Expert system knowledge acquisition for melasma skin diagnosis and treatment with Thai herbal medicine

1Pornchai Nopparatkiat, 2Byaporn na Nagara, 3Chuvej Chansa-ngavej*
1Shinawatra University, Bangkok 10400, Thailand
2Suvarnabhumi Institute of Technology, Samutprakarn 10540, Bangkok, Thailand

DOI: 10.6088/ijaser.0020101069

Abstract: Thai traditional medicine is a viable alternative medicine and there are a large variety of Thai herbs available for melasma treatment. Spreading the knowledge of Thai herbal medicine to people world-wide should therefore be made a top priority. The development of an expert system for melasma diagnosis and treatment with Thai herbs is the first step in that direction. The aim of this research is to establish knowledge acquisition for an expert system for melasma skin problem diagnosis and treatment with Thai herbal recipe or Thai herbal cosmetics. The study makes use of an expert system, an artificial intelligence technology that has been used for medical diagnosis. In-depth interviews with Thai traditional doctors and dermatologists were arranged in order to gather expert knowledge and skills as primary data for diagnosis of melasma problems and treatment with Thai herbal medicine. The knowledge as secondary data was collected from textbooks of Thai traditional medicine and dermatology, internet, and other open source. The outcome of this research is used to support the building of an expert system for melasma diagnosis and treatment with Thai herbal recipes or Thai herbal cosmetics for alternative medicine for use by the general public.

Keywords: Rule-based expert system, Knowledge acquisition, melasma skin problem, Thai herbal recipes, Thai herbal cosmetics.

1. Introduction

There has been an upsurge of interest in traditional medicine as an alternative for medicine for quite some time. Knowledge on Chinese traditional medicine, for example, has been organized in a systematic manner using various forms of expert and intelligence systems as the preferred tool (Wu et al., 2011; Huang and Chen, 2007; Wang et al., 2004). Thai traditional medicine has been in use for centuries. However, in contrast to Chinese traditional medicine, Thai traditional medicine body of knowledge has not been as well-organized and is in urgent need of scientific management and organization. In conducting the present research, Thai herbal knowledge has been examined and collected for creating database of Thai herbal recipe for melasma treatment and the knowledge organized in a systematic format that can be accessed and learned by people via automated system (e–learning). The ultimate aim is to encourage Thai traditional medicine students, skin care practitioners and the general public to use the expert system for their health benefit from using Thai herbal recipe and Thai herbal cosmetics for their skin problems. The developed expert system comprises of two main domains of knowledge, namely diagnosis of skin problems in the area of melasma and giving the recommended treatment for the skin problems with various kinds of Thai herbs and Thai herbal cosmetics. This includes the advice for protecting and preserving skin health. The diagnostic procedures in this study can be used for self-training by primary skin healthcare practitioners. This would be beneficial to skin healthcare system by alleviating the lack of resource persons specializing

*Corresponding author (e-mail: chuvej.c@svit.ac.th)
Received on August 19, 2012; Accepted on October 09, 2012; Published on October 28, 2012
Expert system knowledge acquisition for melasma skin diagnosis and treatment with Thai herbal medicine

in Thai traditional skin therapy because an expert system never retires, becomes sick, or resigns (Scown, 1985). Thai herbs for skin care command special academic and commercial interest nowadays. Of particular interest in the present paper are Thai herbal treatments for melasma skin problems, which are common skin problems that can destroy skin beauty. In modern medicine, there are a large variety of cosmetics, drugs and technologies for melasma skin problem treatment. By contrast, using Thai herbal products for skin problem treatment is far from being a common practice by dermatologists. Recently, although there are a lot of Thai herbal products for skin care in the market, users still lack precise knowledge about Thai herbs for melasma treatment. The present study focuses on knowledge acquisition of Thai traditional medicine, particularly Thai herbal recipes and Thai herbal cosmetics for melasma treatment. Thorough literature reviews were conducted on the use of Thai herbs for the skin problem treatment and the use of Thai herbal wisdom for melasma treatment in textbooks as well as recipes on Thai traditional medicine and in websites. As a result of searching, it was found that there have not been reports of the use of expert systems for Thai herbs prior to the present study. Also, although there are websites about Thai herbs for skin care, there are no websites which develop an expert system for Thai traditional herbal medicine. The present study aims to develop an expert system for melasma pre-diagnosis and treatment with Thai herbal recipe. The expert system developed is then installed in a website for easy access by users who can consult the expert system at any time anywhere in the world. A goal of the present expert system development is therefore to ensure that scarce expertise can be utilized when a human expert is not available. For example, when a decision maker needs some expert advice about melasma skin problems, a human expert in Thai traditional medicine for melasma treatment may not be available. Instead of waiting or paying to consult another human expert, the decision maker could immediately consult the expert system to get comparable advice.

2. Methodology

The present research paper focuses on the knowledge acquisition part of the rule-based expert system development process. Typically, the development of an expert system involves four major activities (Changchit, 2008): (1) Knowledge acquisition, (2) Knowledge representation, (3) Knowledge inference, and (4) Explanation and Justification. The main module of this rule-based expert system is a rule base, also called knowledge base. The rule base contains specific knowledge about the various skin problem areas presented in rules. Rules, in the form IF-THEN, are elementary units of knowledge. The process of constructing the knowledge base is knowledge acquisition. Knowledge acquisition is the most important element, and at the same times most difficult step, in the development of expert system (Niwa, Sasak, and Ihara, 1988). Expert knowledge is represented in the form of rules or as data within the computer. A rule-based system consists of IF-THEN rules, facts, and an inference engine controlling the application of the rules based on the facts. The rule-based technique, called knowledge-based technique is a conventional rule-based expert systems using human expert knowledge to solve the skin problems that normally would require human intelligence.

2.1 Concept of the expert system

Expert Systems are computer programs that are derived from a branch of computer science research called Artificial Intelligence (AI) (Durkin, 1994). An expert system, also known as a knowledge–based system, is defined as a computer–based system that uses captured human knowledge to solve problems that ordinarily require human experts (Foltin and Smith, 1994). Most complete and successful expert system applications
were developed using the rule–based approach. Rule management is a valuable technique for representing and processing reasoning knowledge (Holsapple and Whinston, 1987). A comprehensive literature survey of expert systems applications reveals that while there have been hundreds of reported applications, their applications in traditional medicine has not yet been wide-ranging (Liao, 2005). The expert system in this present research uses expert doctor knowledge to solve skin problems. Like a human expert, the expert system is able to use stored expertise in making inferences about Melasma diagnosis, offer recommendations, and provide explanations to a user. The expertise is defined as the knowledge about melasma (particular domain), understanding melasma problem and the skills in solving melasma problems. An expert’s knowledge has both public and private aspects. Public knowledge includes the facts, theories, and definitions as found in texts and journals referenced by those.

2.2 The expert system development process

Typically, the development of the expert system involves four major activities as follows:

1. **Knowledge acquisition:** These activities are conducted to extract, accumulate, transfer, and transform melasma problem–solving expertise from expert doctors and/or documented knowledge sources to a computer program for constructing or expanding the knowledge base. The used techniques are interview, documental analysis, and observation.

2. **Knowledge representation:** These activities refer to the techniques used to represent melasma problem–solving expertise from expert doctors and/or documented knowledge sources into a computer knowledge base. The method by which the expert system internally represents its expertise is Rules.

3. **Knowledge inference:** These activities refer to the techniques of programming a computer in such a way that it can make reference in an attempt to imitate the reasoning behaviors of human experts (expert doctor).

4. **Explanation and justification:** These activities refer to an attempt by the expert system to clarify reasoning, diagnosis, recommendations, and other actions (e.g., asking a question).

5.

**Figure 1:** The rule-based expert system development process

(Source: Adapted from Negnevitsky, 2007)
The main components of the proposed rule-based expert system are: the inference engine, the knowledge base, the working memory, knowledge acquisition facility and explanation facility. (see Figure 1)

![Diagram](image)

**Figure 2**: Simplified overview of the expert system for the skin problem consultation.

The present paper focuses on the part of knowledge acquisition which is the first phase of the expert system development that progress virtually together. (Ignizio, 1991)

### 2.3 The knowledge acquisition method

In designing expert systems, the process of eliciting information has been termed knowledge acquisition. According to Hoffman (1987), knowledge acquisition - also known as knowledge elicitation - involves extracting problem-solving expertise from knowledge sources, which are usually domain experts. Knowledge acquisition is the transfer and transformation of potential problem solving expertise from some knowledge source to a program (Buchanan, 1983). The present knowledge acquisition is conducted to extract, accumulate, transfer, and transform skin problem-solving expertise from human expert doctors (Thai traditional medicine doctors and dermatologists) and/or documented knowledge sources constituting the knowledge base to a computer program. The techniques used are interviews, documental analysis, and observation. The knowledge acquisition process actually has several steps. The most important ones are: selecting melasma skin problem to be solved by the program, interviewing expert doctors, codifying the knowledge in the representation language, and refining the knowledge base by testing it and extending its
capability. A broad treatment of this topic would relate knowledge acquisition to build the expert system for melasma diagnosis and treatment with Thai herbal recipes or Thai herbal cosmetics. Knowledge acquisition plays an importance role in the expert system development. It is evident that the quality of the resulting system depends on the quality of knowledge originally elicited (Bolger and Wright, 1994; Moody et al., 1998). The Knowledge acquisition work in the present research begins with gathering knowledge from two sources that are primary data and secondary data from human experts and/or documented knowledge. Primary data is knowledge about symptoms, signs, diagnosis and treatment of melasma from in-depth interviewing with a mixture of face-to-face and telephone consultation with four Thai traditional expert doctors and a dermatologist for receiving knowledge about melasma diagnosis in modern medicine compare with Traditional medicine and treatment with Thai herbal recipe. Secondary data is documented knowledge from Thai traditional medicine textbook, Thai traditional pharmacy textbook, herbal book, dermatology textbooks, internet, and other open source (Prapaspong et al., 1999; Bureau of Sanatorium and Art of Healing, 2006; Sukhothai Thammathirat Open University, 2006; Wutithamavech, 2004, 2009). This knowledge acquisition process began with the question: what is the process that doctors use to diagnose skin problem? Reviewing and evaluating the diagnoses of skin problems result in the identification and characterization of important aspects of melasma problems for use in building the expert system (see Figure 3).

![Figure 3: Knowledge acquisition process for diagnosis and treatment of the skin problem](Adapted from Changchit and Holsapple, 2004)
In Figure 3, knowledge for building the expert system was acquired through a series of interviews with the experts. The experts doctors were asked to identify all diagnosis of melasma skin problems and describe in detail the techniques and process that were used to diagnose and treat each melasma skin problem with Thai herbal recipes or Thai herbal cosmetics. The authors act as knowledge engineers and have the knowledge transformed into knowledge rules for the expert system. The knowledge system is thereby built into a problem processing system (Inference engine) and the presentation system. The expert system responds to users by giving pre-diagnosis and recommended treatment with Thai herbal recipes and Thai herbal cosmetics via the user interface. Apart from the primary data from expert doctors, secondary data on Thai traditional medicine body of knowledge is also collected; an example of this type of knowledge is listed in the Appendix.

2.4 Knowledge representation
Backward chaining is used by setting each type of melasma problem to be the goal or hypothesis, and set many attributes (symptom and sign of melasma) for proving hypothesis (type of melasma). Backward chaining inference is often called goal-driven reasoning. (Al-Hajji, 2012)

To backward chain from a goal in working memory (WM) the inference engine:
1. Select rules with conclusions matching the goal.
2. Replace the goal by the rule's premises. These become sub-goals.
3. Work backwards till all sub-goals are known to be true -either they are facts (in WM) or the user provides the information.

3. Results

3.1 Typical melasma diagnosis rule in Rule-based diagnosis
In the expert system development, there are 175 knowledge rules of melasma diagnosis for building rule-based reasoning to knowledge base of the expert system. In this paper, for lack of space, only one example is shown of knowledge rules for building knowledge base of the expert system in Table 1. Table 2 then proceeds to show the recommended treatment.

<p>| Table 1: An example of the knowledge rule |</p>
<table>
<thead>
<tr>
<th>IF</th>
<th>THEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Characteristics of the color patch on your skin are &quot;Color patch with well-defined border and flat on skin&quot;</td>
<td>Your skin problem is most probably melasma.(epidermal type)</td>
</tr>
<tr>
<td>2. The color of the patch is black or brown or black-brown.</td>
<td></td>
</tr>
<tr>
<td>3. The size of the color patch is about 3-10 mm.</td>
<td></td>
</tr>
<tr>
<td>4. Locations of the color patch are symmetry on both sides of the face. (Symmetrical on cheeks, nose lips, forehead)</td>
<td></td>
</tr>
<tr>
<td>5. You have not got the symptom(s) of pain or swelling or red or burning sensation at the skin problem.</td>
<td></td>
</tr>
<tr>
<td>6. The color patch occurs in sun-exposed skin area.</td>
<td></td>
</tr>
<tr>
<td>7. The color patch is acquired later in life and not inborn.</td>
<td></td>
</tr>
</tbody>
</table>
Table 2: Thai herbal medication and additional suggestions for melasma treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Additional suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thai herbal medication consist of that are: 1. Topical Thai herbal recipe for melasma 1.1 Apply aloe vera (wan hang chorakhe) jelly on facial skin before and after strong sunlight exposure. (Apply aloe vera liquid over your facial skin, leave until it dries within 5-10 minutes. Routinely apply 2 times a day). 1.2 Use sunscreen cream made from Thai herbs. E.g. wanhom sunscreen cream SPF 19. 1.3 Use rice bran cleansing oil (for removing makeup and impurities clogged in pores) 1.4 Use Thai herbal cleansing gel such as: 1.4.1. Tamarind plus honey facial cleansing gel 1.4.2. Rang chuet face cleaning gel 1.5 Use Thai herbal face scrub powder recipe 4 1.6 Use topical Thai herbal recipe 5 2. Oral Thai herbal recipe for melasma treatment 2.1 Use Oral Thai herbal recipe 1 (for melasma) 2.2 Use Oral Thai herbal recipe 2 (for melasma)</td>
<td>Suggestions for melasma treatment 1. Avoid eating spicy food, fresh meat, refrain from drinking liquor or beer. 2. Avoid exposure to sunlight and wind. 3. Using oral Thai herbal medicine to treat skin blemishes, necessarily to take a long time for 5-6 months to see results. The treatment result of epidermal type melasma is more rapid than dermal type melasma. 4. If you experience problems when using Thai herbal recipe or Thai herbal cosmetic. You have to stop using immediately and see a doctor.</td>
</tr>
</tbody>
</table>

Table 2 suggests the use of some or all of these Thai herbal recipes for melasma (superficial or epidermal type) treatment for patients who have symptoms and signs of this skin problem. The patient is advised to use any suggested Thai herbal recipes or Thai herbal cosmetics in consultation with Thai traditional doctors or Thai traditional pharmacists for the sake of safety. Trial usage of the expert system is available on the website “Thaiherbalexpert.com.”

3.2 Data flow of melasma diagnosis

The example data flow of melasma diagnosis in inference engine of the expert system is as shown in Figure 4.

Figure 4 is the diagram of the data flow of skin problem diagnosis in diagnostic process of the expert system. The process starts by getting data about the skin problem of a user based on his/her answers to the interactive questions. The internal diagnosis process will identify the rules with conclusion matching the skin problem. Once the melasma problem is found, the system will give diagnosis result and recommended treatment for the user.
Expert system knowledge acquisition for melasma skin diagnosis and treatment with Thai herbal medicine

4. Conclusion and future work

This paper focuses on the knowledge acquisition for skin problem consulting in melasma problem. Knowledge is gathered from two sources, namely primary data from Thai traditional doctors and a dermatologist (human experts) and secondary data from documented knowledge. The steps involved in the knowledge acquisition work process are extracting, accumulating, transferring, and transforming problem-solving to a computer program for constructing or expanding the knowledge base. Full details of Thai herbal recipes in this research are accessible from the website “Thaiherbalexpert.com” (see Figure 5 and Figure 6). This paper is designed to be an introduction to the knowledge acquisition for developing the expert system for skin problem consultation in the area of melasma, acne, freckle, wrinkle, and uneven skin tone by giving pre-diagnosis and recommending treatment with Thai herbal recipe or Thai herbal

Figure 4: The data flow of melasma diagnosis in diagnostic process of the expert system
cosmetics. In this work, many limitations have to be overcome, for example, the scattering of knowledge of Thai herbal recipes for melasma treatment and secrecy maintained by many Thai traditional doctors. Nevertheless, for in-depth interviews of expert doctors, there are some Thai traditional medical doctors who willingly donate their knowledge for the public. However, the knowledge has not been readily available in one place or one expert doctor. In-depth interviews have to be taken from several Thai traditional medicine doctors to collect and combine their knowledge. The primary data from knowledge of Thai traditional medicine doctors are essential and key to the present work. The obstacles have had to be overcome for the development of the expert system to be completed.

The expert system developed in this work would benefit three groups of users, namely:

1) People who have skin problems and want to treat their skin problems with Thai herbal recipes or Thai herbal cosmetics.

2) Students of Thai traditional medicine/applied Thai traditional medicine and skin care practitioners who can learn and use the knowledge of the expert system by themselves as part of their training.

3) The expert system can sustain knowledge of Thai traditional expert doctor, knowledge of Thai herbal recipes and knowledge of Thai herbal wisdom, which is very valuable for the maintenance of Thai local wisdom.

Acknowledgement

The present research work was supported by the internal research funds of Shinawatra University and generous scholarship to the first author. Parts of this work were conducted while the second author was at Shinawatra University.

References


22. Sukhothai Thammathirat Open University. 2006. Thai Traditional Pharmacy, 1, 2, Nonthaburi: Sukhothai Thammathirat Printing. (in Thai)
26. Wutithamavech, W. 2009 Thai Traditional Medicine Ingredients 1 (Kruang Ya Thai 1), Bangkok: Silsiam Packaging and Printing Corporation. (in Thai)
Appendix-An example of secondary data - knowledge about melasma

In this research the authors have collected knowledge of Thai traditional medicine, Thai herbal recipe and suggestion for melasma treatment from various Thai traditional medicine sources. (Prapaspong et al., 1999; Bureau of Sanatorium and Art of Healing, Ministry of Public Health, 2006; Sukhothai Thammathirat Open University, 2006; Wutithamavech, 2004, 2009). An example of secondary data about melasma collected from such sources is presented below:

Melasma is an acquired hypermelanosis of sun-exposed areas. Melasma presents as symmetric hyperpigmented macules, which can be confluent or punctate. The cheeks, the upper lip, the chin, and the forehead are the most common locations, as shown in the images below, but melasma can occasionally occur in other sun-exposed locations. Melasma, also called ‘chloasma’, is a common skin condition of adults in which light to dark brown or greyish pigmentation develops, mainly on the face. The name comes from melas, the Greek word for black. Although it can affect both genders and any race, it is more common in women and people with darker skin-types who live in sunny climates. Melasma usually becomes more noticeable in the summer and improves during the winter months. It is not an infection, it is not contagious and it is not due to an allergy.

Causes of melasma: in medical science
The exact cause is not known, but several factors contribute. These include pregnancy, hormonal drugs such as the contraceptive pill, and very occasionally medical conditions affecting hormone levels. Some cosmetics, especially those containing perfume, can bring on melasma. There is research to suggest that it can be triggered by stress. Sunshine and the use of sun-beds usually worsen any tendency to melasma. There is a genetic predisposition to melasma. Triggers include: 1. Pregnancy – the pigment often fades a few months after delivery, 2. Hormonal contraceptives, including oral contraceptive pills and injected progesterone, 3. Sun exposure, 4. Scented or deodorant soaps, toiletries and cosmetics – a phototoxic reaction, 5. Unknown factors, when it arises in apparently healthy, normal, non-pregnant women.

Clinical features
Melasma usually affects women; only one in twenty affected individuals are male. It generally starts between the age of 30 and 40. It is more common in people that tan well or have naturally dark skin compared with those who have fair skin. Melasma affects the forehead, cheeks and upper lips resulting in macules (freckle-like spots) and larger patches. Melasma may be divided into epidermal (skin surface) and dermal (deeper) layers.