Journal of Pharmacopuncture

ISSN 2093-6966 [Print], ISSN 2234-6856 [Online]
Journal of Pharmacopuncture 2019;22[4]:260-268
DOI: https://doi.org/10.3831/KPI.2019.22.035

Review article

Trends and Future Direction of the Clinical Decision Support System in Traditional Korean Medicine

Hyung-Kyung Sung[2†], Boyung Jung[3], Kyeong Han Kim[4], Soo-Hyun Sung[5], Angela-Dong-Min Sung[5], Jang-Kyung Park[1†*]

[1] Division of Clinical Medicine, School of Korean Medicine, Pusan National University
[2] Department of Pediatrics, College of Korean Medicine, Semyung University
[3] Jaseng Spine and Joint Research Institute
[4] Department of Preventive Medicine, College of Korean Medicine, Woosuk University
[5] Department of Korean Medicine Policy, National Institute of Korean Medicine Development

Key Words

Traditional Korean Medicine, Herbal medicine, Clinical Decision Support System (CDSS), Electronic Health Records (EHR)

Abstract

Objectives: The Clinical Decision Support System (CDSS), which analyzes and uses electronic health records (EHR) for medical care, pursues patient-centered medical care. It is necessary to establish the CDSS in Korean medical services for objectification and standardization. For this purpose, analyses were performed on the points to be followed for CDSS implementation with a focus on herbal medicine prescription.

Methods: To establish the CDSS in the prescription of Traditional Korean Medicine, the current prescription practices of Traditional Korean Medicine doctors were analyzed. We also analyzed whether the prescription support function of the electronic chart was implemented. A questionnaire survey was conducted querying Traditional Korean Medicine doctors working at Traditional Korean Medicine clinics and hospitals, to investigate their desired CDSS functions, and their perceived effects on herbal medicine prescription. The implementation of the CDSS among the audit software developers used by the Korean medical doctors was examined.

Results: On average, 41.2% of Traditional Korean Medicine doctors working in Traditional Korean Medicine clinics manipulated 1 to 4 herbs, and 31.2% adjusted 4 to 7 herbs. On average, 52.5% of Traditional Korean Medicine doctors working in Traditional Korean Medicine hospitals adjusted 1 to 4 herbs, and 35.5% adjusted 4 to 7 herbs. Questioning the desired prescription support function in the electronic medical record system, the Traditional Korean Medicine doctors working at Korean medicine clinics desired information on 'medicine name, meridian entry, flavor of medicinals, nature of medicinals, efficacy,' 'herb combination information' and 'search engine by efficacy of prescription.' The doctors also desired compounding contraindications (eighteen antagonisms, nineteen incompatibilities) and other contraindicatory prescriptions, 'medicine information' and 'prescription analysis information through basic constitution analyses.' The implementation of prescription support function varied by clinics and hospitals.

Conclusion: In order to implement and utilize the CDSS in a medical service, clinical information must be generated and managed in a standardized form. For this purpose, standardization of terminology, coding of prescriptions using a combination of herbal medicines, and unification such as the preparation method and the weights and measures should be integrated.

Received: Sep 02, 2019 **Reviewed:** Dec 06, 2019 **Accepted:** Dec 11, 2019

*Corresponding Author
Jang-Kyung Park. Division of Clinical Medicine, School of Korean Medicine, Pusan National University, Yangsan 50612, South Korea.
Tel: +82-55-360-5978
Fax: +82-55-360-5978
Email: vivat314@pusan.ac.kr
†These authors contributed equally to this work.

1. Introduction

With aging of the world's population, and the increasing number of patients with chronic diseases such as diabetes, heart disease, obesity and lung diseases (COPD, asthma), the value of Traditional Korean Medicine for diagnosis and treatment from a holistic perspective is emerging. Korean medical practice is based on dialectic, individualized diagnosis and treatment according to the patient's personalized condition[1]. Treatment that is selected and subtracted based on the dialectic has the advantage of allowing personalized treatment for each patient, but it is also subject to scientific standards of objectification and standardization.

As people age and the incidence of chronic diseases increase, health care is moving towards value based services, providing high-quality care safely and cost-effectively [2]. Recently, the development of computer science and increased access to information processing technology have made it possible to generate meaningful information by analyzing vast information called big data [3]. While a clinician's ability to gather information during the diagnosis process is rather limited [4], electronic health records (EHR) allow for the collection of considerable clinical information and re-creation into meaningful information for diagnosis. It is thought to contribute to improving the quality of medical care by implementing patient centric medical care services.

Improving the quality of EHR is believed to play an important role in future medical development, and would be further improved when data utilization functions such as the Clinical Decision Support System (CDSS) are implemented [5-6]. The CDSS is an electronic system developed to help physicians make decisions in clinical practice based on clinical information obtained from patients [7]. Initially, the CDSS mainly used statistics, logic, and probability theory to support the diagnosis process, but since the late 1980s, it has been implemented to recommend decision-making from the treatment planning stage [8].

In Traditional Korean Medicine, research on the CDSS has been focused on terminology and diagnosis [9-14], and in 2010, Kim et al [15] established a prescription delivery and dispensing system but was not able to grasp the specific prescription support needs.

Therefore, in this study, we investigated the prescription forms of Korean medical doctors to determine the development direction of the prescription support function. We analyzed the current implementation status of the prescription support function of the electronic chart, investigated the desired prescription support function by the Traditional Korean Medicine doctors, and suggest a roadmap for further research and development.

2. Methods

2.1. Participants

This study consisted of surveys of Traditional Korean Medicine doctors and interviews of software developers. The questionnaire survey was conducted with Korean medical doctors working in Traditional Korean Medicine clinics and hospitals. Through the cooperation of the Association of Traditional Korean Medicine, the survey was conducted. The participating clinicians were assigned proportionally to each specialist department from 12 Traditional Korean Medicine hospitals affiliated with Korean medical schools, via an online survey method.

In accordance with the outlined sampling method, the interviews were conducted by three developers of three billing software platforms used in Traditional Korean Medicine hospitals, and two billing software developers working in the same Traditional Korean Medicine hospital in which the researchers worked. Surveys and interviews were conducted from August 17, 2017 to September 30, 2017.

2.2. Questionnaire

The questionnaire was developed based on the results of previous studies, expert consultations, and researcher meetings. The questionnaire was then revised by two appointed doctors working at a Traditional Korean Medicine clinic. The completed questionnaire was converted into an electronic document form online, and respondents accessed the URL and responded in a self-written manner. The respondents were asked for general information, forms of medical records, reasons for not using electronic medical records, and helpful factors for patient diagnosis and prescription.

The interviews were based on pre-developed methods to provide in-depth interviews on the factors useful in the diagnosis and prescription of patients, the type of prescription, and the priority and implementation of prescription support functions. A test-retest method was performed to ensure reliability of interview results.

2.3. Ethics

The survey was limited to those who read and indicated agreement with the research purpose. Surveys were conducted anonymously and used only for academic purposes. The entire survey process was approved by the Institution Review Board of Semyung University, Traditional Korean Medicine Hospital in Chungju (IRB number 1708-12).

3. Results

3.1. Basic characteristics

In the survey population of Traditional Korean Medicine doctors, the proportion of males was greater than that of females, at 86.4%. A majority of respondents were in their 40s and represented 43.4% of our study cohort. Most had more than 15 years of clinical experience, with 41.6% in

this category. 85.7% of respondents were the head of their respective hospitals, and 82.4% were general practitioners (Table1).

Doctors in Traditional Korean Medicine hospitals were more than twice as likely to be male. 60% of the age group were in their 40s, and their clinical experience was over 7 years with 72.5%. They were all specialists in their respective fields (Table 2).

Table 1 Surveyee Demographics of the Traditional Korean Medicine Clinics

(Unit : Person)

Category		Surveyed Amount	Percentile Rank
Gender	Male	241	86.4%
	Female	38	13.6%
Age	20s	7	2.5%
	30s	93	33.3%
	40s	121	43.4%
	50s	53	19.0%
	60s	5	1.8%
Clinical Experience	Less than 5 years	36	12.9%
	5~10 years	60	21.5%
	10~15 year	67	24.0%
	Over 15 years	116	41.6%
Specialist Training and subjects	Generalist	230	82.4%
	Specialist	49	17.6%
Work Type	Director	239	85.7%
	Vice Director	40	14.3%

Table 2 Surveyee Demographics of the Traditional Korean Medicine Hospitals

(Unit : Person)

Category		Surveyed Amount	Percentile Rank
Gender	Male	28	70.0%
	Female	12	30.0%
Age	20s	0	0.0%
	30s	11	27.5%
	40s	24	60.0%
	50s	5	12.5%
	Over 60s	0	0.0%
Clinical Experience	Less than 5 years	0	0.0%
	5~10 years	5	12.5%
	10~15 year	6	15.0%
	Over 15 years	29	72.5%

3.2. Forms of prescription

Considering that the dialectic treatment system of Traditional Korean Medicine predicates that 'the same treatment for different diseases may be modified from a given algorithm by symptom presentation,' a single prescription may be used for a wide variety of conditions [16], and therefore, the average number of additives or subducted medicinals to complete a prescription were investigated.

When investigating the prescriptions given by Korean medicine doctors working in clinics over a 1-year period, the average number of manipulated herbs was found to be most frequent in the 'More than 1 and less than 4' category, at 41.2%, followed by the category 'More than 4 and less than 7' at 31.2% (Fig. 1). In the case of Korean medicine doctors working in Korean medicine hospitals, the average number of adjusted herbs was found to be most frequent in the 'More than 1 and less than 4' category at 52.5%, followed by the category 'More than 4 and less than 7' at 35.5%. The Korean medicine doctors that responded

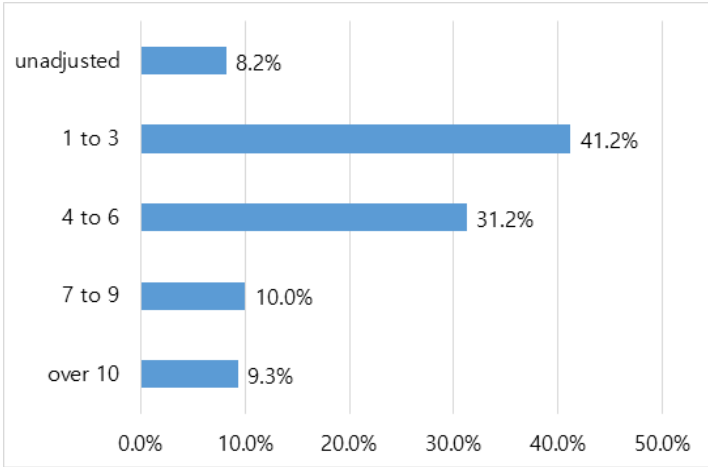

Figure 1 Average number of manipulated herbs for prescription in Traditional Korean Medicine clinics

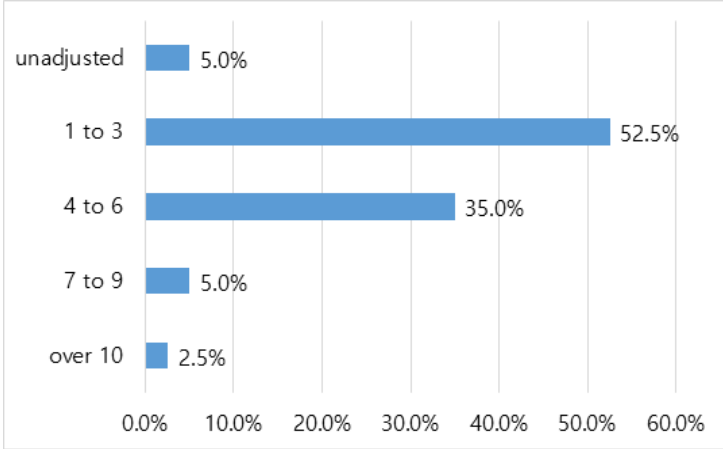

Figure 2 Average number of manipulated herbs for prescription in Traditional Korean Medicine clinics

Table 3 The priority and implementation of requested prescription support function for the electronic records

Division		Clinic				Hospital		
		Requested Rank	A	B	C	Requested Rank	D	E
Prescription Search	Search by prescription name	19	○	○	○	22	○	○
	Search by effects	3	X	○	○	15	△	○
	Search by medicine name and source	4	○	○	○	11	○	○
	Offer prescription with similar effect	6	X	○	X	10	△	X
Basic Prescription Information	Prescription name, medicine composition and amount, effect, source	19	○	○	○	21	○	○
Prescription Structural Analysis	Prescription translation information through basic constitutional analysis	4	X	○	○	4	○	X
Basic Medicine Information	Medicine name, meridian entry, nature of medicinals, effect	1	X	○	○	2	○	X
Medicine Interaction	Information on combination	2	X	○	X	2	X	X
Forbidden Medicine Notification	eighteen antagonisms, nineteen incompatibilities and other contraindication medication	7	X	○	X	1	X	X
Toxic Medicine Information	Provide toxicity information for medicine	21	X	○	X	20	○	X
Patient history management	Search function by patient, disease, and date	22	X	○	○	18	○	X
Clinical statistics management	Personal records of Traditional Korean Medicine doctors on the disease-prescription	12	○	○	○	5	○	X
	Personal formulary management function	16	X	○	○	17	○	○
	Frequent prescription record	15	○	○	○	14	X	X
	Recent use prescription list	14	X	○	○	11	○	○
	Display clinical statistics period-prescription data	9	X	○	○	9	○	X
Prescription transfer between Traditional Korean Medicine doctors	Shared prescription records and disease information	11	X	○	○	8	○	○
Prescription transfer to pharmacology	Prescription contents (medicine, dose), prescription dose calculation, dispensing method	17	○	○	○	18	○	○
Patient prescription	Chief complaint, total dose, instructions for taking, daily care, next visiting date	17	○	○	○	16	○	○
Medicinal Inventory Management	Real-time medicine inventory management linked with prescription	10	X	○	○	13	○	X
Medicine Sensory Information	Information on selected medicine that require sensory evaluation	8	X	○	X	7	X	X
Medicine Management Information	Information on selected medicine that need management	13	X	○	X	6	X	X

Index. ○ Possible, △ Partially possible, X Impossible

have been found to have adjusted between 1 and 7 herbs when prescribing Korean medicine (Figure 2).

3.3. Priority and implementation of prescription support

Traditional Korean Medicine doctors working in clinics were questioned on the prescription support function that they wish to see realized in the EHR. The resulting answers include functions such as 'Provision of the name of herb, meridian entry(orientation of the medicinal action according to the meridian/channel on which the therapeutic action is manifested, also called meridian tropism), nature of the medicinal agent, and effect,' 'Information on combination,' 'Search function of prescriptions by the name of medicine and the source,' 'Prescription structure analysis, prescription translation information through basic constitution analysis,' and 'Suggest prescriptions with similar effects.'

Traditional Korean Medicine doctors working in Korean medicine hospitals have been found to seek the implementation of functions such as 'eighteen antagonisms, nineteen incompatibilities and other contraindicated herbs,' 'Information on combination' and 'prescription translation information through basic constitution analysis.'

The developers of the software were investigated to examine whether the prescription support function was implemented. As a result, all programs had a working prescription support function, but the implementation was different for each company (Table 3).

4. Discussion

In Traditional Korean Medicine, diagnosis and treatment are made individually and dialectically with sensitivity according to the physiological and pathological characteristics of the individual [1,16]. This feature can be tailored to the pathology of the patient and has the advantage of excellent therapeutic effects [16]. In this study, more than 90% of Traditional Korean Medicine doctors used prescriptions in the form of adjusting drugs according to the patient's condition. It is common practice that the medicines are combined according to the theories of 'Kun-Shin-Choa-Sa' and that treatments are administered dialectically with sensitization, meaning that the pharmacy and prescription structure is of great importance in the overall treatment. Therefore, the study result showing that the Traditional Korean Medicine doctors desired prescription support functions such as information on basic medicine and interaction, prescription search, and analysis of prescription structure, can be explained in the same context.

The Decision support system (DSS) is divided into clinical DSS and external DSS. Clinical DSS includes clinical guidelines such as Drug Utilization Review (DUR), Drug Preparation, Critical Value Report (CVR), Allergy Management and Inspection, patient safety such as Transfusion Prescriptions, clinical records including incomplete records and corresponding restrictions, and Clinical Quality Indicator Management. Out-of-clinical DSS includes automatic pay selection, checks for low dosage prescriptions, notification criteria such as notification criteria notice, and hospital management [17]. DUR, a representative CDSS, provides guidance on drug prescriptions such as combination contraindications, contraindications for pregnancy and/or lactation, and the maximum duration allowed based on clinical data on accumulated drug use [18]. The DUR was designated as a mandatory system in 2011 by the Health Insurance Review and Assessment Service in hospitals, clinics, and pharmacies.

Prescription errors form a considerable part of Medication-related errors, thus computerized physician order entry (CPOE) systems and CPOE with a Clinical Decision Support System (CDSS) are considered to be conducive to improving patient safety by reducing medication errors [19].

In this study, the prescription support function suggested by Korean doctors was found to be a similar DSS to prescription support systems rather than external clinical DSS. As a result of investigating the implementation of the prescription support function of the electronic medical record system, the basic information and the analysis of the prescription structure were provided by three of five companies. Interaction functionality was found to be provided by one of five vendors. If the prescription support function desired by Traditional Korean Medicine doctors is implemented in the future, the use of electronic medical records can be increased, and can contribute to the management of the information of the prescriptions prescribed by Traditional Korean Medicine institutions.

In order to conduct various studies using electronic medical records, clinical information should be created and managed in a standardized form, and term standardization should be preceded by form standardization [20]. Standardization of these terms is also a necessary condition for clear communication between the various stakeholders involved in health care services and ensuring interoperability between systems. Prior studies that included Korean medicines in their coding include the WHO's Herbal Anatomical Therapeutic Chemical (HATC) code[21], ISO-18668 (Traditional Chinese Medicine – Coding system for Chinese Medicines), and ISO / DIS 20334 (Traditional Chinese Medicine–Coding System) [22-25]. However, China's own industrial classification is included in the code composition, and it is difficult to apply in Korea, and they have a disadvantage in that it is difficult to reflect the dosage form that is adjusted from the actual clinical practice by the code-based application.

Therefore, in order to systematically manage the prescription information from Korean medicine institutions, the most rational method was to use a combination of Korean medicines that constitute the prescription. To this end, standardization such as the name of the prescription, name of the herb, name of the formulation, and unification of the weights and measures should be available and accurate for each medicinal agent. In particular, the same prescription name was described in the survey of Korean hospitals, but the composition was different, and the method of describing the herb was different even when

the same herb was considered (Figure 3). Therefore, it is urgent to standardize the name of the herbal medicine that constitutes the prescription.

In conclusion, it is necessary to develop a standardized Traditional Korean Medicine prescription terminology and format, structure the prescription of Korean medicine, and conduct verifiable research on the effects of these changes.

First, in the study on the development of standard Traditional Korean Medicine terminology, the creation of database of the name of the Traditional Korean Medicine, the dosage, preparation method terminology, terminology from both in and out of country, frequently used formula research, and manual prescription. In addition, terms that do not exist in the 'Health Terminology Standard' will need to go through the process of being mapped to internationally accepted terminology. This may include collection of consultation opinions, and identification and description of representative prescription names to reach consensus for entry of standard terminology.

The research on the development of standardized formatting examines domestic and foreign clinical documents and information security related to Traditional Korean Medicine, and it is necessary to develop a law, institution, infrastructure, risk review and improvement plan for the use of Korean medicine information, and to create a standard document format suitable for the Korean medicine environment.

To develop a standard Korean medicine prescription structuring program, the process of developing an algorithm for structuring Korean medicine prescription names, drawing consensus on the structure of Korean medicine prescriptions through expert meetings, and presenting of a model for developing a standard Korean medicine prescription structuring program that can be commercialized as a final result will be necessary. In addition, the prescriptive terminology standard for constructing common data model should be verified and the possibility for clinical application and practical use should be evaluated according to the standard Korean medicine prescription program.

The limitations of this study are as follows. The most difficult objective in building a Traditional Korean Medicine prescription DB is that the number and dose of herbs can be adjusted depending on the symptoms and constitution of the patient, all of which may vary considerably. In this study, it was not possible to investigate the composition and dosage of Traditional Korean Medicines. Therefore, further study is needed in this area.

Nevertheless, it is meaningful that this study explored whether it is possible to construct a diagnosis and prescription system using the CDSS system. In order to expand above research continuously and stably, it is necessary to establish an infrastructure for acknowledging the uniqueness and diversity of Korean medical care and utilizing Korean medical information in various fields. It is necessary to draw up a system of promotion through a dedicated state-led organization and to establish a council of diverse stakeholders and related experts to overcome the major issues. In addition, in order to promote the exchange of medical information of Korean medical institutions, it may be necessary to establish a legal or clinical system related to the standardization of terms and the collection and utilization of medical information records to establish a foundation for collecting and using data.

Clinical decision support had a favorable effect on prescribing treatments, facilitating preventive care services, and ordering clinical studies across diverse venues and systems [26].

If these data are accumulated by providing prescription support functionality after developing the Traditional Korean Medicine prescription structure program through standard terminology and formatting development, it may be possible to build a continuous cycle structure that provides enhanced clinical decision support. In addition, it may be possible to standardize and structure information on over-the-counter prescriptions, which represent uninsured items, and in the long term may be used as a secondary data source. By providing timely and standardized prescription information, it is expected these systems will contribute to the improvement of national health and medical service, and strengthen the international competitiveness of Korean medicine by securing information interoperability and improving standardization and access.

5. Conclusion

CDSS is a system that can be used for clinical management, such as hospital prescription management, and can provide a comprehensive guide to prescription guidelines based on data accumulated in a patient's EHR. In order to build the CDSS system for traditional Korean medicinal treatment, the current implemented systems and structures used by Traditional Korean Medicine doctors have been investigated. Clinical information should be generated and managed in a standardized form to establish the CDSS of Korean medical treatment. For this purpose, it is necessary to standardize Korean medical terminology and to unify the terms and codes of medicine and prescription. In addition, the standardization of the prescription com-

A	*Astragali Radix*	*Ginseng Radix*	*Crataegii Fructus*	*Massa medicata Fermentata*	*Hordei Fructus Germiniatus*												
B	*Astragali Radix*					*Atractylodis macrocephalae Rhizoma*	*Ledebouriellae Radix*	*Longanae Arillus* (Wonyook)	*Angelicae gigantis Radix*	*Dioscoreae Rhizoma*	*Paeoniae Radix Rubra*	*Poria*	*Citri Pericarpium*	*Cnidii Rhizoma*	*Lycii Fructus*	*Amomi Rotundus Fructus*	
C	*Astragali Radix*					*Atractylodis macrocephalae Rhizoma*		*Longanae Arillus* (Yonganyook)	*Angelicae gigantis Radix*	*Dioscoreae Rhizoma*	*Paeoniae Radix Alba*		*Citri Pericarpium*	*Cnidii Rhizoma*		*Amomi Rotundus Fructus*	*Glycyrrhizae Radix*

Figure 3 Composition of Prescriptions Listed as 'Boa-Tang'

position DB using the combination of Traditional Korean Medicines making up the prescription, and the unification of the formulation and weighting method should be further investigated.

Through the research on the development of a standardized Traditional Korean Medicine prescription terms, the name, dosage, herbal preparation terms, prescription name, route of administration, identification of domestic and international terminology, formulation survey using frequency, and prescription, a comprehensive DB could be constructed. Based on this, prescription information should be standardized and structured, and is expected to contribute to the improvement of public health and medical service.

Acknowledgement

This paper is a supplement to the report of "Study on the survey and management of non-insured Herbal Medicines at Hospitals of Traditional Korean Medicine".

Conflict of interest

The authors declare that there are no conflicts of interest.

References

1. Wang S, Long S, Wu W. Access Application of Traditional Chinese Medicines as Personalized Therapy in Human Cancers. The American Journal of Chinese Medicine. 2018;46(5):953-70.
2. Elf M, Flink M, Nilsson M, Tistad M, von Koch L, Ytterberg C. The case of value-based healthcare for people living with complex long-term conditions. BMC Health Serv Res. 2017;17(1):24.
3. Lee CH, Yoon HJ. Medical big data: promise and challenges. Kidney Res Clin Pract. 2017;36(1):3-11.
4. Morris AH. Developing and Implementing Computerized Protocols for Standardization of Clinical Decisions. Ann Intern Med. 2000;132(5):373-83.
5. Linder JA, Ma J, Bates DW, Middelton B, Stafford RD, Electronic health record use and the quality of ambulatory care in United States. Archives of internal medicine. 2007;167(13):1400-5.
6. Zhou L, Soran CS, Jenter CA, Volk LA, Orav EJ, Bates DW et al. The relationship between electronic health record sse and quality of care over time. 2009;16:457-64.
7. Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success.BMJ. 2005;330:765.
8. Lee DH, Jung HY, Kim MH, Lim ME, Kim DH, Han YW et al. Trends of clinical decision support system. Electronics and telecommunications trends. 2016;31(4):77-85.
9. Choi SH. Develpment of Web-based diagnosis expert system of traditional oriental medicine. Korean J Oriental physiology & pathology. 2002;16(3):528-31.
10. Park KM, Park JH. A Methodology for representation of clinical data in Oriental medicine. Korean J Oriental physiology & pathology. 2002;16(5):845-50.
11. Park JH, Shin SW, Jung GS, Park KM, Kim SH. Development and evaluation of ontology for diagnosis in oriental medicine. Korean J Oriental physiology & pathology. 2006;20(1):202-8.
12. Anastasi JK, Currie LM, Kim GH. Understanding diagnostic reasoning in TCM practice: tongue diagnosis. ALTERNATIVE THERAPIES. 2009;15(3):18-28.
13. Kim SK, Kim JH, Jang HC, Kim AN, Yea SJ, Kim C et al. Reasoning and learning methods for diagnosis in oriental medicine. Korean J Oriental physiology & pathology. 2009;23(5):942-9.
14. Oh YT, Kim AN, Kim SK, Jang HC. A Study on Diagnosis Support using Knowledge of Diseases from Literature. Journal of Haehwa Medicine. 2014;23(1):13-20.
15. Kim C, Kim SK, Jang HC, Kim AN, Kim IT, Song MY. Development of Efficient Order Communication and Pharmacy Supporting System for Traditional Korean Medicine. KOREAN JOURNAL OF ORIENTAL MEDICINE. 2010;16(3):127-133.
16. Park JK, Kim DI. An Analysis of Clinical Application of Guibi-tang for Obstetrics and Gynecological Disease. The Journal of Oriental Gynecology. 2011;24(2):79-96.
17. Park JH, Koon DS, Lee MY. A Study on the Effects of the Service Quality of Hospital's Decision Support System on Management Performance-the Case of K-University Hospital. JOURNAL OF INFORMATION TECHNOLOGY APPLICATIONS & MANAGEMENT. 2014;21(2):81-98.
18. Park CS, Ko SH. A Study on the Data Warehousing System of General Hospital. Conference of The Korea Society of Information Technology Applications. 2002;1(1):304-318.
19. Krähenbühl-Melcher A., Schlienger R., Lampert M. Haschke M, Drewe J, Krähenbühl S. Drug-related problems in hospitals: a review of the recent literature, Drug Saf. 2007;30:379–407.
20. Song MY, Kim C, Janh HC, Kim SK. Introduction to Korean Medicine Informatics. Seoul:Jipmoondang. 2012;14-7.
21. World Health Organization. WHO guidelines on safety monitoring of herbal medicines in pharmacovigilance systems. World Health Organization. 2004.
22. ISO. Traditional Chinese medicine Coding system for Chinese medicines. Part 1 : Coding rules for Chinese medicines. ISO. 2016.
23. ISO. Traditional Chinese medicine Coding system for Chinese medicines. Part 2: Codes for decoction pieces. ISO. 2016.
24. Traditional Chinese medicine Coding system for Chinese medicines. Part 3: Codes for Chinese material medica. ISO. 2016.
25. Traditional Chinese medicine Coding system for Chinese medicines. Part 4: Codes for granule forms of individual medicinals for prescriptions. ISO. 2016.
26. Bright TJ, Wong A, Dhurjati R, Bristow E, Bastian L,

Coeytaux RR, et al. Effect of Clinical Decision-Support Systems: A Systematic Review. Ann Intern Med. 2012;157(1):29-43.