A System for Nutritional Consulting Using Quick Questionnaires on Diet and Unidentified Complaints

Naotaka Hashizume1, Teiji Nakamura2, Kumiko Minato3, Dai Furuie4, Kaya Sugihara4,*, and Minoru Okamoto5

1Department of Health and Nutrition, Wayo Women’s University, Kounodai, Ichikawa-shi, Chiba 272-8533, Japan
2Faculty of Health & Social Work, Kanagawa University of Human Services, Heisei-cho, Yokosuka-shi, Kanagawa 238-8522, Japan
3Exercise Nutrition Laboratory, Wayo Women’s University, Kounodai, Ichikawa-shi, Chiba 272-8533, Japan
4Sysmex Corporation, Takatsukadai, Nishi-ku, Kobe-shi, Hyogo 651-2271, Japan
5Ancient Tree Inc., Ohji, Kusatsu-shi, Shiga 525-0032, Japan

Summary The aging of society and ongoing health care cost-control policy set the trend for the self-medication which leads to the growing interest in health promotion and prolongation of healthy life expectancy through self-health management. We developed a self-medication support system to provide comprehensive support to consumers at pharmacies and drug stores. This system facilitates the effective use of information and knowledge based on medicine and health. This self-medication support system comprised a set of two terminals connected network server in the data center: a user terminal for consumers use and an advisor terminals for specialized advisor, pharmacists, registered dieticians, and etc. This system enables specialized sales people to provide the appropriate advice based on the factors of consumer’s problem, and to make suggestions for improving his/her lifestyle: eating habit, doing exercise, and having relaxation time. As a result of the trial use of this system at pharmacy stores, a certain degree of correlation between the results of a questionnaire on unidentified complaints and dietary patterns causing potential micronutrient deficiency was demonstrated.

Key Words: self-medication support system, dietary patterns, micronutrient deficiency, unidentified complaints

Introduction

As amid the aging of society and ongoing health care cost-control policy, consumers were able to find wide variety of drugs and dietary supplements, and to take self-medication. This environment surrounding consumers led to both cares: preventive care by maintaining and enhancing their health, and primary care for mild symptom with maximum usage of medical knowledge base. Moreover, the consumers needed to select from an enormous amount of information in order to make proper use of dietary supplements. In addition to this situation, there was an increasing need for specialist advice given by skillful pharmacists and registered dieticians at pharmacies and drug stores.

Therefore, we developed a self-medication support system providing comprehensive support for the consumers at pharmacies and drug stores. This system consisted of the input part and the output part. The input part was composed of measuring devices e.g. hemoglobin monitoring device and some questionnaires while the output parts were specifically designed for consumers use and for specialized advisor use, such as pharmacists and registered dietitians.

We operated this system on a trial basis to assess its
Table 1. Questionnaire on Unidentified Complaints

| No. | Questions                                                                 | Answers       |
|-----|---------------------------------------------------------------------------|---------------|
| 1   | I feel low or depressed.                                                  | Always        |
| 2   | I feel frustrated or get angry easily.                                   | Often         |
| 3   | I often have a headache.                                                 | Sometimes     |
| 4   | I feel weak and fatigue easily.                                          | Never         |
| 5   | I have diarrhea and constipation.                                        | Never         |
| 6   | I have nausea.                                                           | Never         |
| 7   | I don’t feel like eating (have a poor appetite).                         | Never         |
| 8   | I have a chill in my hands, feet, and back.                              | Never         |
| 9   | I feel heavy in the stomach.                                             | Never         |
| 10  | I get sleepy easily.                                                     | Never         |
| 11  | My face or legs get swollen.                                              | Never         |
| 12  | I feel something is stuck deep in my throat.                              | Never         |
| 13  | I can’t work efficiently and am reluctant to do anything.                | Never         |
| 14  | I am tired of my life.                                                   | Never         |
| 15  | I have stiff neck or shoulders.                                          | Never         |
| 16  | I feel suffocated and feel pressure in the chest.                        | Never         |
| 17  | I get breathless.                                                        | Never         |
| 18  | I feel lethargic especially in the morning.                               | Never         |
| 19  | I have trouble getting to sleep or frequently awake from sleep in the night.| Never |
| 20  | I feel lightheaded on standing up or feel dizzy.                          | Never         |
| 21  | I feel palpitations.                                                     | Never         |
| 22  | I have numbness in my hand and feet/legs.                                | Never         |
| 23  | I sweat a lot.                                                           | Never         |
| 24  | My face burns (feel hot in the face).                                     | Never         |
| 25  | I have a ringing in my ear(s).                                           | Never         |
| 26  | I get eye strain easily.                                                 | Never         |
### Table 2. Questionnaire on Food Consumption Patterns

| No. | Questions                                                                 | 3 to 4 times a week | Once or twice a week | Once or twice a month | Once or twice a year | Never |
|-----|---------------------------------------------------------------------------|---------------------|----------------------|-----------------------|----------------------|-------|
| 1   | I regularly eat liver.                                                     |                     |                      |                       |                      |       |
| 2   | I regularly eat eels.                                                     |                     |                      |                       |                      |       |
| 3   | I regularly eat green and yellow vegetables, such as a kind of Chinese cabbage, spinach, and Jew’s marrow. |                     |                      |                       |                      |       |
| 4   | I regularly eat brown rice.                                               |                     |                      |                       |                      |       |
| 5   | I regularly eat pork.                                                     |                     |                      |                       |                      |       |
| 6   | I regularly eat soy food, such as fermented soybeans, bean curd, and deep-fried bean curd. |                     |                      |                       |                      |       |
| 7   | I regularly eat eggs.                                                     |                     |                      |                       |                      |       |
| 8   | I regularly eat strawberries, kiwi fruit, and citrus fruit, such as oranges and grapefruit (or 100% citrus juice). |                     |                      |                       |                      |       |
| 9   | I regularly eat dairy products, such as milk and cheese.                  |                     |                      |                       |                      |       |
| 10  | I regularly eat nuts.                                                     | 3 to 4 times a week |                      |                       |                      |       |
| 11  | I regularly eat chicken.                                                  |                     |                      |                       |                      |       |
| 12  | I regularly eat pumpkins.                                                 |                     |                      |                       |                      |       |
| 13  | I regularly eat small fish.                                               |                     |                      |                       |                      |       |
| 14  | I regularly eat shellfish, such as oysters, freshwater clams, and short-necked clams. |                     |                      |                       |                      |       |
| 15  | I regularly eat seaweed.                                                  |                     |                      |                       |                      |       |
| 16  | I regularly eat blue-skinned fishes, such as sardines, Pacific saury, and mackerels. |                     |                      |                       |                      |       |
| 17  | I regularly eat fish, such as bonito, tuna, and salted cod roe.           |                     |                      |                       |                      |       |
| 18  | I regularly eat sweet potatoes, potatoes, etc.                            |                     |                      |                       |                      |       |
| 19  | I regularly eat beef.                                                     |                     |                      |                       |                      |       |

### Table 3. Questionnaire on Lifestyles

| No. | Questions                                                                 | Answers                                           |
|-----|---------------------------------------------------------------------------|---------------------------------------------------|
| 1   | I drink 180 mL or more of sake at a time at least 3 times a week (180 mL of sake is equivalent to 1 large bottle of beer, a glass of double whisky, or two glasses of wine). | Yes | I don’t drink that much, but I do drink. | I seldom drink. |
| 2   | I am often aware of my stress.                                            | Yes | Sometimes | I am not aware of my stress. |
| 3   | I have smoking habit.                                                     | Yes | I stopped smoking. | I have never smoked. |
| 4   | I have been getting exercise or playing sport at least 30 min at a time twice or more often a week for one year or more. | No particular exercise or sport. | I get exercise or play sport, though not regularly. | Yes |
usefulness and the usefulness was successfully demonstrated. We reported here the results of the test installation.

Materials and Methods

Outline of the system

Both a user terminal and an advisor terminal were connected to the network for information communication with the server in the data center (Fig. 1). Some measuring devices e.g. hemoglobin monitoring device were connected to the user terminal to which the results were transmitted from each measuring device. Users followed the guideline on the screen for the measurements and answered all the questions displayed. When all measurements and inquiries were finished, the system showed the user his/her physical condition [1, 2]. This information was able to be printed out on a paper with a readable barcode by an advisor terminal. Based on these information, the appropriate guideline suggested by the system was presented on the advisor terminal [3–5], which facilitates the specialized advisor, such as a pharmacist and a registered dietician, to provide appropriate advice for the user. User terminal had a magnetic card reader. With the magnetic card, users can preserve their records and monitor their trend of condition. In addition, a barcode printed on the magnetic card helped specialized sales people to see the previously given advice to the user in chronological order.

Table 4. Other questions

| No. | Questions                        | Answers   |
|-----|----------------------------------|-----------|
| 1   | Age                              | —         |
| 2   | Sex                              | —         |
| 3   | Height                           | —         |
| 4   | Weight                           | —         |
| 5   | Waist                            | —         |
| 6   | I have difficulty in eyesight at night or in the dark. | Always     | Often | Sometimes | No |
| 7   | I often have a crack in the angle of the mouth, stomatitis, or glossitis. | Always     | Often | Sometimes | No |
| 8   | I have become less sensitive to taste. | Always     | Often | Sometimes | No |
| 9   | I was found to have a slightly higher blood sugar level during a health examination, etc. during the last one year. | Yes       | No     |
| 10  | I was found to have a slightly higher cholesterol level during a health examination, etc. during the last one year. | Yes       | No     |
| 11  | I was found to have a slightly higher level of neutral fats during a health examination, etc. during the last one year. | Yes       | No     |

Fig. 2. Age Distribution of Males and Females

Fig. 3. Correlation between Overall Micronutrient Deficiency Scores and Unidentified Complaint Scores.

Null hypothesis: There is no correlation between the two variables. There is no correlation in the population, with the population correlation coefficient being 0. Alternative hypothesis: There is a correlation between the two variables. There is a correlation in the population, with the population correlation coefficient not being 0. Since the probability value is 0.00068, the null hypothesis is rejected at $p<0.001$ level of significance. Thus it is concluded that there is a correlation.
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Questionnaires on diet and unidentified complaints

The subjects were 61 customers who visited a chain drug store. They answered 26 questions concerning the frequency of unidentified complaints (Table 1) and 19 questions concerning the frequency of ingestion of selected micronutrient foods (Table 2).

We investigated a possible correlation between the frequency of unidentified complaints caused by potential micronutrient deficiency and the frequency of overall intake of micronutrient foods.

The frequency of unidentified complaints was classified as follows; 0 point for ‘Never’ (the lowest frequency); 1 point for ‘Sometimes’; 2 points for ‘Often’; and 3 points for ‘Always’ (the highest frequency). The total score (referred to as unidentified complaint scores) of 26 points or less were regarded as ‘normal’ while 27 points or more were regarded as ‘possible potential micronutrient deficiency’ (patent public publication No. 2000-158853) [6].

The frequency of micronutrient food ingestion was classified into 5 grades ranging from 0 point for ‘Everyday’ (the highest frequency) to 4 point for ‘Never’ (the lowest frequency). Based on the total score, the level of insufficient intake of micronutrient food was measured. The scores for all questions were aggregated and normalized by the number of questions by the type of nutrient. Then the calculated scores were aggregated and normalized by the number of micronutrient types (averaged score). Then possible correlation between the averaged micronutrient deficiency scores and the unidentified complaint scores was examined. The Pearson product-moment correlation coefficient was applied for the statistical calculation.

The questionnaire on unidentified complaints had a total of 26 questions to assess the possibility of potential micronutrient deficiency (Table 1). The questionnaire on the intake of food had a total of 19 questions to assess possible micronutrient deficiency caused by food ingestion (Table 2). The questionnaire on lifestyle had a total of 4 questions about the extent of exercise and drinking habits to identify risks of lifestyle-related disease and areas to be improved (Table 3). The other 11 questions were prepared to ask about symptoms that appear when certain micronutrients were insufficient, abnormal parameters e.g. blood sugar and
cholesterol levels detected during physical examination, etc. and basic user information e.g. age and height (Table 4).

Measuring devices i.e. a hemoglobin monitoring device (ASTRIM, Sysmex Co.), a blood-pressure gauge, a body fat scale and a sphygmograph were connected to user terminals and users performed measurement according to the instructions displayed on the terminal screen. Measurement was performed to determine the physical condition quantitatively.

Results

Age distribution

The age distribution of the samples was shown in (Fig. 2).

Correlation between the averaged micronutrient deficiency scores and the unidentified complaint scores

The micronutrient deficiency scores were aggregated and normalized by the number of questions by the type of nutrient. Then the calculated scores were aggregated and normalized by the number of micronutrient types (averaged score). Then possible correlation between the averaged micronutrient deficiency scores and the unidentified complaint scores was examined.

As a result, the correlation was demonstrated as shown in (Fig. 3) \( (r = 0.42, p<0.001) \).

Correlation between the micronutrient deficiency scores for single micronutrient and the unidentified complaint scores

Correspondence between each food and micronutrients were shown in (Table 5). Possible correlation between the micronutrient deficiency scores for single micronutrient and the unidentified complaint scores was examined and it was found that there was a significant positive correlation \( (p<0.05) \) with vitamin B1, vitamin B2, pantothenic acid, vitamin B12, folic acid, vitamin A, vitamin D, vitamin E, vitamin C, calcium, magnesium, zinc, iron, and copper (Table 6).

Discussion

In this system architecture, the user terminal for consumers use and the advisor terminal for specialized advisor use, such as pharmacists and registered dieticians, are connected to the network for information communication with the server in the data center.

The measurements and questionnaire are done on the user terminal with using measurement devices to check the physical condition of the user. The questions and measuring devices will be enhanced in the future, but at present, the questions were prepared for unidentified complaints, dietary patterns and lifestyles. It is generally known that potential micronutrient deficiency will result in unidentified complaints.

Advisors can immediately see a link of each highly prioritized item to the item in the printed paper. This enables the advisor to select pieces of advice in order of priority and identify main points that the advisor should convey to the user. The main points include dietary advice such as suggested food and the required amounts, the favorable / unfavorable combination of health-promoting food and drugs, advice for the change in the lifestyle and suggestions to not to visit a medical institution.

The present system is characterized by the specialized advice produced based on the combination of measurement results obtained from various measuring devices and the answers of questionnaires. For example, the low level of hemoglobin implies anemia, but it is difficult to specify particular nutrient for the user to take with this limited information. However, if a risk of insufficient intake of iron, vitamin B12 and folic acid, which are necessary in the synthesis of hemoglobin, is found at the same time by the questionnaire, the advisor can advise the user to increase the intake of these nutrients. Similarly, if a user ticks no particular exercise habit in the questionnaire and suffers from stiff neck or shoulders as unidentified complaints, insufficient exercise most probably is a factor for the stiff neck or shoulders. The advisor could suggest that the user do stretching exercise.

Thus, this system facilitated advisors to provide appro-
appropriate advice based on the found factor and provided tailor-made suggestions to the users in a manner suitable for individual physical/living condition.

In order to assess the usefulness of the present system, we actually introduced the system to a pharmacy store and operated the system on a trial basis.

As a result, we successfully found a positive correlation between the frequency of unidentified complaints and the deficiency of micronutrients due to the insufficient ingestion with using the results of the questionnaires on unidentified complaints and dietary patterns sampled from users.

This system will be more useful after the nutritional evidence is verified with using a larger number of samples.

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