On the Development of Nutrition Information Systems for Kidney Disease Patients

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Abstract

Patients with kidney disease are increasing every year. The majority of these are a chronic disease. These patients, in addition to modern medicine in the treatment should be treated by diet to some extent on the type and stage of disease, because the diet of patients with kidney disease, it is necessary to limit certain nutrients such as sodium salt, salty food, which comes from them and various kinds of food that the patient must eat the tasteless This unusual diet, the majority of Thai people like to eat spicy food. We address the development of an information system for kidney disease patients. It includes knowledge about the nutrition, the disease information as well as questions to help suggest nutrition for each patient. The knowledge are gathered from a cookbook for people with kidney disease. The user must answer questions about the symptoms. The answers are used together with the mechanism of forward chaining to suggest proper nutritious foods for the patients. The system contains food database and nutrition which can further be modified. The user satisfactory testing by 30 samples shows that the system in good on average.

Keywords: Kidney Disease, Nutrition Information System

1. Introduction

In particular, kidney diseases can be divided into the following kinds [1].

-Glomerrular diseases which can be divided into two kinds: Nephritic syndrome, and Nephrotic syndrome.

For Nephritic syndrome, there is a symptom of swelling on legs, stomach, body, *etc.* The patient needs to consume sodium about 0.5 – 2 grams per day. The water may be also limited and the potassium needs to be limited to 2 grams per day.

For Nephrotic syndrome, the patient usually loses proteins in urinating and has a low albumin. Thus, he should have the food that has a high protein about 100-120 grams per day. Perhaps, the sodium should be limited to 1-2 grams per day.

- Renal failure which can be divided into acute renal failure and chronic renal failure [17-18].

For acute renal failure, for the case with less urinating, the protein needs to be reduced to 0.5-0.6 gram per 1 patient's kilogram. The total protein should be around 30-40 grams per day. The patient can increase the food with carbohydrate to increase the calories instead. The sodium and potassium need to be limit to 1-2 grams per day.

For chronic renal failure, the protein needs to be limited to 30-40 grams per day. The sodium and potassium may not need to be limited.

In general, the kidney disease patient needs to limit sodium, potassium or maybe both. When both sodium and potassium need to be limited. It is more difficult to arrange the food menu. For the sodium limitation only, the meat can be avoided since it contains lots of

sodium. The patient may consume vegetable or fruit instead. However, when the potassium needs to be limited, the vegetable and fruit needs to be avoided since they contain more potassium. Thus, the nutritionist needs to select the food with average sodium and potassium in every meal and need to be various so that the patient will not get bored. Also, the protein may need to increase, or need to be restricted in some case. Also, in some case, the patient needs to restrict all protein, potassium, and sodium which make it more difficult to select the material for cooking since the variety becomes less. Therefore, the nutrition information system for kidney disease patient which integrates food nutrition information and contains a variety of food raw material will help suggest interesting food menu and balance a nutrition for the patient for the whole day.

2. Backgrounds

Information systems are commonly used nowadays in the medical area. An information system contains proper information to be easily queried or lookup. The database is designed properly to store information about patients, diseases, period of diseases, medicine, *etc*. Such information systems may be called as medical information system, healthcare informatics, clinical information system, hospital information system, disease information system, diagnostic information system, nutrition information system, *etc*. Generally, the hospital information system helps the management of administrative issues, legal issues, medical issues and services in a hospital. This is sometimes called healthcare information system, clinical information system, *etc*. [2] Health informatics is an intelligence information system which may optimize, process the existing health information to provide the clinical guidelines [3]. The nutrition information system provides information about nutrition in many cases to avoid malnutrition [4]. Diagnostic information system provides useful information for diagnosis diseases such as plant disease or animal disease [5]. Disease information system provides a database of specific diseases such as for endemic diseases [6]. Actually, from the typical information system, it may be evolved to expert systems or decision support system, *etc*.

For example, expert systems have been around since 1970. It is a part of an artificial intelligence. It was designed to imitate solving problems just like a human expert. The key idea is the use of reasoning approaches to conclude the new knowledge [7]. This is an important engine called an interference engine. A mechanism is used to perform interference such as a forward chaining, backward chaining [8].

The important use of expert systems in the history is for the medical system experts [9]. Starting from 1972, De Dombal's system was invented to diagnose the acute abdominal pain. It is based on naïve Bayesian approach. In 1976, MYCIN is a rule-based system kind which is to diagnose and recommend treatment for blood inflection. It uses IF-Then rules and backward chaining. Other than that, there are ABEL by MIT which uses casual reasoning,

ONCOCIN, by Stanford University, to diagnose Oncology, which uses the flowchart language, *etc*. The using the expert system or decision support system for medical treatment needs to be cautious. Wrong diagnosis may cause to life in some cases [10, 19]. Some of the systems may just suggest preliminary diagnosis to help patients prepare themselves or do some simple treatment at home without any bad effect.

There are many expert systems or decision support systems around related to nutrition systems [20-21]. Some of the work are related to specifically the kidney disease. Roventa (2009) presented the expert system prototype using Visual Prolog 5.2

[11]. He implements a simple implementation of kidney disease diagnosis. The Prolog has an inference engine with a built-in backward chaining. The system contains about 27 kidney diseases from 9 categories. NKDEP provides information about kidney disease and illustrations [12].

Renal diseases is another expert system in the field of medicine. It targets at renal disease. Garcia EV, Taylor A, Manatunga D, Folks R. [13] also presents a software to detecting renal disease. The software is called RENEX. It uses forward-chaining and contains 60 rules. It was evaluated against 60 patients.

Andreas Lun, Marina Suslovych, Jens Drube, Reinhard Ziebig, Leo Pavicic and Jochen H. H. Ehrich measured a reliability of various expert systems for profiling proteinuria in children kidney diseases [14]. Sandeep Soman, Gerard Zasuwa, Jerry Yee built an expert system for Nephrology. It is used in a form of CDSS (clinical decision support system) [15].

3. The Nutrition Information System Design

As an initial stage, we address the issues in the development of an information system and nutrition suggestion for kidney disease patients. The prototype information system should contain two parts: information about the patient such as sex, the preferred food, the type and period of the disease the patient gets, information about the food and nutrition, information about the symptom of the disease and nutrition required for each type/period of the disease and the questions about the patients' symptom, favorite food, *etc.*, for intelligence features in the future.

To analyze the nutrition, the patient needs to put the information about himself such as age, sex, weight, height, favorite food, food that the patient is allergic to, *etc.* Then, the system calculates the calories needed per day. Next, the user answers some questions about the food information. Then, the system will suggest the daily menu.

For example, the Basal Metabolic Rate (BMR) is the total calories that each patient should receive per day. It is computed by:

BMR = 370 + (21.6 x Lean Body Weight in kilograms)

The Lean Body Weight is calculated based on the sex as follows.

Lean Body Weight (male) = (1.10 x Weight (kg)) - 128 x (Weight 2/ (100 x Height (m))2)
Lean Body Weight (female) = (1.07 x Weight (kg)) - 148 x (Weight 2/ (100 x Height (m))2)

Together with the patient information, the amount of protein, potassium, calcium that the patient can have per day is calculated. With the patient favorite and allergic food, the 3 meals menu is suggested including the desserts.
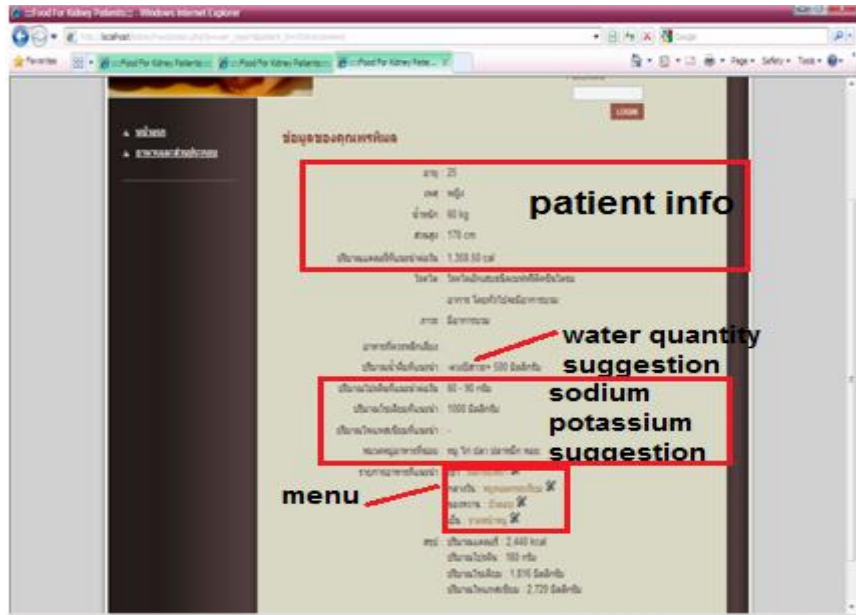
Figure 1. User Interface Layout for Patient Information, Nutrition and Menu

Figure 1 shows the information display for each patient. It includes the patient information, favorite food, type of diseases, and also the suggestion for potassium, sodium, calories, *etc.*, and suggested menu after the patient information is considered.

Besides, the system contains the database about the food and its nutrition, the database about symptoms, and database about patient information.
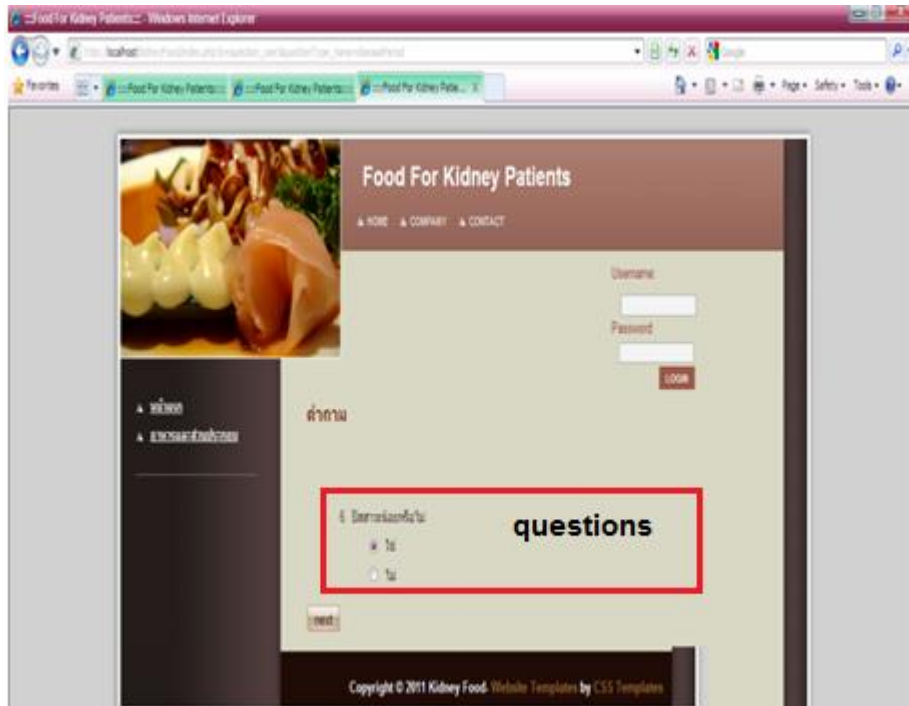
Figure 2. User Interface Layout for Patient Questions

Figure 2 shows the user interface about the questions for the patient. Patients need to be asked carefully to gather information about his age, sex, type and period of disease, favorite/allergic food, *etc*.

Figure 3 presents a sample database design of the system. It should contain information about types and period of kidney (diseaseType), (diseasePeriod), the patient (patient), food and food nutrition food (food), *etc*. With the database included, the prototype system can be easily extended and customized.
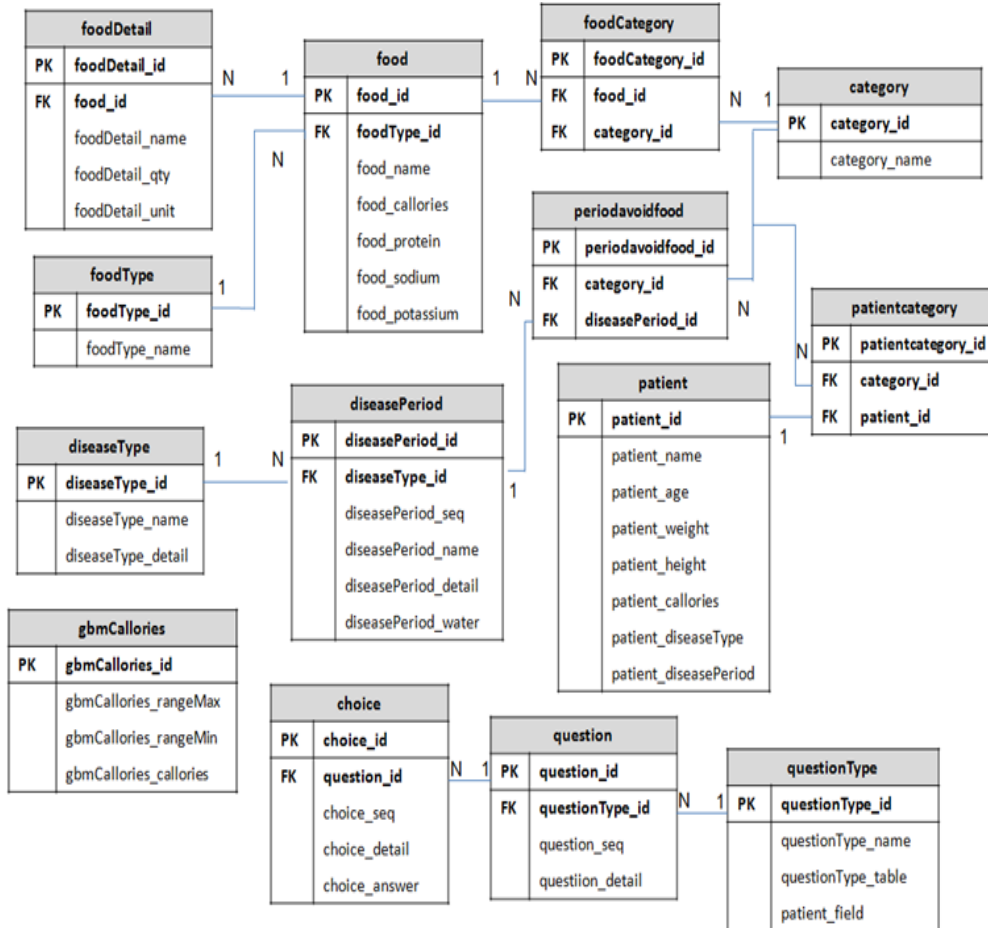

Figure 3. Database Design

4. Conclusion and Future Work

The paper focuses on the use of information system to aid kidney disease patients. There are various kinds of kidney diseases. Each of them requires the certain limitation of food nutrition, especially, sodium, potassium, protein, *etc*. In some situation, the protein may need to increase while in some case the protein needs to be decreased. In some case, the potassium and sodium are restricted at the same time. Some food has less sodium but has high potassium. This makes it difficult for designing food menu for the patient. The calories and nutrition for all day consumption need to be considered as whole. The design of such an

information system is discussed as well as the user interface of the system to be specific to the patient.

For this preliminary version, we have experimented the software with the 30 samples of kidney disease patients using the questionnaires. It is found that about 46.7% of these evaluate the software as a good level, while 21.3 % of these evaluates the software as excellent.

Beyond the information system that provides the food nutrition and food menu, the trends of decision support system or expert system may be applied. The decision support system gives information for suggestion for nutritionists to select the food menu while the expert system can be consulted about the kidney disease symptom, types of kidney diseases, and the recommend the food menu for a whole day that is suitable for the patient.

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