Clinical Decision Supporting by Interacting User Interfaces using Ontology in Traditional Medicine

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Abstract: An ontology which contains diseases, involved symptoms, available prescriptions (formulas), and the efficacy by the prescriptions was built for various health care systems based on traditional medicine. An information support system was developed to test the effect of treatment support in the clinical environment by using the ontology. The result of diagnoses at a low level represented higher matching with the result of diagnoses by practitioners than the decision tree by using questionnaires, and relatively higher matching for specific diseases. In testing the system by presenting an exemplary symptom for a specific prescription, low matching was shown with the result of practitioner's diagnosis or correct answers. However, system users were highly satisfied with the system, and there were opinions that the result was similar to their result of diagnoses and many positive reviews that the result of the system was ideal for real patients. It is expected that the information support system can be used ideally for treatment support for practitioners or as a health care system, provided that explicit description and collection of symptoms is implemented and then well reflected in the ontology.
[Hyunchul Jang, Yong-Taek Oh, Anna Kim, Jinsoon Seo, Sang-Kyun Kim, Hanmin Jung, Min-Seog Oh, Eun-Jung Lee, Jinsung Kim. **Clinical Decision Supporting by Interacting User Interfaces using Ontology in Traditional Medicine.** *Life Sci J* 2014;11(7s):122-126]. (ISSN:1097-8135). http://www.lifesciencesite.com. 22

Keywords: Clinical decision support, health care, ontology, traditional medicine, oriental medicine

1. Introduction

Development of information technology contributes to knowledge informatization and fast introduction of information systems. There is an increasing need of systems which assist practitioners when they treat patients in the field of traditional medicine. Because practitioners must make a decision through complicated processes, a system for assisting the decision is needed. Wikipedia says that 'Clinical decision support system (CDSS) is an interactive decision support system (DSS) computer software, which is designed to assist physicians and other health professionals with decision making tasks, such as determining diagnoses of patient data." That is, the CDSS is an interactive decision-making support system which supports medical professionals' decision-making when they treat patients.

Numerous studies have been done on medical diagnoses, including improving them by various approaches (Warner et al., 1961, Szolovits and Pauker, 1978, Amaral et al., 1995, Adlassnig, 1986, Kononenko, 1993, Kononenko, 2001, Ibrahim, 2013, Ashrafi, 2013). Unlike modern medicine (McNeil et al., 1975), traditional medicine practitioners make a diagnosis by analyzing collected medical indications, that is to say, patient's symptoms (Wang et al., 2004). In spite of the fact that the most basic step in the procedure of a medical diagnosis by traditional medicine practitioners is to detect patient's symptoms, traditional medicine practitioners have a low level of dependence on diagnostic devices because of various barriers including legal constraints, traditions and lack of standards (Hogeboom et al., 2001).

In the field of oriental medicine, a few systems are suggested. Two of them are an Internet-based professional diagnosis system for using rule-based inference on the basis of a formal knowledge base (Choi, 2002), and a system for automatically creating a logical expression method to build a diagnosis requirement ontology, and then automatically creating the next question when a symptom is typed to find a diagnosis name through inference (Park, 2006, Park 2009). In addition, there has been proposed ontology for diagnoses, and a diagnosis system (Kim, 2008, Moon, 2010).

However, the system needs objective symptoms and explicit diagnosis standards, and practitioners should decide in advance whether to use

the collected symptoms from patients as an input into the system, and such a decision strictly acts in the knowledge base and functions which the system uses.

As described above, treatment support studies in the field of oriental medicine have a focus on searching information for typed diseases or prescriptions, or providing diagnosis candidates or prescription candidates. This is because practitioners cannot but use treatment equipment, for example, tongue diagnosis systems or pulse diagnosis systems, just available in a limited way (Yang, 2008, Eun, 2010).

The ontology defines a terminology in a specific field, the relation between terminologies, as well as the relation for combination rules and extension of the terminology. It is possible to model an information system close to a real world by providing common concepts to enable communication between humans and a system in a limited area, and then formally defining the relation between the concepts.

This study aims to suggest and test a web-based oriental treatment support system for using oriental medicine ontology (Jang 2010, Jang 2013, and Seo 2014).

2. Material and Methods

A system was designed and built for supporting information and functions, and a flexible treatment process required by oriental medicine practitioners to treat patients, rather than providing exact diagnoses or prescription results for the collected symptoms of patients as conventional systems do. An oriental medicine practitioner searches prescriptions for treating patients with symptoms or deciding a method of treatment to add or subtract a prescription by means of the next prescription for treatment without making a decision of a diagnosis. Therefore, a variety of processes are required, and a flexible process is needed to find symptoms, diseases, prescriptions, methods of treatment and medicines although each process is in progress without fixing process progress.

A suggested key process is 3 types of "diagnosis - prescription - addition and subtraction of prescription", "prescription - addition and subtraction of prescription", "treatment - addition and subtraction of prescription". The process is established to enable symptoms, diseases, prescriptions, treatment and medicines to be found although each process is in progress, and process progress to be flexibly typed without being fixed.

Symptoms in this ontology were extracted from items of symptoms involved in diseases, prescriptions and symptoms for treatment by medicines. Prescriptions, the efficacy of medicinal materials and treatment of diseases were also extracted. Each piece of information extracted as described above are organically connected to enable it to be found.

Figure 1. A user interface

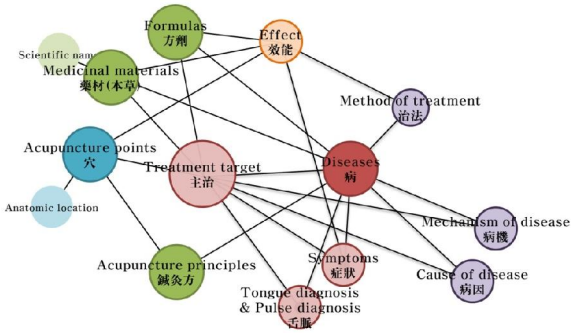

Figure 2. A graph of the TKM ontology

This system was used to conduct two tests and to survey user's satisfaction. The first test was conducted to apply a questionnaire for diagnoses after a practitioner consults a visiting patient as usual, and to use the collected symptoms to use the system. The second test was conducted to suggest a typical symptom of a specific prescription to a plurality of oriental medicine practitioners and oriental medical students so that they could compare their own prescription with the prescription derived through the system to analyze matching with a given prescription. Finally, participants in the second test were allowed to use the system with their focus on the existing patients' charts to survey their satisfaction.

3. Results

The first test was conducted for diagnosing 52 patients who visited a gastroenterology clinic and an oral cavity clinic. Three practitioners carried out a diagnosis and prescription selection in the treatment procedure to apply a questionnaire for diagnosing indigestion in an independent space.

The collected symptoms were then used to use the treatment support system. Thirty-one patients visited the gastroenterology clinic and 21 patients visited the oral cavity clinic. The patients were

divided into two patient groups to compare the diagnosis result by using the decision trees through practitioners, the treatment support system and questionnaires, respectively.

In the pattern-identification matching between oriental medicine practitioners and the system for supporting their treatment, the deficiency-excess pattern was shown 58.06%; the cold-heat pattern was shown 70.97%; and the pattern for both cold-heat and deficiency-excess was shown 41.94%. In the pattern-identification matching between oriental medicine practitioners and questionnaires, the deficiency-excess pattern was shown 38.71%; cold-heat pattern was shown 16.13%; and the pattern for both cold-heat and deficiency-excess was shown 0.00%. In the pattern-identification matching between the system for supporting oriental medicine practitioners and the questionnaires, the deficiency-excess pattern was shown 41.94%; the cold-heat pattern was shown 16.13%; and the pattern for both cold-heat and deficiency-excess was shown 9.68% (Table 1).

Table 1. Correlation rate about dyspepsia between Doctor and Application, Doctor and Questionnaire, Application and Questionnaire by Criteria eight principles pattern identification (D: Deficiency, E: Excess, C: Cold, H: Heat)

Pattern Identification	Dyspepsia								
	OMD-CDS			OMS-DT			CDS-DT		
	D&E	C, H	C-H, D&E	D&E	C, H	C-H, D&E	D&E	C, H	C-H, D&E
Correlation rate	58.06%	70.97%	41.94%	38.71%	16.13%	0.00%	41.94%	16.13%	9.68%

In the patient group who had problems of mouth pain, the deficiency-excess pattern was shown 85.71%; the cold-heat pattern was shown 78.57%; and the pattern for both cold-heat and deficiency-excess was shown 71.43%. In the patient group who had problems of foul breath, the deficiency-excess pattern was shown 57.14%; the cold-heat pattern was shown 71.43%; and the pattern for cold-heat and deficiency-excess was shown 42.86% (Table 2).

Table 2. Correlation rate about two oral diseases between Doctor and Application by Criteria eight principles pattern identification (D: Deficiency, E: Excess, C: Cold, H: Heat)

Pattern Identification	Oral disease					
	Burning Mouth Syndrome			Halitosis		
	OMD-CDS			OMD-CDS		
	D&E	C, H	C-H, D&E	D&E	C, H	C-H, D&E
Correlation rate	85.71%	78.57%	71.43%	57.14%	71.43%	42.86%

This result suggests that the suggested system can produce better results than treatment support based on well-defined questionnaires.

The second test was conducted for 60 oriental medicine practitioners in oriental medicine clinics and oriental medical students to suggest typical symptoms of a specific prescription and then to compare their prescription with the prescription suggested by the system. This aimed to identify matching between the prescriptions.

Ten cases showed matching between their prescriptions and the prescription by the system, and 50 cases showed non-matching. Five cases showed matching between the prescription by the system and correct answers, and 55 cases showed non-matching. Twenty-eighty cases showed matching between their prescriptions and correct answers, and 32 cases showed non-matching. Although their direct prescriptions showed matching close to 50%, matching thereof with the system was shown slight low. Pattern identification and medicinal component materials were in a similar series although the prescriptions by the system did not exactly match the correct answers. This implies a certain level of significance.

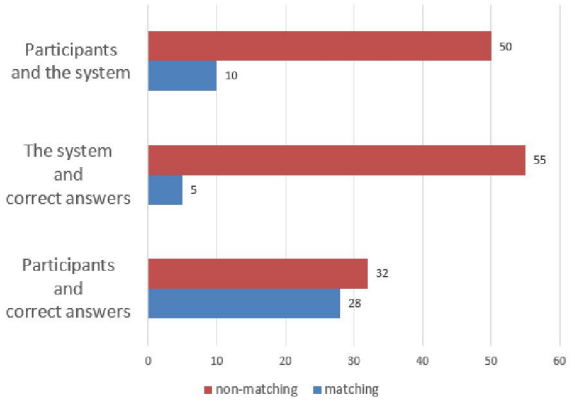

Figure 3. Matching between participants and the system

In the third survey for examining satisfaction, 60% of the participants said it was easy to learn how

to use the system; 30% said moderately easy; and 10% said difficult. Sixty percent of participants said easy to use the system, but 18% said not easy. Thirty-two percent of participants said the data in the system was reasonably enough, but 32% said not enough.

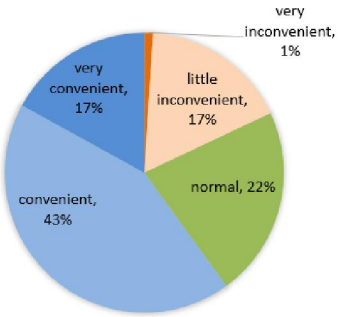

Figure 4. Convenience of the system

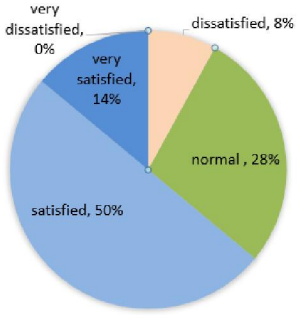

Figure 5. Satisfaction on the interface of the system

In the survey for examining matching and appropriateness between the prescriptions by the system and participants ' prescriptions, 22 participants said that the result by the system was similar to their diagnosis, but 16 said different. Thirty-one participants said that the prescriptions by the system were appropriate to be given to real patients, but 4 participants said not appropriate. This implies quite positive review.

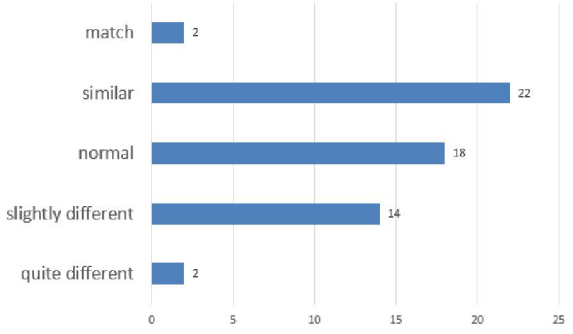

Figure 6. Similarity of prescription between the system and participants

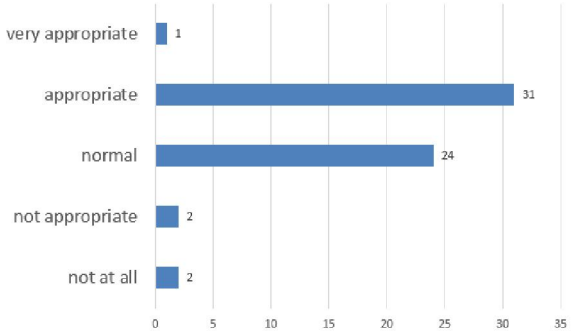

Figure 7. Consistency of the system

4. Discussions

Although 40% of participants said their own prescription was different from the prescription by the system, they said they are willing to use the suggested prescription by the system. This implies that diagnoses by the system are valuable as an auxiliary.

Practitioners who participated in evaluating the system pointed out the following issues while using the system with reference to the record of patients who visited their clinic, which are a major part of diagnoses in traditional medicine which is not fully assisted by diagnostic equipment.

First, because oriental medicine terminology to describe one symptom is varied, problems accordingly occur when typing symptoms in the system to result in different results suggested by the system depending on the typed symptoms.

The terminology described in books for traditional medicine should be translated into symptoms described in modern language. A difference should be implemented depending on the importance of symptoms.

The names of diseases and classifications in traditional medicine are different from the modern version thereof (ICD, International Classification of Diseases).

While it is not easy to describe some knowledge in the ontology of which the clinical application is thus not easy, the system does not take into consideration of patient state, for example, patient ages and genders, and disease state, for example, acute or chronic.

As described above, although the system for supporting treatment by using ontology is an auxiliary convenient tool to assist users in terms of symptom collection and candidate discovery, it is definitely not a system enough to detect and prevent risks in the process of treating patients.

However, the system is regarded enough to provide various intelligent information services by collecting subjective or objective symptoms in routine health care, and will be widely used in the field of health care.

Acknowledgements:
Foundation item: This research was supported by a Grant-in-Aid from the Korea Institute of Oriental Medicine (no. K14091).

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4/28/2014