# Change of Stress Reaction of the Elderly by Interaction with Robot Seal in Health Services Facility for the Aged

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**Abstract- We have been developing a therapeutic robot whose appearance is from a baby of harp seal with white fur on its soft body. We introduced the robot seal to a health services facility for the aged. The purpose was to clarify relationship between interaction with the robot and change of stress reaction by the level of 17-hydroxycorticosteroids (17-OHCS) and 17-Ketosteroid sulfates (17-KS-S) in urine of elderly. The robot was provided to the elderly two days a week for nine weeks. The results show that interaction with the robot improved adjustment ability of elderly to their stress, and therefore, the robot has great potential for maintenance of health of elderly.**

***Keywords- therapeutic robot; health services facility; stress reaction; elderly; 17-Ketosteroid sulfates***

## Ⅰ. Introduction

In various countries throughout the world, the relationship between people and pets has been thoroughly researched, elucidating the psychological and physiological benefits that keeping pets can have for people [1-4]. When the health degree is investigated in the United States, the item "Breeding of the pet" is seen in the item of emotional happiness besides physical activity, nutrition, and disease prevention [5]. This is based on a lot of researches on the good influence from a pet to a human's health. In the physiologic effect which the pet gives man, it is reported that the blood pressure value and the cholesterol value decreases by touching and seeing the animal [6].

There is the result of investigation that dog owners' frequency of going to hospital regularly is less than non-keeping pets, when they are compared with the frequency of going to hospital regularly, too [7]. Moreover, in a 10-month prospective study examined changes in behaviour and health status in 71 adult subjects following the acquisition of a new pet (either dogs or cats), both pet-owning groups reported a highly significant reduction in minor health problems during the first month, and this effect was sustained in dog owners through to 10 months. In addition, they also showed improvement in their scores on the GHQ (General Health Questionnaire) over the first 6 months and, in dog owners, this improvement was maintained until 10 months [4].

There is a research that the existence of the pet has a constant effect for the stress with a large loss of the death of a spouse or an intimate friend [8].

In general, it is said that keeping a pet is good for health. Therefore, dogs, cats and other pets have come to be called companion animals in recent years [9].

However, there is a lot of elderly who can not keep a dog or a cat even though they want to keep them because of the worry of common infectious disease between men and beasts. Moreover, it is difficult to take animals into hospitals and elderly institutions.

By now, authors have researched and developed "mental commit robot" which aims for therapy. We verified the effects of hospitalized children's QOL improvement in the infantile ward. It was confirmed that the introduction of the robot was useful for the improvement of the desire of leaving hospital and for the improvement of symptom as autism [10].

On the other hand, as a method of measuring the stress, it is possible that we evaluate physiology by using urinary tests which are the inspection method handiness and non-infestation for elderly [11]. We had conducted research on elderly living at home as subjects using the index of urine 17-Ketosteroid sulfates (17-KS-S) and 17-hydroxycorticosteroids (17-OHCS), and had obtained the result that elderly who were keeping the companion animal had excellent adaptability to the stress [12].

In this study, we introduced mental commit robot to an elderly institution, and examined the change of stress reaction of elderly by urine 17-KS-S value and the 17-OHCS value before and after introduction of mental commit robot.

## Ⅱ. Mental Commit Robot

Mental commit robot (Fig.1) was developed to have physical interaction with human beings. Robot's appearance is from a baby of harp seal, which has white fur for three weeks after it's born. As for perception, seal robot has tactile, vision, audition, and posture sensors beneath its soft white artificial fur. In order for the robot to consist of a soft body, an air-bag type tactile sensor was developed and implemented. As for action, it has eight actuators; two for upper and lower eyelids, one for rotation of eyes, two for neck, one for each front fin, and one for two rear fins. Weight of the seal robot is 2.8 kg [13].

The seal robot has a behavior generation system that consists of hierarchical two layers of processes: proactive and reactive processes. These two layers generate three kinds of behaviors; proactive, reactive, and physiological behaviors:

A. Proactive Behaviors

The robot has two layers to generate its proactive behaviors: behavior-planning layer and behavior-generation layer. Considering internal states, stimuli, desires, and a rhythm, seal robot generates proactive behaviors.

**(a) Behavior-planning layer:** This has a state transition network based on internal states of robot and robot's desire produced by its internal rhythm. The robot has internal states that can be named with words of emotions. Each state has numerical level and is changed by stimulation. The state decays by time. Interaction changes internal states and creates character of the robot. The behavior-planning layer sends basic behavioral patterns to behavior-generation layer. The basic behavioral patterns include some poses and some motions. Here, although "proactive" is referred, proactive behaviors are very primitive compared with those of human beings. We implemented similar behaviors of a real seal into the robot.

**(b) Behavior generation layer:** This layer generates control references for each actuator to perform the determined behavior. The control reference depends on strength of internal states and their variation. For example, parameters change speed of movement, and the number of the same behavior. Therefore, although the number of basic patterns is countable, the number of emerging behaviors is uncountable because numeral parameters are various. This creates living like behaviors. In addition, as for attention, the behavior-generation layer adjusts parameters of priority of reactive behaviors and proactive behaviors based on strength of internal states. This function contributes to situated behavior of robots, and makes it difficult for a subject to predict robot's action.


Fig.1 Mental commit robot "Paro"

**(c) Long-term memory:** The robot has a function of reinforcement learning. It has positive value on preferable stimulation such as stroked. It also has negative value on undesirable stimulation such as beaten. The robot put values on relationship between stimulation and behaviors. Gradually, the robot can be shaped to preferable behaviors of its owner.

B. Reactive behaviors

Seal robot reacts to sudden stimulation. For example, when it hears big sound suddenly, the robot pays attention to it and looks at the direction. There are some patterns of combination of stimulation and reaction. These patterns are assumed as conditioned and unconscious behaviors.

C. Physiological behaviors

The robot has a rhythm of a day. It has some spontaneous desires such as sleep based on the rhythm.

## Ⅲ. 17-KS-S, 17-OHCS

Selye regarded stress as the rate of wear and tear and 17-OHCS as its indicator [14]. But Nishikaze et al. considered that living organisms, unlike inanimate objects, exist in a dynamic balance between "wear and tear" and "repair and recovery," and sought for a compound related to tissue "repair and recovery," and they discovered 17-KS-S in urine [15]. 17-KS-S value shows the descent by the ageing, progress of the disease or social psychology stresses.

Though 17-OHCS value rises at the stress, 17-KS-S shows high level in healthy individuals and decrease with failing health or the progress of disease [16]. In addition, 17-KS-S value shows a sensitive change by psychological

and social factor, and relates greatly to person's will, desire, and energy [16]. 17-KS-S/17-OHCS which is the value into 17-KS-S is divided with 17-OHCS, is a method of enabling the grasp of the distortion of the living organisms brought by stressor and understanding the living organisms reaction inclusively [16]. It is reported that 17-KS-S/17-OHCS is indicated clear low value (0.15 or less) under social psychology stress and rises with release of stress cause [15].

In a word, 17-KS-S value indicates the restoration degree to the stress, 17-OHCS value indicates the stress load degree, and ratio of 17-KS-S/17-OHCS indicates inclusive living organisms reaction.

Both 17-KS-S value and 17-OHCS value are shown in ratio to Creatinine (mg/g Creatinine). As a result, the influence of the physique (such as racial difference and sex difference) decreases [16].

We introduced mental commit robot to the same health services facility for the aged in 2001. We measured the level of 17-KS-S and 17-OHCS value in urine of elderly [17].

## Ⅳ. Methods

We began to investigate at the health services facility for the aged in July 2003. Though we keep still researching now, we analyzed the data of thirteen weeks from July to October 2003.

A health services facility for the aged is an institution that aims to provide nursing care and rehabilitation services to enable elderly who do not need to be hospitalized to return home. Capacities in facilities for the experiment are 100 people. Users' stay period of average is three months. The total staff is 30 people (18 nurses and 12 care attendants). About choosing a suitable person of the subjects, the staff of nurses explained the content of the experiment to the elderly, and decided 15 people from the person who had agreed. We excluded the elderly with a heavy dementia symptom from the collection of urine, for the reasons of difficulty of taking their urine. Moreover, we also excluded the person who was taking the medicine which influenced the urine value. Informed consents were obtained by themselves those who live or their family.

Three seal robots were provided to the elderly two days a week for nine weeks. We prepared a desk to put the robot in the center of people, and the elderly sat around the table. The elderly interacted with the robot for about one hour at a time. Because the number of people was large, elderly people could not interact with the robot at the same time, so we sequentially moved the robot among the elderly.

Urine was gathered in the early morning and was analyzed after frozen preservation by -18 degrees afterwards gathering. Each value was corrected with the creatinine. We gathered the urine seven times, two times before introduction, and five times after the introduction.

We interviewed them concerning life events by social readjustment rating scale of Holmes and Rahe [18] which happened in one week before gathering urine and we considered the influence on the urine value.

## Ⅴ. Results and Discussions

Fig. 2-1 shows the appearance of interactions between elderly and Paro at the health services facility for the elderly. They are looking forward to touching with Paro very much twice a week. They said, "Paro has become accustomed to us, too". It seemed that they identified Paro as life, and we felt an interesting reaction. At the day of the experiment, we had the elderly who were not subjects participate freely. Every time a lot of elderly participated.

Fig. 2-2 shows the appearance of the elderly who was kissing Paro. She was 98 years old and the highest people of the health services facility for the elderly. She liked Paro very much, and she kissed Paro every time.

Though the experiment is continuing still now, the appearance which gets bored with Paro is not seen still. In the comment of the nursing staff on the experiment, they wrote that the elderly who were quiet usually often laughed, and it was different from the usual appearance.

Analytical subjects were fourteen women. Average and standard deviation of their age were 87.6±5.3 years, and the highest was 98 years old.

As I described it ahead, we measured the level of 17-KS-S and 17-OHCS value in urine of elderly at the same health services facility for the aged in 2001. In order to know the standard level of the urine of the elderly, we used the data they had not interacted with the robots in November 2001, July 2003. We used the data in July 2003 about the person who had been participating in 2001. Because, we did not use two times individual data with time different in consideration of influence of individual. We obtained the standard level of urine 17-KS-S value, the 17-OHCS value and 17-KS-S/17-OHCS of elderly ( Table 1).

Fig.2-1 Interaction between elderly people and Paro at a Health Services Facility for the Aged

Fig. 2-2 The elderly who is kissing Paro at a Health Services Facility for the Aged

Table 1 The change of 17-KS-S/17-OHCS by age

| | Age | 17-KS-S | 17-OHCS | KS-S/OHCS |
|---|---|---|---|---|
| 70's | 76.0±1.0 (n=5) | 2.89±1.51 | 7.32±2.49 | 0.39±0.21 |
| 80's | 84.3±2.6 (n=16) | 2.01±1.28 | 8.77±3.10 | 0.24±0.14 |
| 90's | 91.9±2.3(n=12) | 1.51±0.90 | 6.58±1.70 | 0.23±0.12 |

In concerning with the average and standard deviation of 17-KS-S, the value of the elderly who are seventies, eighties and nineties are 2.89 ±1.51, 2.01±1.28 and 1.51 ± 0.90, respectively. The 17-KS-S value showed the descent by the ageing as reported [14].

The average and standard deviation of 17-OHCS of the elderly who are seventies, eighties and nineties are 7.32 ±2.49, 8.77±3.10 and 6.58±1.70, respectively. They did not show the influence by the aging.

The average and standard deviation of 17-KS-S/17-OHCS of the elderly who are seventies, eighties and nineties are 0.39 ± 0.21, 0.24 ± 0.14 and 0.23 ± 0.12, respectively. They showed the descent by the ageing.

It seems that this result is valuable, though the number of subjects is little, because the standard level of elderly more than eighties has not been reported up to now.

Then, Fig. 3-1, Fig.3-2 and Fig. 3-3 showed the change of the level of 17-KS-S, 17-OHCS and 17-KS-S/17-OHCS of six elderly people for thirteen weeks. Though the subjects of beginning were 14 people, we excluded the elderly whose data we did not obtain whole period. Moreover, we also excluded the person who had outlier.

We measured the level of 17-KS-S and 17-OHCS value in urine of elderly in 10 and 31 July before introduction of the robots. We showed the average two times as “Before Introduction”. These were their usual value.

We showed individuals from A to F, and showed their age in parentheses.

In Fig. 3-1, their usual 17-KS-S value shows the descent by the ageing, F (93 years old) was lowest. The value of A, B and C (younger than D, E and F) were higher than D, E and F. This result was similar to precedence research [14].

In Fig. 3-2, the usual 17-OHCS value of F (93 years old) was higher than A, B, D and E (younger than F).

In Fig. 3-3, ratio of 17-KS-S/17-OHCS of their usual value shows the descent by the ageing, F (93 years old) was lowest. The value of A, B and C (younger than D, E and F) were higher than D, E and F. This was the same as that of precedence research [14].

We introduced the robot on August 7. The level of 17-KS-S rose than usual value in four subjects (B, D, E and F). 17-KS-S value indicates the restoration degree to the stress. It seemed that the result had been brought by the introduction of the robots.

In Fig. 3-2, the level of 17-OHCS of August 7 lowered than usual value in five subjects (A, B, D, E and F). 17-OHCS value indicates the stress load degree.

In Fig. 3-3, 17-KS-S/17-OHCS went up than usual value in four subjects (B, D, E and F). The ratio of 17-KS-S/17-OHCS indicates inclusive living organisms reaction. It seemed that the introduction of the robot gave the elderly good influence.

However, 17-KS-S/17-OHCS showed the tendency to fall August 23 and September 4. As a reason of low level of 23 August and 4 September, we thought going out by summer vacation and Bon Festival and the staff's work changes. Though the levels of 23 August and 4 September returned to the usual value, they rose again after that.

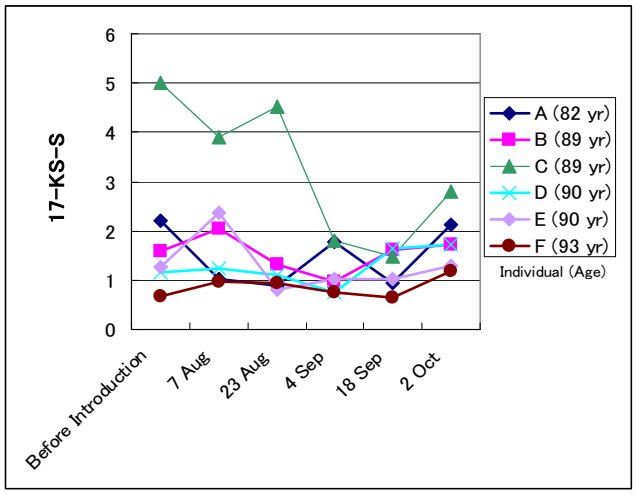


Fig. 3-1 The change of the level of 17-KS-S

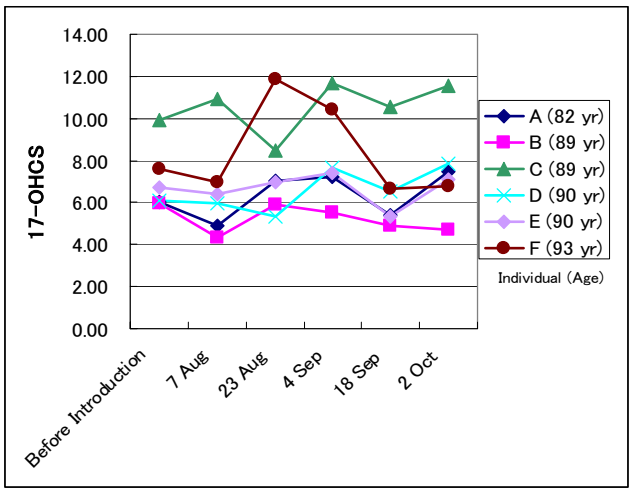


Fig. 3-2 The change of the level of 17-OHCS

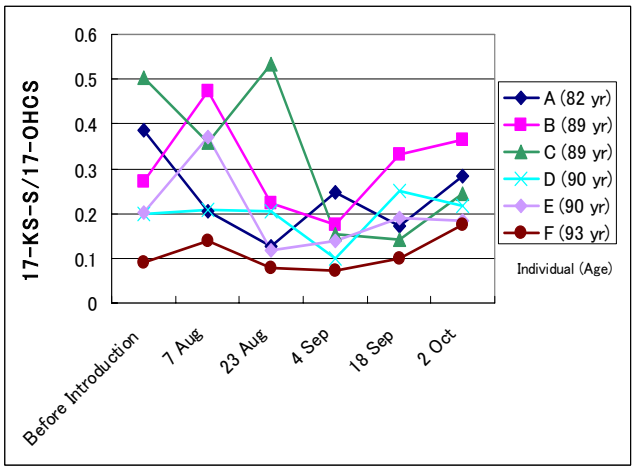


Fig. 3-3 The change of the level of 17-KS-S/17-OHCS

## VI. Conclusions

We obtained the standard level of urine 17-KS-S value and the 17-OHCS value of a elderly more than eighties. We thought that this result is valuable, because the standard level of elderly more than eighties has not been reported up to now.

We introduced mental commit robot to an elderly institution from last July. Though we keep still researching now, we analyzed the data of thirteen weeks from July to October 2003. We examined the change of stress reaction of elderly by urine 17-KS-S value, the 17-OHCS value and 17-KS-S/17-OHCS.17-KS-S/17-OHCS that indicates inclusive living organisms reaction, went up than usual value by the introduction of the robot. It seemed that the introduction of the mental commit robot gave the elderly good influence. As the results, excellent adjustment ability to the stress was shown, and mental commit robot had a useful possibility for maintenance of health of elderly.

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