Deployment of ARCS Model and Utilization of Communication Robot in Patient Education

Keitaro Ishiguro[1], Yukie Majima[1] and Nobuhiro Sakata[2]
[1]*Department of Sustainable System Sciences, Osaka Prefecture University, 1-1 Gakuencho Naka-ku, 599-8531, Sakai-shi, Osaka, Japan*
[2]*Department of ICT Education, Dokkyo Medical University, Shimotsuka, Tochigi, Japan*

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Abstract: "Medication non-compliance" is a failure to take medication properly. Therefore, medication is necessary for patients to be able to understand medication properly and to participate in treatment voluntarily with the right motivation. For this study, we design medication education based on the ARCS model(Attention, Relevance, Confidence, Satisfaction), which classifies concepts related to learning motivation (Keller, 1984), and which incorporates utilization of the communication robot "Pepper".

1 INTRODUCTION

In Japan, where the population is expected to decrease, the share of elderly people among the population, which is about 30% in 2025, is expected to reach about 40% in 2060. Moreover, the proportion of elderly people living alone among the elderly population is expected to increase for both men and women (Statistics Bureau, 2014). Therefore, the demand for elderly care is increasing year by year. Furthermore, more than 60% of the population has expressed a desire for recuperation at home. Therefore, it is necessary to promote home care and medical care (Ministry of Health, Labour and Welfare, 2012). According to a 2010 survey, elderly people take about 4.5 types of medicine per day, on average, and have 3.5 disease types (Akimoto, M. 2010). Depending on the pathology and medicine, fragile elderly patients who have not taken a medicine as doctors directed are 30–40%. The cause is mainly their life alone and related depression.

Advanced management using digital devices has become more common because approximately 30% of medical accidents at all medical institutions (July–September 2014) are caused by medication. However, burdens on medicine management of elderly people living alone persist because few elderly people know how to use digital devices. (Foundation Japan Council for Quality Health Care Medical Accident Prevention Division, 2015.)

Based on these circumstances, we examined the educational method based on the ARCS model (Keller, 1984), which classifies the concepts related to learning motivation into "caution," "relevance," "confidence," and "satisfaction." Our purpose is that elderly people, including those who live alone, can also actively participate in medication therapy. In other words, not only the understanding of the educational content in the treatment education of elderly patients, we examine patient education to support voluntary action.

2 MEDICATION CONCEPT

2.1 Compliance with Medication

Compliance means taking medicines properly as doctors prescribe. By compliance, the patients can prevent recurrence of the disease, and can reduce medical costs and improve the quality of life (QOL).

2.2 From Compliance to Adherence

Compliance has been called medication compliance. However, medication compliance refers to the following of a physician's instructions. The matter then is whether patients follow the doctor's instructions or not.

However, the concept of medication adherence

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became widely known recently in Japan. Medication adherence refers to a patient's active participation in treatment and is used in the active connotation, whereas medication compliance carries passive connotations.

In medication therapy, it is important for patients to understand their disease and medicines they are taking, rather than just being faithful to their doctor. In actual medical scenes, the main idea has been shifted from physicians' initiative to medication adherence on the patients' initiative.

Furthermore, to improve medication adherence, it is important to communicate well to let patients listen to educational contents and build a trusting relationships to perform medication assistance.

3 UTILIZATION OF COMMUNICATION ROBOT

3.1 Communication with the Robot

Along with prevalence of smartphones, applications that support medication management through oral communication have been developed, and have been downloadable easily at no charge. However, many Japanese elderly people feel embarrassed to communicate with inorganic, unmoving objects such as smartphones.

On the contrary, with a moving robot, they say that it is possible to communicate and receive feedback just as humans and animals do. Therefore, their reports say that robots reduce embarrassment. Elderly people try to communicate actively with robots.

3.2 Communication Robot in Japan

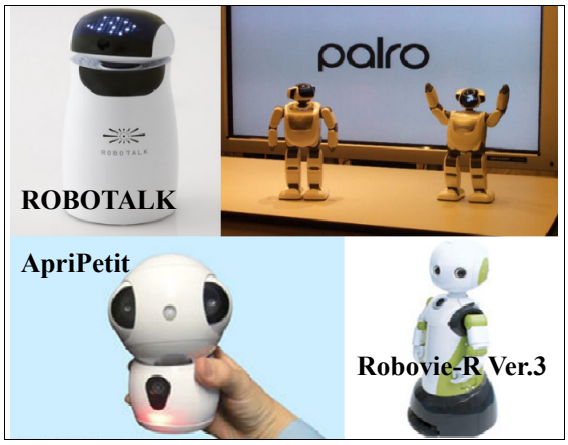

Figure 1: Japanese communication robots.

The main communication robots in Japan are described above. The upper left robot in Fig. 1, named ROBOTALK (OKAMURA CORPORATION, 2008-2013), is a robot made for conversation with people. The upper right robot, called PALRO (FUJISOFT, 2010-2015) can move and recognize human faces. Finally, the bottom right robot is a large communication robot named Robovie-R Ver.3 (Vstone Corporation, 2010-2015). Robovie-R3 is an everyday-use robot developed for a robot-based communication research platform.

3.3 Emotion Recognition Robot Pepper

Various Japanese robots exist, but this time we conducted patient education using the emotion recognition robot Pepper. Pepper is a humanoid robot that has been developed for symbiosis with humans (Aldebaran; Softbank Robotics). Pepper can recognize user emotions from facial expressions and voices. It can move autonomously, having conversations while moving around.

Reasons for using Pepper for this study include the following: (1) it has a camera to ascertain whether medication is properly administered by photographing the pill case after medication, (2) its affectionate human form attracts elderly people, (3) it enables communication to let them listen to an explanation related to treatment, (4) its rich interactivity gives incentives by dance and song etc., (5) because of its rich communication function, it is possible to maintain contact with the doctor while at home, and (6) it is inexpensive.

The Pepper development environment is the SDK called Choregraphe. It is possible to set the program intuitively merely by dragging the mouse.

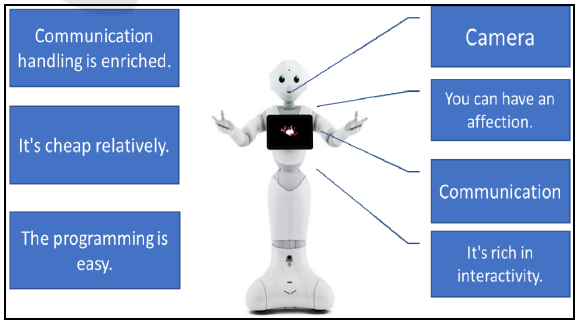

Figure 2: Benefits of utilizing Pepper.

4 ARCS MODEL

Keller conducted a detailed survey of the literature

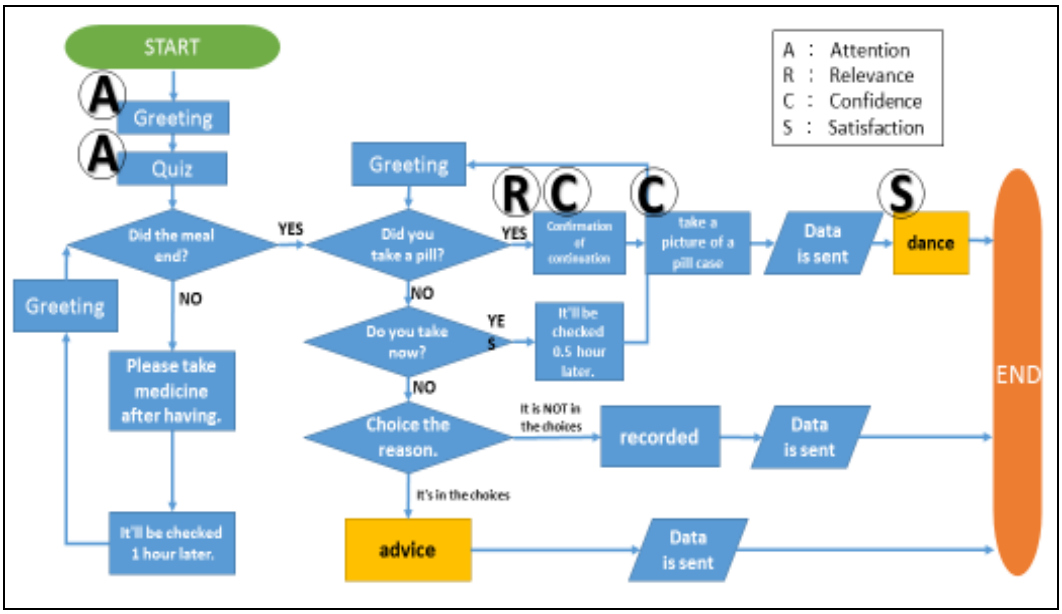

Figure 3: The medication advice example by communication robots.

related to learning motivation, and attempted clustering of concepts based on the common attributes. Results show that concepts related to learning motivation are classifiable into four categories: "attention," "relevance," "confidence," and "satisfaction" (ARCS model, 1984). This classification enables to overview the key aspects of a person's desire especially in the context of learning motivation, and to create a strategy for stimulating and maintaining the desire in the following four areas.

1. Attention: winning the interest of the learner and stimulating study curiosity
2. Relevance: meeting the personal needs and goals to fill the positive needs of learners
3. Confidence: helping learners to realize and have confidence that they can succeed, and success can be obtained by their own ingenuity
4. Satisfaction: strengthening the achievement by (internal and external) rewards

We perform patient education using Pepper based on this ARCS model to improve medication adherence.

5 FUNCTION PROPOSAL

5.1 Medication Advice

The basic flow of the medication assistance in Pepper is shown in Fig. 3. First, it starts with the medication time set, confirming the medication and recording, with confirmation of the reasons for not taking medicines and recording, and ending with a dance to motivate the medication. The concept of the ARCS model is added to make this flow more effective.

First, to meet the first concept of "Attention," Pepper greets humans as the interaction of Fig. 3 starts, and administers a quiz about the medication, for example about leftover medicine and side effects. Although it is difficult to catch a person's attention by this alone, Pepper has rich interactivity, such as BGM and posing, and quizzes can be displayed on the tablet terminal on its chest, thereby effectively maintains person's interest and curiosity.

Next, as for "Relevance," when the correct medication is continually taken, it tells the person how many days or months the medication (success) has been performed, thereby filling positive needs.

Category "Confidence" is performed after "Relevance" by taking a picture of pill case after the medication is taken and sending the photograph to the doctor, thereby realizing continuation.

Finally, "Satisfaction" is performed by dances and songs only after the correct medication is done. Observation of the reaction to dance and song at nursing care facilities showed that elderly people hummed along with the song, especially with famous songs, which can be said to be a sufficiently intrinsic reward. This is one means of reinforcing the achievement by giving incentives.

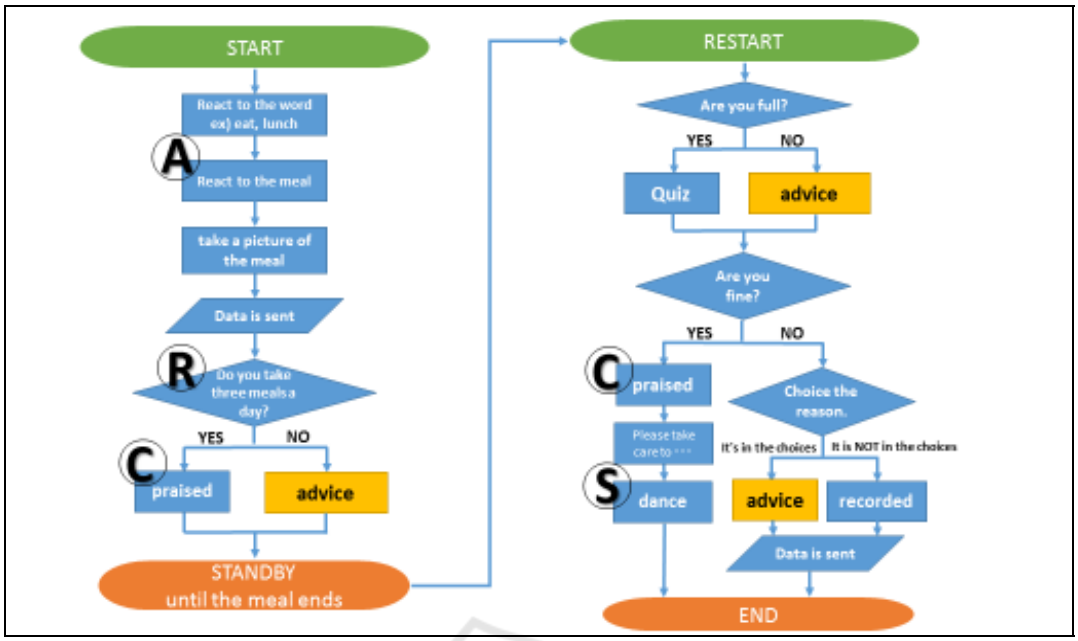

Figure 4: The diet advice example by communication robots.

5.2 Diet Advice

Medication advice of 5.1 is given based on the concept of medication compliance rather than the concept of medication adherence to emphasize autonomy.

After considering the medication adherence and receiving description of the proper medication, if the patient understands side effects and so on and does not feel like taking medication, then it is better to improve the patient health condition mainly through diet rather than through medication.

The diet advice is divisible into that given before and after meals. In the first pre-dinner part, Pepper should be programmed to react when the meal is prepared at the table. Specifically, it reacts to words such as "rice," "eat," and "ready." Then, it takes the reaction to the meal and takes a photograph of the meal using a camera. After sending the image to the attending physician, it asks if you are eating three meals at sufficient intervals. The reason for this question is that if the energy is ingested frequently little by little through more than three meals per day. It helps to reduce fluctuation of the blood glucose level. In addition, if the patient eats three meals at appropriate intervals, then Pepper compliments the patient. If not, then it encourages the patient to eat three meals. After reaction of the question, it waits until the end of the patient's meal.

In the postprandial part, the patient is addressed by Pepper after a meal. Subsequently it asks the second question, which is "whether you are full or not." When the patient is full, it gives a quiz about meals, if not, it waits until 20 min after the meal started. For the patient to start feeling fullness, and if it is already after 20 min, it advises the patient to eat at intervals. After this question, it asks about the patient's recent physical condition as the third question. If the physical condition of the patient is good, then it compliments the patient on the patient's healthiness, and advises the patient about common health problems of people of the same age, and also gives an incentive of dance and song. When the physical condition of the patient is bad and some reason is suspected and readily apparent, it tells the patient the cause and remedy along with diet and light exercise. However, if the reason is not readily apparent, Pepper records the patient's voice and transmits the audio file to the attending physician.

The ARCS model concept is to inform a patient that Pepper is interested in the diet of the patient by its reaction to the meal, to attract the patient's "attention," to give "relevance" by asking if three meals are taken continuously and frequently. As for the "confidence," if the patient can continue, then it helps by ensuring and giving compliments on his health. Finally, "satisfaction" is given by dances and songs performed when physical conditions of the patient are good.

6 EVALUATION

Table 1: Attribute.

Gender	N	%	(N=19)
Male	4	21.1	
Female	15	78.9	
age	N	%	(N=19)
30's	1	5.3	
40's	4	21.1	
50's	4	21.1	
60's	3	15.8	
70's	5	26.3	
80's	2	10.5	

I performed a questionnaire about the application (the medication advice based on the ARCS model) in Kimotsuki Town, Kagoshima Prefecture, Japan in October, 2015. Kimotsuki Town is predicted that the depopulation and aging will advance so much and the town demands the solutions to the problems with the information appliance. The questionnaire caters to the care receivers and care providers in the town who are between 30 and 89 years old (Table 1).

The purpose of the questionnaire is an evaluation of the Pepper's medication advice which we developed based on the ARCS model. They evaluated "Pepper's impression", "attachment to Pepper", "motivation to learn", "comprehension", "attention", and "future" with 5 phases.(Scale: 1: Lowest Value; 5: Highest Value, Table 2, 3)

All the results were positive evaluations (More than 4). We understood that women have the high evaluations for Pepper and its support than men have. Furthermore, we interviewed them. It showed that the communication with dementia elderly person and Pepper was effective. This is because it can accept the same topics again and again, and treat an elderly person who needs intensive nursing care or not fairly. We found that communication technology using Pepper is expected in the field of caring and nursing.

7 CONCLUSIONS

For problems of medication non-compliance, where medication is not taken properly, there is a need for medication education for patients to understand medication correctly and to be able to participate in the treatment voluntarily having appropriate motivation.

For this study, based on the ARCS model that classifies the concepts related to learning motivation to design medication teaching, we examined how to use a communication robot: "Pepper."

As future challenges, it is necessary to create and evaluate a comprehensive application by adding functions to exercise together or to remind patients of their young age and so on because if the implemented applications include only diet advice and medication advice, it is very likely that the learning effect will fade and patients will stop communicating with Pepper. The program of communication robot by the programmer or the contents causes good and bad reactions. Therefore, one must reflect that in the program by the form of the implicit knowledge of effective communication skill of caregivers or nurses. Specifically, it will be integrated into a counseling technique called pacing, to adjust the tone and speed of speech to the listener, in Pepper.

After developing an application for which an effect can be expected, we must conduct experiments to target elderly people and examine

Table 2: 5 stage evaluation.

Question	quite agree: 5	(%)	agree: 4	(%)	Whichever: 3	(%)	against: 2	(%)	quite against: 1	(%)	unknown	(%)
Pepper's impression is good.	16	84.2	3	15.8	0	0.0	0	0.0	0	0.0	0	0.0
I want to meet with Pepper again.	14	73.7	5	26.3	0	0.0	0	0.0	0	0.0	0	0.0
When Pepper cheers me up, I will drink the medicine.	8	42.1	9	47.4	2	10.5	0	0.0	0	0.0	0	0.0
I can get knowledge from Pepper	6	31.6	11	57.9	1	5.3	0	0.0	0	0.0	1	5.3
I listen to Pepper carefully.	10	52.6	9	47.4	0	0.0	0	0.0	0	0.0	0	0.0
When Pepper cheers me up, I will be healthy.	9	47.4	8	42.1	2	10.5	0	0.0	0	0.0	0	0.0

Table 3: Average.

Question	male	female	30's	40's	50's	60's	70's	80's	all
Pepper's impression is good.	4.5	4.9	5.0	4.8	5.0	5.0	4.6	5.0	4.8
I want to meet with Pepper again.	4.5	4.8	5.0	4.8	4.8	4.7	4.8	4.5	4.7
When Pepper cheers me up, I will drink the medicine.	4.0	4.4	4.0	4.5	4.5	4.0	4.0	5.0	4.3
I can get knowledge from Pepper	4.3	4.3	4.0	4.3	4.5	4.0	4.0	5.0	4.3
I listen to Pepper carefully.	4.3	4.6	5.0	4.8	4.8	4.0	4.2	5.0	4.5
When Pepper cheers, I will be healthy.	4.0	4.5	4.0	4.5	4.5	4.7	3.8	5.0	4.4

whether their understanding on their disease and medication status or health status is deepened or not.

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