical Terms (SNOMED_CT) can be effective in solving the problems (Feng et al., 2006; Gao and Watanabe, 20; Jokiniemi, 201011).

*Necessity of data quality*

Missing and heterogeneous data and poor quality of the clinical data resources in use in TM all have made the knowledge discovery problematic (Feng et al., 2006). The abnormal data recognized worthless for diagnosis and treatment purposes should not be recorded in the clinical data. Data quality plays a critical role in the data analysis and processing. Despite the quantitative variables such as the laboratory test results, some clinical data including the major complications, the patient's medical records and their respective diagnoses are expressed in natural language in TM. Treatments in TM are often prescribed based on the disease symptoms (Liu et al., 2012). These factors make the data gathering, integration and analysis more dif-

ficult. A summary of the reviewed articles has been rendered in Table 3.

## DISCUSSION

The scientific evaluation of TM is possible through access to information on all the involved aspects. As an appropriate and integrated resource, the TM database provides comprehensive information on all aspects including diagnosis, mechanism of treatment effect, prescription and research on the nature of herbal combinations (Chen et al., 2006; Xue et al., 2012).

To use the TM database effectively, it is necessary to combine a huge amount of data from the database with the laboratory and clinical data. This process is commonly hindered by some obstacles including the insufficient gathering of the data, the poor quality and nonhomogeneous data and the non-reproducibility of the available data (WHO, 2013; Bouin and Wierer, 2014; Zhang et al., 2016). These obstacles will in turn make the organization, processing, analysis, storage and sharing of the data more difficult (Herrera-Hernandez, 2012). Hence, one of the main objectives of the information technology is developing the computer-based information systems, knowledge sharing systems and supporting and consulting tools for diagnosis in the TM (Jokiniemi, 2010).

Another challenge reported for the development and promotion of TM is the lack of guidelines and protocols for the treatment and evaluation of safety and quality control (Mukherjee et al., 2015). Besides, self-medication practice has traditionally been prevalent in TM. As natural products, the herbal medicines are wrongly thought to be safe without any side effects (You et al., 2013).

The WHO is trying its best to facilitate the global standardization of the TM and herbal medicines. Accordingly, in its planned strategy, it has attempted three goals, namely constructing a database and compiling national policies, promoting the safety, quality and efficacy of the TM services through laws and standards establishment and integrating the TM services and self-medication into the national health system (WHO, 2013). Up to now, the majority of the relevant works using the clinical record of TM have been based on well-structured data of prescriptions extracted and organized manually. This method of data collection is highly time-consuming and cumbersome making the provision of enough data required for achieving reliable knowledge impossible (Wang et al., 2010).

Developing a unique information system in TM capable of supporting a huge volume of nonhomogeneous data and information is considered as an intriguing progress in TM modernization. The collected information is used for both pattern recognitions that is the main concept of diagnosis in TM and the treatment technique that may be herbal medicine prescription, acupuncture and other similar practices (Lee et al., 2015). Given the progress of the modern technologies, however, the requirements for data normalization in the clinical records must be met. This is possible through applying a unified terminology and constructing an ontology (Jokiniemi, 2010; Wulamu et al., 2014; De Capitani 2017). This initiative will both facilitate the application of query complex algorithms in the TM domain (Wang et al., 2010) and provide the necessary substructure required for implementing the TMEMR (Feng et al., 2006) and adopting the supporting systems of clinical medicine in the TM field (Lai et al., 2014; You et al., 2013).

## CONCLUSIONS

Following the development of the universal standardization and application of information technology, TM has witnessed a remarkable growth. As it is clear-crystal, we presently face with an ever-increasing volume of medical data and different treatment approaches taken in the TM. Under such circumstances, the role of health information technology has become more important as far as the healthcare quality and safety is concerned. By creating an effective database, it is possible to organize a huge amount of data. Furthermore, the development of CDW, knowledge discovery process and medical decisions support system all have opened new windows into technology applications in TM.

**Table 3.** Comparison of articles included in the review.

| No | Reference | Country | Domain | Result |
|---|---|---|---|---|
| 1 | Noraziah et al., 2011 | Malaysia | Empirical study on medicinal herbs information system (MHIS) in Malaysia | All the information on herbs will be stored an appropriate database enhancing the safety and management of data |
| 2 | Ogirima et al., 2015 | Nigeria | Web-Based Decision Support System for Prescription in Herbal Medicine | The web-based DSS framework prescribes the herbal medicines. This system tries to increase the efficacy of the herbal medicines and promote the proper decision-making by recording the herbal information in the database |
| 3 | Shetti et al., 2011 | Malaysia | Pharmacovigilance of herbal medicines: Current state and future directions | The challenges in the safety monitoring of the herbal medicines were reviewed and he necessity of data quality control, data storage, WHO's database analysis, database management and herbal medicines classification coding were addressed |
| 4 | Chen et al., 2006 | China | Database of traditional Chinese medicine and its application to studies of mechanism and to prescription validation | TCM-ID database was introduced as an appropriate and integrated resource for information on all the aspects of TCM |
| 5 | Ikram et al., 2015 | Malaysia | An analysis of application of health informatics in traditional medicine: A review of four traditional medicine systems | TM progresses such as the development of a database for TM for supporting the decision making system, data research and informatics substructure in TCM, Ayurveda, Arabic, Islamic TM and Malaysian TM have been addressed |
| 6 | Feng et al., 2006 | China | Data Quality in Traditional Chinese Medicine | Given the importance of integration, analysis and application of the data in TM, it is necessary to pay attention to the aspects of data quality including consistency, granularity and completeness in the TM information system |
| 7 | WHO, 2013 | WHO | WHO traditional medicine strategy: 2014-2023 | WHO traditional medicine strategy 2014-2023 has been established so as to promote the safe and efficient use of the herbal medicine |
| 9 | Liu et al., 2012 | China | Data processing and analysis in real-world traditional Chinese medicine clinical data: challenges and approaches | Data quality is important in the analysis of the observational data in clinical TM since it can discover the latent rules and patterns in the clinical records. Data quality is also important in the clinical decision making |
| 10 | Bjering et al., 2011 | *A*ustralia | Electronic medical record information system for patient consultations in Chinese medicine | Designing an information system that helps the TM's practitioners and patients in consultations |

**Table 3.** Comparison of articles included in the review (continued…).

| No | Reference | Country | Domain | Result |
|---|---|---|---|---|
| 11 | Hu and Liu, 2012 | China | The basic theory, diagnostic, and therapeutic system of traditional Chinese medicine and the challenges they bring to statistics | The TM is regarded as a huge treasure in which the application of research tools and data mining and numerous medical technologies are being developed |
| 12 | Celik, 2015 | Turkish | Traditional medicine and modern medicine with information technology | HIS will continue the promotion of quality and safety of the healthcare beyond the modern advancements and initiatives |
| 13 | Herrera-Hernandez, 2012 | USA | A web-based knowledge management system integrating Western and traditional Chinese medicine for relational medical diagnosis | This research has provided the web-based knowledge management system provides as a tool for education and research to be used for the discovery of the key relations between the Western and Chinese traditional medicine facilitating the medical diagnoses |
| 14 | Ru et al., 2014 | China | TCMSP: a database of systems pharmacology for drug discovery from herbal medicines | TCMSP is a pharmacological database for the herbal medicines that covers 499 Chinese plant variants recorded in China's drug inventory along with 29384 combinations as well as 837 diseases |
| 15 | Yang et al., 2013 | China | An automated technique to identify potential inappropriate traditional Chinese medicine (TCM) prescriptions | It is an automated technique for identifying the inappropriate traditional Chinese medicine (TCM) prescriptions to promote the drug safety and care quality |
| 17 | Zhou et al., 2005 | China | An information system model in Chinese herbal medicine manufacturing enterprises | It represents the modeling of information system for the Chinese herbal medicines, describes its functions and discusses the requirements for its implementation |
| 18 | Zhou et al., 2010 | China | Development of traditional Chinese medicine clinical data warehouse for medical knowledge discovery and decision support | CDW combines over 2000 data on the TM treatment on the inpatients with 2000 data on the treatment data relating to the outpatients that includes the symptoms, disease diagnosis and prescription writing as the main constituents of the information |
| 19 | Ansani et al., 2003 | American | Hospital policies regarding herbal medicines | In designing the methods of using herbal medicines in the hospitals, the creation of treatment standard and treatment protocols throughout the country is important |
| 20 | You et al., 2013 | China | Customized Management of Clinical Data in Traditional Chinese Medicine | The management of clinical data in TCM covering the demographic information, symptoms, tests, syndromes and the treatment principles is collected in the TMIS |

**Table 3.** Comparison of articles included in the review (continued…).

| No | Reference | Country | Domain | Result |
|---|---|---|---|---|
| 21 | Wulamu et al., 2014 | China | The research and application of ontology-based information retrieval | The ontology is used for the shared understanding of the desirable scope and can be used as a framework for solving the problem of ambiguous terms |
| 22 | Lai et al., 2014 | Taiwan | Physician and Consumer Acceptance of the Traditional Chinese Medicine Clinical Practice Support System (TCMCPSS) | TCMCPSS has been developed to promote the IS and support the decision making in designing the clinical treatment and practice in TM and is subject to ontology-based information |
| 23 | Wang and Miao, 2012 | China | Automatic symptom name normalization in clinical records of traditional Chinese medicine | The structured data set is vital in the TM clinical record. A unified terminology, automated normalization of data in wide-scale is important for the application of research tools and knowledge discovery |
| 24 | Wang et al., 2016 | China | Current Status of Standardization of Traditional Chinese Medicine in China | Standardization of TM is a gradual process like the practice of innovation and progress in this field. It requires universal promotion and support |
| 25 | Fang et al., 2005 | China | CHMIS-C: A Comprehensive Herbal Medicine Information System for Cancer | CHMIS-C is a comprehensive information system for herbal treatment of cancer. It has been developed based on five modules including the formula, ingredients, compositions, molecular target and reference to be used for cancer treatment |
| 27 | Katayama et al., 2012 | Japan | Analysis of questionnaire for traditional medical and develop decision support system | Designing a questionnaire that asks the lifestyle and mental symptoms from the patients. The practitioners use the data obtained from the questionnaire for supporting the clinical decisions, diagnosis and prescription in TM |
| 28 | Gu and Chen, 2013 | China | Modern bioinformatics meets traditional Chinese medicine | The application of informatics in TM will potentially remove the gap between the TM and modern medicine |

Finding the data associations and features using the search tools not only assists the quality standards promotion but also will clarify the TM's treatment principles for the practitioners. Adopting this method will allow the efficient use of the huge volumes of data more efficiently providing the required reliable information for the TM field researchers. It is clear-crystal that the information plays a critical role in the TM. As discussed earlier, a collection of comprehensive and integrated data is produced from the patient observation time, record of the symptoms and diagnosis pattern. Besides, the terms in use in TM are highly varied while the clinical data record is done using free-text entry. All these factors convincingly justify the need to the development of a unified terminology to facilitate the data management. Accordingly, the data normalization and medical ontology development might prove to be effective in attaining higher levels of recognition and information technology application in TM.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## ACKNOWLEDGMENTS

This article has been extracted from a Ph.D. thesis (ID: no.1396.9321563001.IR.IUMS.FMD.REC) in Health Information Management defended in Iran University of Medical Sciences. The authors confirm that the project has not funding or grants.

## REFERENCES

Aghebati A, Safdari R, Dargahi H, Gushe Gire A (2014) Traditional medicine information management. Am J Health Res 2(2): 43–48.

Ansani NT, Ciliberto NC, Freedy T (2003) Hospital policies regarding herbal medicines. Am J Health Syst Pharm 60(4): 367–370.

Benzie IF, Wachtel-Galor S (2011) Herbal Medicine: Biomolecular and Clinical Aspects. 2nd edition CRC Press Taylor & Francis Group.

Bjering H, Ginige A, Maeder AJ, Bensoussan A, Zhu X, Lattuca C (2011) Electronic Medical Record Information System for Patient Consultations in Chinese Medicine. HIC.

Bonifácio BV, Silva PB, Ramos MA, Negri KM, Bauab TM, Chorilli M (2014) Nanotechnology-based drug delivery systems and herbal medicines: a review. Int J Nanomed 9(1): 1–15.

Bouin A-S, Wierer M (2014) Quality standards of the European Pharmacopoeia. J Ethnopharmacol 158: 454–457.

Carmona F, Pereira AM (2013) Herbal medicines: Old and new concepts, truths and misunderstandings. Rev Bras Farmacogn 23(2): 379–385.

Carvalho ACB, Ramalho LS, de Oliveira Marques RF, Perfeito JPS (2014) Regulation of herbal medicines in Brazil. J Ethnopharmacol 158: 503–506.

Celik MY (2015) Traditional medicine and modern medicine with information technology. Int Res J Basic Clin Stud 4(2): 1–10.

Chen X, Zhou H, Liu Y, Wang J, Li H, Ung C, Han LY, Cao ZW, Chen YZ (2006) Database of traditional Chinese medicine and its application to studies of mechanism and to prescription validation. Br J Pharmacol 149(8): 1092–1103.

Claeson P (2014) Requirements on efficacy of herbal medicinal products. J Ethnopharmacol 158: 463–466.

De Capitani EM (2017) Traditional medicine preparations and health risks: Time to revisit their regulatory status. Clin Toxicol 55: 79–80.

Evans S (2008) Changing the knowledge base in Western herbal medicine. Soc Sci Med 67(12): 2098–2106.

Fang X, Shao L, Zhang H, Wang S (2005) CHMIS-C: A comprehensive herbal medicine information system for cancer. J Med Chem 48(5): 1481–1488.

Feng Y, Wu Z, Zhou X, Zhou Z, Fan W (2006) Knowledge discovery in traditional Chinese medicine: State of the art and perspectives. Artif Intell Med 38(3): 219–236.

Gao PF, Watanabe K (2011) Introduction of the World Health Organization project of the international classification of traditional medicine. Chin J Integr Med 9(11): 1161–1164.

Gu P, Chen H (2013) Modern bioinformatics meets traditional Chinese medicine. Brief Bioinform 15(6): 984–1003.

Hasanpour-Dehkordi A, Dehghani A, Solati K (2017) A comparison of the effects of pilates and McKenzie training on pain and general health in men with chronic low back pain: A randomized trial. Indian J Palliat Care 23(1): 36–40.

Herrera-Hernandez MC (2012) Engineering of a knowledge management system for relational medical diagnosis. University of South Florida [Ph.D Thesis].

Hu J, Liu B (2012) The basic theory, diagnostic, and therapeutic system of traditional Chinese medicine and the challenges they bring to statistics. Stat Med 31(7): 602–605.

Ikram RRR, Ghani MKA, Abdullah N (2015) An analysis of application of health informatics in traditional medicine: A review of four traditional medicine systems. Int J Med Inform 84(11): 988–996.

Janamian T, Myers SP, O'Rourke P, Eastwood H (2011) Responding to GPs' information resource needs: implementation and evaluation of a complementary medicines information resource in Queensland general practice. BMC J Complement Altern Med 11(1): 77.

Jivad N, Bahmani M, Asadi-Samani M (2016) A review of the most important medicinal plants effective on wound healing on ethnobotany evidence of Iran. Der Pharm Lett 8(2): 353–357.

Jokiniemi J (2010) Ontologies and computational methods for traditional Chinese medicine. Aalto University. [Master Thesis].

Katayama K, Imoto S, Watanabe K, Ymaguchi R, Matsuura K, Miyano S (2012) Analysis of questionnaire for traditional medical and develop decision support system. IEEE International Conference on Bioinformatics and Biomedicine Workshops, Philadelphia, PA, pp. 762–763.

Kim EJ, Chen Y, Huang JQ, Li KM, Razmovski-Naumovski V, Poon J, Chan K, Roufogalis BD, McLachlan AJ, Mo SL, Yang D, Yao M, Liu Z, Liu J, Li GQ (2013) Evidence-based toxicity evaluation and scheduling of Chinese herbal medicines. J Ethnopharmacol 146(1): 40–61.

Lai TY, Tseng YT, Lee CN (2014) Physician and consumer acceptance of the traditional Chinese medicine clinical practice support system (TCMCPSS). Stud Health Technol Inform 201: 321–325.

Lee JC, Lee S, Jin HJ (2015) Development of decision-making rules for pattern identification. Eur J Integr Med 7(4): 348–353.

Liu B, Zhou X, Wang Y, Hu J, He L, Zhang R, Chen S, Guo Y (2012) Data processing and analysis in real-world traditional Chinese medicine clinical data: Challenges and approaches. Statist. Med J (31): 653–660.

Lukman S, He Y, Hui S-C (2007) Computational methods for traditional Chinese medicine: A survey. Comput Methods Programs Biomed 88(3): 283–294.

Mafuva C, Marima HT (2014) Towards professionalization of traditional medicine in Zimbabwe: A comparative analysis to the South African policy on traditional medicine and the Indian Ayurvedic system. Int J Herb Med 2(2):154-161.

Mukherjee PK, Bahadur S, Chaudhary SK, Kar A, Mukherjee K (2015) Quality related safety issue-evidence-based validation of herbal medicine farm to pharma. Evidence-based validation of herbal medicine. Elsevier Inc., p. 1–28.

Niemeyer K, Bell IR, Koithan M (2013) Traditional knowledge of Western herbal medicine and complex systems science. J Herb Med 3(3): 112–119.

Noraziah A, Abdella AN, Hamid RA, Sidek RM, Omardin MA (2011) Empirical study on medicinal herbs information system (MHIS) in Malaysia. Afr J Bus Manag 5(13): 5292–5295.

Ogirima SA, Olabiyisi SO, Omidiora EO, Oke AO (2015) Web-based decision support system for prescription in herbal medicine. J Emerg Trends Eng Appl Sci 6(7): 245–254.

Ozaki K, Namiki T, Kageyama M, Nakamura Y, Rakugi H (2017) The trends in global standardization of traditional medicine: A review on the meetings of ISO/TC249. Innov Aging 1(suppl. 1): 199–200.

Parsaei P, Bahmani M, Naghdi N, Asadi-Samani M, Rafieian-Kopaei M, Tajeddini P, Sepehri-Boroujeni M (2016) Identification of medicinal plants effective on common cold: An ethnobotanical study of Shiraz, South Iran. Der Pharm Lett 8(2): 90–97.

Rouhi-Boroujeni H, Asadi-Samani M, Moradi MT (2016) A review of the medicinal plants effective on headache based on the ethnobotanical documents of Iran. Der Pharm Lett 8(3): 37–42.

Ru J, Li P, Wang J, Zhou W, Li B, Huang C, Li P, Guo Z, Tao W, Yang Y, Xu X, Li Y, Wang Y, Yang L (2014) TCMSP: A database of systems pharmacology for drug discovery from herbal medicines. J Cheminform 6(1):13.

Sen S, Chakraborty R (2017) Revival, modernization and integration of Indian traditional herbal medicine in clinical practice: Importance, challenges and future. J Tradit Complement Med 7(2): 234–244.

Sen S, Chakraborty R, De B (2011) Challenges and opportunities in the advancement of herbal medicine: India's position and role in a global context. J Herb Med 1(3): 67–75.

Shetti S, Kumar CD, Sriwastava NK, Sharma IP (2011) Pharmacovigilance of herbal medicines: Current state and future directions. Pharmacogn Mag 7(25): 69–73.

Smith A, Jogalekar S, Gibson A (2014) Regulation of natural health products in Canada. J Ethnopharmacol 158: 507–510.

Snow J (2016) Context effects in Western herbal medicine: Fundamental to effectiveness? Explore (NY) 12(1): 55–62.

Solati K (2016) Effectiveness of cognitive-behavior group therapy, psycho-education family, and drug therapy in reducing and preventing recurrence of symptoms in patients with major depressive disorder. J Chem Pharm Sci 9(4): 3414–3418.

Solati K (2017) The efficacy of mindfulness-based cognitive therapy on resilience among the wives of patients with schizophrenia. J Clin Diagn Res 11(4): VC01–VC03.

Souza SB, Silva MMA, Rodrigues RP, Malta MEB, Gusmao CM, Santos WP (2014) PlantasMED: A mobile application to promote the rational use of medicinal plants in Brazil's countryside based on participatory HCI design and popular education for health. Paper presented at: Serious Games and Applications for Health (SeGAH), IEEE 3rd International Conference on 27-29 Nov. 2014:1–4.

Telles S, Pathak S, Singh N, Balkrishna A (2014) Research on traditional medicine: What has been done, the difficulties, and possible solutions. Evid-Based Complement Alternat Med 2014: ID 495635.

Walker DR (2015) Report on the regulation of herbal medicines and practitioners. Dpt. of Health and the Medicines (UK), Healthcare Products Regulatory Agency.

Wang J, Guo Y, Li GL (2016) Current status of standardization of traditional Chinese medicine in China. Evid Based Complement Alternat Med 2016: ID 9123103.

Wang Y, Yu Z, Jiang Y, Xu K, Chen X (2010) Automatic symptom name normalization in clinical records of traditional Chinese medicine. BMC Bioinformatics 11(1): 40.

Wang Z, Miao M (2012) Discovery the relationship in properties of traditional Chinese medicine based on data mining. Paper presented at: Information Technology in Medicine and Education (ITME), International Symposium on 3-5 Aug 2012; 2: 782–785.

WHO (2004) WHO guidelines on safety monitoring of herbal medicines in pharmacovigilance systems. [Updated 2017 Feb 10; cited 2017 March 12]; Available from http://apps.who.int/medicinedocs/documents/s7148e/s7148e.pdf

WHO (2007) WHO international standard terminologies on traditional medicine in the western pacific region. Manila: WHO Regional Office for the Western Pacific.

WHO (2013) WHO Traditional Medicine Strategy 2014–2023.

Wiesner J (2014) Challenges of safety evaluation. J Ethnopharmacol 158: 467–470.

Wiesner J, Knöss W (2014) Future visions for traditional and herbal medicinal products a global practice for evaluation and regulation? J Ethnopharmacol 158: 516–518.

Wulamu A, Zhou Y, Zhang D, Li H, Rui H (2014) The research and application of ontology-based information retrieval. 9th IEEE Conference on Industrial Electronics and Applications on 9–11 June 2014.

Xue R, Fang Z, Zhang M, Yi Z, Wen C, Shi T (2012) TCMID: Traditional Chinese medicine integrative database for herb molecular mechanism analysis. Nucleic Acids Res 41(D1): D1089–D1095.

Yang D, Yin X, Ong C, Tang D (2013) Multidimensional information-based HPLC technologies to evaluate traditional Chinese medicine. J Chromatogr Sci 51(7):716–725.

Yang HC, Iqbal U, Nguyen PA, Lin SH, Huang CW, Jian WS, Li YC (2016) An automated technique to identify potential inappropriate traditional Chinese medicine (TCM) prescriptions. Pharmacoepidemiol Drug Saf 25: 422–430.

You M, Yan SX, Li GZ, Sun S, Zeng XQ, Zhao QC, Xu LY, Huang SY (2013) Customized management of clinical data in traditional Chinese medicine. IEEE Int Conf Bioinformatics Biomed 292–293.

Zhang G, Li Q, Chen Q, Su S (2013) Network pharmacology: a new approach for Chinese herbal medicine research. J Evid Based Complementary Altern Med 2013: 621423.

Zhang Y, Mao X, Guo Q, Lin N, Li S (2016) Network pharmacology-based approaches capture essence of Chinese herbal medicines. J Chin Herb Med 8(2): 107–116.

Zhou X, Chen S, Liu B, Zhang R, Wang Y, Li P, Guo Y, Zhang H, Gao Z, Yan X (2010) Development of traditional Chinese medicine clinical data warehouse for medical knowledge discovery and decision support. J Artif Intell Med 48(2): 139–152.

Zhou Y, Chuah K, Chen S (2005) An information system model in Chinese herbal medicine manufacturing enterprises. J Manuf Technol Manag 16(2): 145–155.

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|---|---|---|---|---|
| Concepts or ideas | | x | | x |
| Design | | | x | x |
| Definition of intellectual content | | x | x | |
| Literature search | x | | | |
| Experimental studies | | | | |
| Data acquisition | x | x | x | |
| Data analysis | x | x | x | |
| Statistical analysis | | | x | x |
| Manuscript preparation | x | | | |
| Manuscript editing | | x | x | x |
| Manuscript review | x | x | x | x |

**Citation Format:** Mirzaeian R, Sadoughi F, Tahmasebian S, Mojahedi M (2019) Progresses and challenges in the traditional medicine information system: A systematic review. J Pharm Pharmacogn Res 7(4): 246–259.