# User Guiding Information Supporting Application for Clinical Procedure in Traditional Medicine

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**Abstract.** Medical diagnostic procedures generally comprise a step of collecting patients' symptoms, a step of diagnostic decisions, and a step of selecting appropriate methods of treatment. In traditional medical treatment based on analogical inference, analyzing present collected symptoms and choosing symptoms to query are mightily important for the diagnosis and these are essential conditions for appropriate treatment. Use of information systems that support present diversity of symptoms information and considerable options for the next step can avoid missing out timely and useful knowledge during the procedures. We have developed an application that having user interfaces guiding various analytic cases and their next optional choice and clinicians are able to improve the efficiency of procedures with this. By analyzing semantically linked data to symptoms, the application is possible to support efficiently collecting symptoms and selecting methods of treatment. This interfaces help users by requiring a minimal operation but supporting diverse probabilities.

**Keywords:** User guiding, Decision support, Ontology, Traditional medicine, Korean medicine.

## 1 Introduction

A medical diagnosis, in the sense of diagnostic procedure, can be regarded as an attempt at classification of an individual's condition into separate and distinct categories that allow medical decision about treatment and prognosis to be made [1, 2]. Numerous studies have been done on medical diagnosis, including improving itself by various approaches [3–8]. The initial task is to detect medical indication to perform a diagnostic procedure. Medical indication includes patients' symptoms present in them currently, their physical information, and their past medical history. This information is designed to accurately describe the overall patient condition and form the basis of diagnostic data. Modern medicine doctors may make decision on whether to determine which diagnostic examination is required for the patient [9].

Unlike modern medicine [10], traditional medicine doctors make a diagnosis by analyzing collected medical indication, that is to say patient's symptoms [11]. In spite of the fact that the most basic step in procedure of medical diagnosis by traditional

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medicine doctors is detecting patients' symptoms, traditional medicine doctors have a low level of dependence on diagnostic devices because of various barriers including legal constraint, tradition and lack of standards [12]. This is why both patients' appeals and some diagnostic process including tong diagnosis and pulse diagnosis are very important elements in traditional diagnostic procedure. Moreover, lots of symptoms dealt in the traditional way, such as thirst, dry mouth, sweating or no sweating, and yellow urine are very ordinary but good criteria of patients' health.

Therefore, proper symptom collection including ordinary condition is an essential factor for precise treatment, and it will be helpful if a supporting system provide necessary information for collecting symptoms from patients. And after decision of classification, it will be also helpful if the system provide necessary information for determining a method of treatment and for deciding a formula because there are various methods and formulas for treating a disease that is distinguished by patients' condition.

## 2 Materials and Methods

The general composition of knowledge in Traditional Korean Medicine (TKM), excluding basic theoretical concepts, consists of medications, acupuncture points, symptoms, and diseases (or patterns) [13]. Fig. 1 illustrates this general composition of TKM knowledge, where a node represents class or instance and a link represents a property. Because pattern in TKM or traditional Chinese medicine (TCM) is similar to disease, it was omitted from the graph in Fig. 1 to increase visibility. And because relations among concepts are possible to be analyzed bilaterally, the directivity of properties was also omitted.

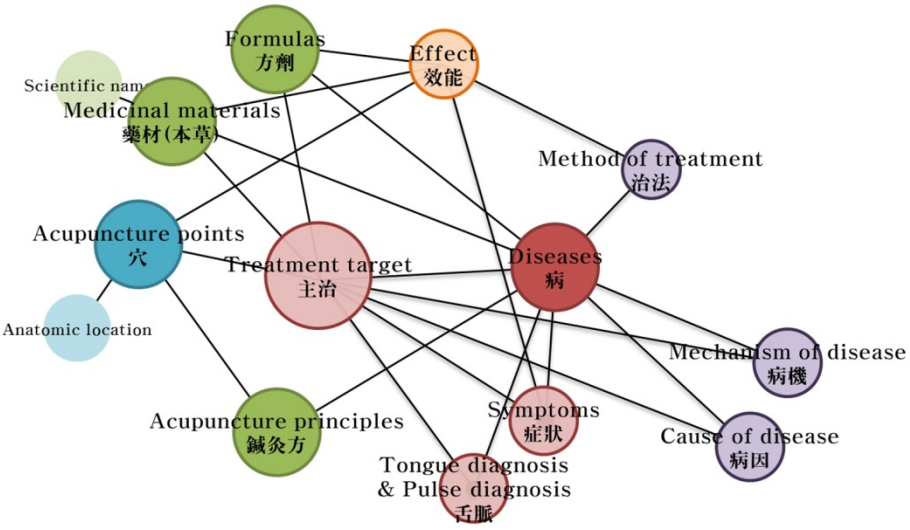


**Fig. 1.** A graph of the TKM knowledge

Treatment targets, objects of major indication of treatment, are often represented as a combination of diseases, symptoms, or causes of disease and symptoms cannot be simply expressed as dealt with a medicinal material or a formula. A disease contains symptoms that can appear in patients, causes, mechanisms, and methods of treatment. Medicinal materials, formulas, and acupuncture points contain information on effects as treatment methods, as well as information on the treatment target or disease. Methods of treatment are linked to the corresponding proper effects of treatment, whereas treatment targets can be linked to the proper diseases, symptoms, diagnoses, or causes of a disease.

Medical literature on TKM, such as Donguibogam and present textbooks, has described diseases (or patterns) and their treatment information. But each book is focusing on describing one among diseases, formulas, or medicinal materials even though all kind of diseases, formulas and medicinal materials are dealt in them. Ontologies of diseases, formulas, medicinal materials, or acupuncture points can be built based on these features. But it cannot be easily declared that a formula treating a symptom is identical to a formula known to treat a disease involving this symptom even though the names of these two formulas are same.

Traditional medicine knowledge of this character is described in lots of books and the contents of these books are organized according to the table of contents. Thus text cannot provide necessary comprehensive information at an appropriate time, even when information retrieval systems are used. After searching is conducted many times by a doctor, relevant information is integrated on a node, such as a disease, a formula, and a symptom.

The abovementioned manner of utilizing knowledge requires a continuous information retrieval process, and many difficulties are encountered when integrating and utilizing a series of concepts obtained in this manner, which makes it unreasonable to use this type of knowledge in clinical practice. From the perspective of computer engineering, such separated knowledge can be built into a number of ontologies and integrated knowledge, as shown in Fig. 1, can be reproduced by linking these ontologies together.

To achieve this, the resource description framework (RDF) [14] was used to build TKM ontology, and the Jena Ontology application programming interface (API) was used to process appropriate data. The ontologies of medicinal materials, formulas, or disease described above were linked together by experts in TKM to prevent any restriction in accessing the linked data or ontologies from the systems perspective. In the real world, each element of the expert knowledge will be published by the experts in each field and could be represented as fused knowledge through a mutual connection.

### 2.1 Supporting Suitable Knowledge for Collecting Symptoms

Patient symptom collection is roughly divided into two cases. One is collection from appealed by patients and patients recognize these symptoms themselves. Another one

is collection from queried by doctors and doctors gather these symptoms by reasoning and examination. Doctors' collecting may be repeated in processes of diagnosis and treatment determination.

A patient suffers from one disease or from a number of diseases like a complication. A doctor can presume a number of diseases the patient suffers from by analyzing appealed symptoms. From that, the doctor can query additional symptoms which are not appealed at that time for determining one result or can exclude symptoms which are neither related with the presumed disease nor appealed by the patient. Some of appealed symptoms could be excluded if those symptoms might be ignored or analyzed to mistaken symptoms.

In the step of collecting symptoms, the supporting system can suggest candidate presumed diseases which have collected symptoms by using linked data. Linked data enables the system to sort these diseases in order of having more collected symptoms and to suggest symptoms for reducing candidates. Adding a symptom which is accompanied in most candidate diseases leads to exclude a few candidates and adding a symptom which is accompanied in few candidate diseases leads to exclude a lot of candidates. At this point, doctors select a next proper symptom based on candidate diseases, neither by the number of matched symptom nor by the number of candidate diseases. Fig. 2 shows this flow. Fig. 3 shows a user interface for this step.

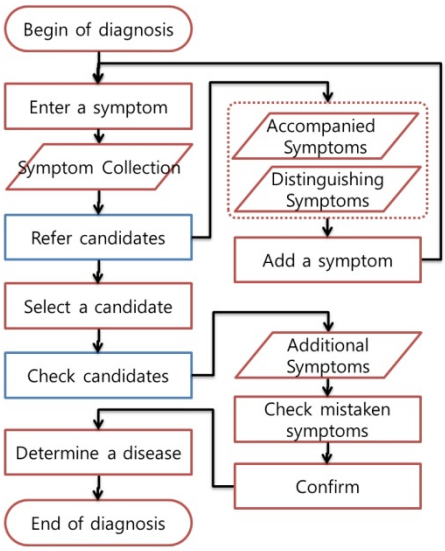


**Fig. 2.** A flowchart of collecting symptoms from a patient


**Fig. 3.** A user interface of collecting symptoms

## 2.2 Supporting Suitable Knowledge for Deciding Treatment

In the step of determining the methods of treatment after diagnosis, formulas linked to the collected symptoms or formulas linked to the decided diagnosis results can be selected. As shown in Fig. 1, information regarding the given formulas is initially given for the disease. After a treatment method is selected by the doctor, effects linked to the treatment method are searched, and additional formulas with corresponding effects can be found.

Moreover, if the major indications of the searched formulas were analyzed and it was found such that there is a match between the information on the linked disease from the searched formula and the disease as a result of a diagnosis, then the selection of the corresponding formulas can be presented as an appropriate choice. The formulas linked to the collected symptoms can be selected from among the possible selections.

As shown in Fig 4, this is why there are more reasonable treatments by considering cause of disease, mainly appealed symptoms, and their aspect depending on the patient among a number of treatments linked with a disease as a diagnosis result.

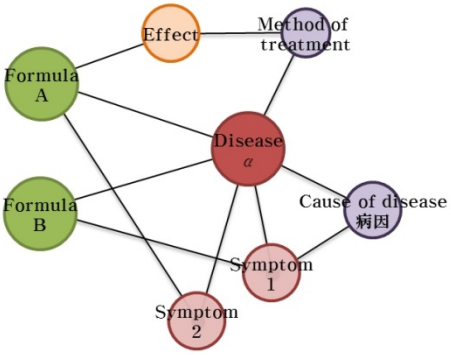


**Fig. 4.** An example of determining a proper treatment

When symptom 1 in Fig. 4 is a mainly appealed symptom and symptom 2 is not accompanied, then formula B is more proper. When a doctor determines a method of treatment and a corresponding formula having proper effect is formula A, formula A could be considered. Fig. 5 shows a user interface for this step.


**Fig. 5.** A user interface of deciding a formula

# 3 Results and Discussion

## 3.1 Collecting Symptoms

We supposed that two symptoms “feeling cold” and “fever” were collected by a patient’s appealing. In current TKM ontologies, there are ten diseases accompanying both two symptoms and 46 additional symptoms could be accompanied with these ten diseases. Table 1 shows accompanied symptoms and their frequency. The two symptoms above could be accompanied with ten diseases but other symptoms could be accompanied with up to five diseases.

**Table 1.** Symptoms accompanied with given symptoms “feeling cold” and “fever”

| Symptoms accompanied with 5 diseases | Symptoms accompanied with 4 diseases | Symptoms accompanied with 3 disease |
|---|---|---|
| headache | no sweating | cough, asthma |

If a doctor supposes that the patient has a headache or one of candidate is possible, then he should check whether the patient has a headache or not. If the patient has a headache, the system returns information shown in table 2. There are five diseases accompanying all three symptoms. A disease not accompanying headache should be excluded.

**Table 2.** Symptoms accompanied with given symptoms “feeling cold”, “fever” and “headache”

| Symptoms accompanied with 3 diseases | Symptoms accompanied with 2 diseases | Symptoms accompanied with only one disease |
|---|---|---|
| no sweating | - | cough, dry mouth, pain in the chest, dizziness, etc. |

After the doctor check whether the patient has sweating or not, he could make a decision or check more symptoms in the same way. If the patient has not a headache and has a cough, then the system returns information shown in table 3 instead of table 2. In this case, the number of candidate diseases is three.

**Table 3.** Symptoms accompanied with given symptoms “feeling cold”, “fever” and “no sweating”

| Symptoms accompanied with 2 diseases | Symptoms accompanied with only one disease |
|---|---|
| asthma | headache, dry mouth, pain in the chest, dizziness, etc. |

If the doctor checked the patient has not a headache in the previous step, the system let him know the only one disease accompanying a headache and he could determine whether the disease should be excluded or not. By showing this kind of further information, the system does support doctors and providing proper knowledge at the right time.

### 3.2 Deciding a Formula

We searched formulas from the TKM disease ontology by a symptom and then searched after linking effect to method of treatment. This result shows more information can be obtained by linking data not merely because an additional ontology was used. By linking medicinal materials used for diseases to formulas, more formulas can be retrieved.

The primary property statistics for finding formulas to care symptoms in the disease ontology are shown in Table 4 and Table 5.

**Table 4.** Number of formulas to care cough

| Number of having effect to "cough" | Number of diseases having cough | Number of formulas treat diseases having cough |
|---|---|---|
| 22<br>(a) | 56 | 109<br>5 overlapped with (a) |

**Table 5.** Number of methods of treatment for diseases having cough

| Number of methods for 56 diseases having cough | Number of effects EXACTLY corresponding these treatment methods | Number of formulas having these effects |
|---|---|---|
| 58 | 12 | 43<br>10 overlapped with above<br>136 |

From the TKM disease ontology, 109 referable formulas from diseases having cough were found and 58 methods of treatment were found. It is dependent on how to find effects corresponding to these methods, but 12 effects were linked by name. From the TKM formula ontology, 43 formulas having these effects were found and 8 formulas were overlapped. But, 35 referable formulas could be presented after linking.

Knowledge regarding TKM is largely based on traditional medical literature, and such knowledge actually exists independent of TKM. This information exists in the minds of Korean medicine doctors through the incorporation and interpretation of such knowledge, and the interpretation and application of TKM theory is determined by Korean medicine practitioners. However, knowledge based on traditional medical literature, as well as clinical knowledge, must be accumulated and shared by linking

these types of knowledge to achieve the standardization and objectification of traditional medicine.

If the knowledge discussed in Section 2 is divided and expressed in a different space in which the data storage or access methods are varied, and the management of the knowledge is conducted independently, it will be virtually impossible to integrate and manage such knowledge; therefore, it will be extremely difficult to merge and use elements of knowledge that are not linked.

However, if each piece of knowledge is shared or linked using a unique uniform re-source identifier (URI) through RDF/OWL [15], this knowledge can be readily accessed on the Web, and each set of data can be shared rather than becoming subordinate to a specific system [16]. Furthermore, knowledge that is made public or shared based on a URI would be reviewed and refined by many individuals and could be realized as user-agreed knowledge. The introduced information supporting system also could be utilized efficiently in process of treatment including collecting symptoms and determining treatment by providing proper knowledge.

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