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**Paper:**

# Use of Robotic Pet in a Distributed Layout Elderly Housing with Services: A Case Study on Elderly People with Cognitive Impairment

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**In recent years, robotic pets have been used by many countries worldwide as a method for treating behavioral and psychological symptoms of dementia (BPSD). The seal robot PARO was loaned intermittently to a distributed layout elderly housing with services over a seven-month period, during which it was observed that three residents with cognitive dysfunctions showed improvements in their BPSD and the nursing care load of the staff was reduced during the periods when PARO was present. The objective of this study is to investigate, through a case study, the effects of intermittent interaction with PARO on those with cognitive dysfunctions and the staff workers. The short version of the Dementia Behavior Disturbance Scale (DBD-13) was used as the medical outcome index, and the KJ method was used to analyze the qualitative data, such as staff reports and interviews. The results show that the DBD-13 total scores reduced during the periods when PARO was present and increased during the periods when PARO was absent. The KJ method yielded similar findings. The use of DBD-13 and the KJ method complemented the results of each other and increased the persuasive power of the findings. By using the KJ method, it was further determined that the workload of the staff was reduced, allowing them to recuperate, which reconfirmed the value of PARO. Further case studies will be undertaken in the future with the aim of constructing a methodology for implementing case studies.**

**Keywords:** robotic pet, PARO, BPSD, CDBD-13, KJ method

## 1. Introduction

Therapeutic robots have been developed and used for patients diagnosed with dementia in recent years in Japan and elsewhere as a method for treating behavioral and psychological symptoms of dementia (BPSD), such as agitation, violent language, wandering around, delusions, and sleep disorders, which are secondary symptoms caused by the deterioration of the cognitive symptoms

(memory impairment, comprehension, judgment) that accompany the decline in cognitive function [1, 2]. Studies to qualitatively and quantitatively verify the effects of robotic pets in improving BPSD have been conducted in various countries. Nearly all of these studies employed a robotic pet called PARO (PARO®), which was developed in Japan, with multiple studies reporting an improvement in BPSD, such as reduced agitation and depression, or improving social skills [3–7].

Abbott et al. [3] conducted a systematic review and meta-analysis of 19 studies targeting care home residents. Seventeen of these studies employed PARO. Leng et al. [5] conducted a similar analysis of six studies on robotic pets, and all these studies employed PARO. Furthermore, in June 2018, the National Institute for Health and Care Excellence of the Department of Health in England released its guidelines for dementia [a], in which the newly added robotic pet therapy was assessed as displaying evidence of the highest quality. This assessment was based on a randomized controlled trial (RCT) conducted in the United States using PARO [4]. It is expected that robotic pet therapy using PARO will be adopted extensively worldwide in the future.

However, the use of PARO for dementia patients has not been widely adopted in Japan. The Happy Net Association (HN) has conducted free workshops, experiential forums, and free rental of PARO for the past four years to advocate its use (refer to Appendix A). In the course of these activities, many of the personnel involved and the participants expressed an interest in the operational methods that are useful in actual practice or specific methods of introducing PARO, in addition to specific phenomena related to the changes that occurred among dementia patients or care-providing workers by the introduction of PARO, and not just the results of the RCT. PARO and other nursing care robots were nonexistent in nursing care situations up to now; consequently, there have been no opportunities to discuss their needs previously. Furthermore, there were no role models because of the lack of accumulated expert experience or knowledge, which increased the difficulty of employing such robots.

In evidence-based practice (EBP) [8], quality patient outcomes are considered to be achieved by clinical decision-making processes based on the integration of "research evidence and evidence-based theories," "clinical expertise and evidence from assessment of the patient's history and conditions," and "patient preference and values." Although there is considerable research evidence, including RCTs, in the EBP using PARO [3–7], there is a lack of clinical expertise and experience or knowledge about patient preference and values, which indicates a requirement to accumulate research in the future through case studies.

In a PubMed search for case studies using robots to aid dementia patients, we were able to identify studies using Telenoid [9], robotic cat (Joy for All) [10, 11], humanoid robot (Pepper) [12], robotic pet (AIBO) [13], and robotic dinosaur (Pleo) [14]; however, only a single study ($N = 1$) using PARO was identified, which was used to aid patients diagnosed with intellectual disability [15] rather than with dementia. This study ($N = 1$), which is also called a single-case design [16], is an experimental method for examining the causal relationship between independent and dependent variables based on the data from a single individual, and does not present a method of onsite operation. Meanwhile, the proceedings of the 1st–11th International Symposium on Robot Therapy with Seal Robot, PARO [17] contained several reports of case studies examined in facilities for the elderly and hospitals; however, these reports were not peer-reviewed or found in PubMed or other search sites. Thus, there is a need to accumulate case studies that examine the scientific validity of using PARO, which will be useful for operating or introducing PARO.

**Fig. 1.** PARO.

As part of the advocacy activities of HN, PARO was leased intermittently over a seven-month period, free of charge, to a home for the elderly with home-care services (refer to Appendix B). During this period, three residents with symptoms of cognitive dysfunction interacted with PARO on an intermittent basis, and it was observed that their BPSD symptoms improved and the nursing load of the staff was reduced during those periods when PARO was available.

The objective of this study is to clarify the effects of the intermittent introduction of PARO on residents with cognitive dysfunction and the staff at this home for the elderly in the form of a case study. For the analysis, we employed data consisting of the business report submitted to HN, questionnaire responses based on recollection, and interviews with staff personnel.

## 2. What is PARO?

PARO [18, 19] is an animal-type robot that was developed at the National Institute of Advanced Industrial Science and Technology by Dr. Takanori Shibata, who obtained this idea from animal-assisted therapy. PARO is modeled on a baby harp seal; the eighth generation of PARO was announced in 2004, the ninth generation in 2013, and over 7000 units have been sold in over 30 countries, including Japan, the United States, and European and Asian countries (**Fig. 1**).


**Fig. 2.** Typical layout of a distributed service home for the elderly.

In the United States, PARO was approved by the Food and Drug Administration as a medical device in 2009. Since 2018, it has been covered by Medicare, which is a national health insurance program for those aged 65 and over, as well as other private medical care insurance plans, under which it can be prescribed to treat pain, depression, anxiety, and agitation (problem behaviors), and for various rehabilitation regimes, where the cost of its usage is reimbursed.

## 3. Distributed Layout Elderly Housing with Services

The elderly residences to which PARO was leased are a part of a complex of distributed layout elderly housing with services operated by Community Net Inc. As shown in **Fig. 2**, the rooms of the elderly residents are distributed within a collective housing complex such that the residents can live in an environment integrated within the community, where the next-door neighbors of an elderly resident are often ordinary child-rearing households; this type of housing arrangement is relatively uncommon in Japan.

A management office with resident staff, which also serves as a multipurpose room (hereafter referred to as "front office"), is located on the first floor of the housing complex, and the residents do not have to pass the front desk when entering or exiting the building, as is common in conventional homes; thus, this affords the residents a sense of freedom. The home has five staff members, including the director; it is supervised by two staff members during the daytime, while a worker is always on standby at night to provide over-the-phone consultations to residents, except in emergencies. The services provided by the front office include monitoring of the safety of residents on a daily basis, providing consultation services to the residents, and supporting social exchange with area residents.

Other features include a cafe, hall, and base facility, including a shop for the sale of goods on the first floor of the building. The Ozone Housing Research Committee was established to undertake the "building of a community-based care system that includes the surrounding area" and is involved in activities related to community development. HN, which leased PARO free of charge, is also a member of the Ozone Housing Research Committee.

## 4. PARO Advocacy Activities

### 4.1. History of PARO and the Period and Method of its Use

The decision by HN to lease PARO in June 2020 was based on the comments of the director ("worker A") of the home, which were made in the context of the activities of the Ozone Housing Research Committee regarding a lowering of the cognitive functions of its residents and the plan of HN to deliver a presentation on PARO as part of a health workshop in July 2020. Before introducing PARO, worker A attended a six-hour training session and then explained the method of operating PARO to the other staff workers. HN requested worker A to submit a report on the advocacy activities and provided consultation and answered questions regarding PARO whenever necessary.

Although it was initially planned to lease out PARO between June 15 and July 4, 2020, it was later decided to lease it free of charge provided that it does not interfere with the advocacy activities. This decision was taken after a discussion based on the information that the symptoms of cognitive dysfunction had become aggravated after PARO had been returned to HN. Consequently, PARO was leased intermittently between June 15, 2020 and January 10, 2021, for a total of 141 days: June 15 to July 4 (20 days), July 16 to August 5 (21 days), August 18 to September 1 (15 days), and October 18 to January 10 (85 days). The social interactions between residents and PARO occurred between 9 a.m. and 6 p.m. every day in the front office of the elderly residence. The front office was also opened to community residents other than the occupants of the elderly residence, allowing them to experience PARO. The PARO models used were the 9th generation models, i.e., two pet robots and one therapeutic robot (refer to Appendix C).

### 4.2. Effect of Coronavirus Disease 2019 on the Interactions with PARO

HN requested worker A to observe the following coronavirus disease 2019 (COVID-19) control measures. The residents were required to wear masks when interacting with PARO and alcohol disinfection was required prior to the interaction. PARO was disinfected daily with a medical disinfectant sheet, a Clinell Universal wipe, for 2 minutes [20]. In addition, an exclusive PARO cleaner was provided for regular cleaning. Worker A was trained on disinfecting and cleaning PARO during the above-mentioned training session (**Fig. 3**). Furthermore, a video footage of cleaning and maintenance was uploaded to the HN website and made accessible to the trainees.

**Fig. 3.** Practice session on how to clean and take care of PARO.

**Table 1.** Study period and presence and absence of PARO.

| Period | Date | No. of days | PARO present? | PARO type |
|---|---|---|---|---|
| Before introduction | -June 14 | - | No | |
| Period I | June 15-July 4 | 20 | Yes | Pet |
| Period II | July 5-15 | 11 | No | |
| Period III | July 16-August 5 | 21 | Yes | Pet |
| Period IV | August 6-17 | 12 | No | |
| Period V | August 18-September 1 | 15 | Yes | Therapeutic |
| Period VI | September 2-October 17 | 46 | No | |
| Period VII | October 18-January 10 | 85 | Yes | Pet |

Pet robot: Behaves in a manner that can be interpreted as expressing joy, anger, sadness, and happiness when interacting with people. Displays a daily rhythm of morning, day, and night, and is programmed to sleep at night.
Therapeutic robot: Behaves in a manner that can be interpreted as expressing feelings, with the exception of anger. Displays a tolerant character. There is no sleep period as it serves therapeutic purposes.

Worker A was also provided instructions on how to interact with PARO during the training session (Appendix D), where she was told to explain that "This is a baby seal robot named PARO" when handing PARO to an elderly resident; moreover, she was particularly instructed to refrain from correcting an elderly person when he or she denied that it was a robot.

## 4.3. Study Period

To determine the changes in the subjects depending on the presence or absence of PARO, the study period was divided into eight periods, including the introductory period and those in which PARO was absent (**Table 1**).

## 4.4. Study Targets

### 4.4.1. Overview of Elderly Residents

Of the 70 units available, 63 units were occupied in June 2020, consisting of 50 single occupants (14 men, 36 women) and 13 married couples, i.e., a total of 76 residents. The average age was 79.8, and approximately 30 residents were care-need certified individuals, including those "requiring assistance" (designated category of support needs). Although many of the residents had been self-reliant and energetic when they moved to the elderly residence, an increasing number exhibited a gradual decline in strength and reduction in their range of activities with aging. In addition, owing to the constraints imposed by the spread of the COVID-19 infection that began in April 2020, several elderly residents started exhibiting symptoms of advanced impairment in cognitive functions, mental problems such as depression, or social withdrawal due to frailty syndrome, in addition to a decline in physical strength.

### 4.4.2. Selection of the Targets of the Case Study

Initially, worker A distributed leaflets to all residents pertaining to interactions with PARO. In addition, she directly conversed with residents who would benefit from interactions with PARO, such as single residents who tend to become isolated; in certain cases, she also visited residential units to show and invite the residents to interactive sessions with PARO. Ten residents (including a married couple) visited the front office on their own on the first day of the interaction with PARO (**Table 2**). Of these, three residents (Nos.5, 7, and 8) who continued an active interaction with PARO over a long period were selected as the targets in this case study. All three exhibited cognitive dysfunction: No.5 had memory impairment, No.7 displayed a wandering behavior and apathy, and No.8 exhibited symptoms that centered on delusions of theft. It should be noted that No.7 was placed in a group home at the end of September, which was during period VI (PARO was absent), owing to the deterioration in the BPSD; consequently, his analysis was performed up to period VI.

## 4.5. Method of Investigation

The investigation involved analyses of the questionnaire results, the responses of the interview with worker A, and her report.

### 4.5.1. Questionnaire Survey

To assess the changes in the behavioral disorders of target subjects due to the use of PARO, we used a questionnaire based on the short version of the Dementia Behavior Disturbance Scale (DBD-13) [21], which was developed as an index with a high sensitivity to the provided care. This scale is a short version of the 28-item DBD and has been reported to be reliable and valid. We employed this scale because it is not legally required to record the symptoms or behavioral disorders related to dementia at elderly residences with supportive services, and also because it allows care workers with a low level of medical knowledge to document and observe the changing levels in the behavioral disorders in a systematic manner using a single index.

Worker A filled the questionnaire between December 2020 and January 2021, covering the period from before the introduction of PARO up to period VII based on her recollections. She was asked to allot a single day to respond to questions covering a single period, instead of answering the items for the entire study period in a single sitting. This was done to prevent the answers for a given period from being affected by the corresponding

**Table 2.** Study targets and targets of case study.

| No. | Sex | Age bracket | Mental and physical condition | "Requires nursing" category | Living arrangement | Continuation status |
|---|---|---|---|---|---|---|
| 1 | Female | 70s | Depression | Self-reliant | Living alone | Refused |
| 2 | Female | 80s | No problem in particular | Requires assistance (level 1) | Living with spouse | As involved as the wife of No. 7I |
| 3 | Female | 80s | Dementia | Requires nursing care (level 2) | Living with spouse | Continued |
| 4 | Female | 80s | No problem in particular | Self-reliant | Living alone | One day only |
| 5* | Female | 80s | Alzheimer dementia (mild) | Requires nursing care (level 1) | Living alone | Continued |
| 6 | Female | 70s | No problem in particular | Requires assistance (level 1) | Living alone | Twice |
| 7* | Male | 70s | Alzheimer dementia (moderate) | Requires nursing care (level 4) | Living with spouse | Continued |
| 8* | Female | 80s | Dementia with Lewy Bodies | Requires nursing care (level 1) | Living with spouse | Continued |
| 9 | Female | 70s | No problem in particular | Self-reliant | Living alone | One day only |
| 10 | Female | 70s | No problem in particular | Requires assistance (level 1) | Living alone | Several days |

*: Target of case study.

ones of a previous period. Note that the responses are those based on the consultations of worker A with the subject or spouse of a subject during regular business hours and her observations during this time; moreover, it should be noted that the responses do not include the conditions of the subjects when they were back at home.

#### 4.5.2. Report

Worker A was asked to write, in free writing, a report on the conditions of the three subjects and the changes and other aspects that were noted during each period, regardless of the presence or absence of PARO.

#### 4.5.3. Interview with Worker A

We interviewed worker A on January 10, 2021 in a room in the front office of the elderly residence following the checklist given below. To maintain objectivity, the interview was conducted by a researcher who had no previous involvement with the activities at the elderly residence; moreover, the interview was conducted over a 60-minute period. The interviewer maintained written notes on the responses provided by worker A with her approval.

[Interview checklist]

1. Regarding the case subject
   - ① Determine further details of the report.
   - ② Were there any occurrences of episodes that were not covered by the report?
2. Regarding the residents of the elderly residence
   - ① How did the interaction with PARO change among the six residents listed in **Table 2** who were not selected as subjects?
   - ② Were there any participant other than those listed in **Table 2** who had interactions with PARO?
   - ③ Other items.
3. Staff reactions and how they changed
   - ① Did worker A experience any change?
   - ② Were there any changes among the other workers?

### 4.6. Methods of Analysis

#### 4.6.1. Short Version of the Dementia Behavior Disturbance Scale (DBD-13)

The results of DBD-13 were used to observe the temporal change of the scores from before the introduction of PARO to period VII and the changes in the raw scores of individual questions and their appearance rates. The respondent answered each question by assigning a score of 0 (never), 1 (rarely), 2 (sometimes), 3 (frequently), or 4 (all the time); then, the total score was calculated [19]. The maximum score was 52. It can be noted that a higher DBD-13 score indicates that various problem behaviors occurred with a higher frequency, and vice versa. A zero score indicates that there were no behavioral disorders.

The appearance rates of the raw scores of the questions were obtained by first determining the respective appearance rates of scores 0, 1, 2, 3, and 4, after that, 2 to 4 answers were calculated as the appearance rate of "$\geq 2$: sometimes or more." The latter procedure allowed observation of the changes taking place among the following three categories of behavioral disorders: no behavioral disorder, almost no behavioral disorder, and a condition in which behavioral disorder was observed fairly commonly.

#### 4.6.2. Report and Interview

The report and interview results were analyzed using association charts and the KJ method. Related dia-

grams are used in the nursing field to assess the physical and psychological conditions and social integration of a client [22]. This was used to assess the status of the subjects before the introduction of PARO. The KJ method was developed by the cultural anthropologist Jiro Kawakita in the 1960s to organize data consisting of observational records measured during field explorations in a manner in which the "data can speak for themselves." It is used in various fields, including psychology, nursing, and English language education, as a method to qualitatively analyze data.

The association charts were produced by writing down pieces of information about the dementia symptoms of subjects and the effects of such symptoms on the lives of the subjects and their surroundings on separate paper slips (post-it notes, hereafter referred to as cards). To examine the reason for the occurrence of dementia symptoms, pathophysiological or psychological information that can be considered as the cause was written down on the cards. The cards were then pasted on a large sheet of paper, and the dementia symptoms and their possible causes were connected with arrow (→) symbols.

In the KJ method, words were extracted from the report and interview records based on the question of "what occurred to the subject or staff worker by introducing PARO?" The cards were divided into those connected to periods in which PARO was present and those in which PARO was absent. For the first stage, similar cards were placed in groups, each of which was assigned a one-line label and ranked as a subcategory. In the second stage, the subcategory labels were once again divided into groups, each of which was assigned a label and ranked as a category. In the third stage, the cards with category and subcategory labels were again regrouped, with each group assigned a label and ranked as a major category. Finally, the subcategories, categories, and major categories were connected by the following two types of arrows: → indicating a causal relationship or sequence, and ⇔ indicating a mutual relationship or mutual reinforcement.

The preliminary results were presented to worker A, the study team, and the Ozone Housing Research Committee to check their reliability and validity, based on which additions and corrections were subsequently made if necessary.

### 4.7. Ethical Considerations

To produce the case studies, worker A orally explained the objectives to the subjects and their families and, after gaining their oral agreement, answered the questionnaire to the extent of her understanding gained within her capacity of carrying out her duties. Furthermore, the introduction of PARO and implementation of the case study were undertaken only after they had been approved by the headquarters of the elderly residence. As the report was assigned as a business report in the context of the advocacy activities of HN, we obtained an approval from the HN board of trustees to conduct the case study analysis. Finally, the manuscript was submitted to worker A and the Ozone Housing Research Committee to verify its validity and obtain approval for its publication.

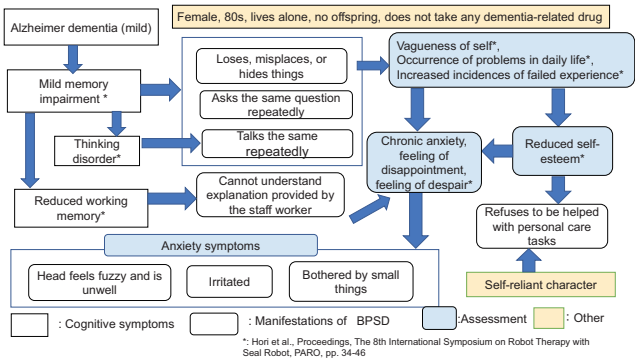


**Fig. 4.** Pre-intervention conditions of Subject No.5.

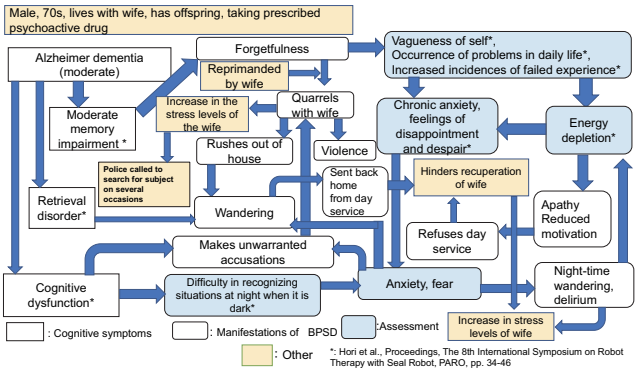


**Fig. 5.** Pre-intervention conditions of Subject No.7.

## 5. Results

### 5.1. Dementia Symptoms Before the Introduction of PARO

All three subjects displayed disorders that generally accompany the decline of cognitive functions (**Table 2**). The elderly residence primarily provides monitoring and life-support services to the elderly who either do not require or require relatively minimal nursing care.

Thus, worker A was unable to obtain detailed clinical information of the subjects, such as the results of cognitive function tests such as the Mini-Mental State Examination or their prescribed medications. **Figs. 4–6** show the cognitive dysfunction symptoms of the three subjects and their living conditions before the introduction of PARO. Subject No.5 (**Fig. 4**) is a woman in her eighties. She lives alone and, although she was diagnosed by the physician as having a mild case of Alzheimer dementia, was not prescribed an antidementia drug. She exhibited memory impairment, such as repeatedly asking the same questions, and displayed anxiety-like symptoms of BPSD, including being irritable and bothered by minor things, as she increasingly experienced problems or failures in daily life; consequently, she had started to increasingly visit the

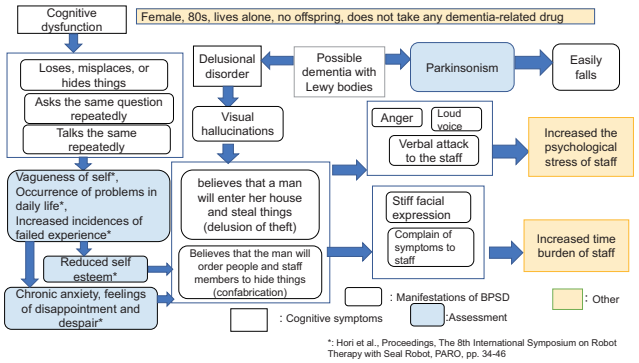


**Fig. 6.** Pre-intervention conditions of Subject No.8.

front office for consultation.

Subject No.7 (**Fig. 5**) is a man in his seventies, who lived with his wife and had been diagnosed by a physician as having moderate Alzheimer dementia and was prescribed a psychoactive drug. He would leave his home every time he had a quarrel with his wife and would be unable to return because of orientation disturbance; consequently, the police had been called in several times to search for him. He often refused the day service; moreover, on the rare occasions when he visited, he would return home after a short period as he was unable to bear being there. Because of this behavioral pattern, his wife had no respite. He also exhibited nighttime wandering and delirium; consequently, his wife experienced considerable accumulated fatigue.

Subject No.8 (**Fig. 6**) is a woman in her eighties who lived alone. Based on her delusions, she was suspected of having dementia with Lewy bodies, but her physician had decided not to subject her to an examination and had prescribed no drugs. She experienced persecutory delusions and delusions of theft; consequently, she was convinced that a man would enter her home to steal or hide things. She directed her delusion-based anger on staff workers, verbally attacked them, or complained about her unpleasant feelings based on her delusions to them for long hours, which placed an increased psychological and physical burden on the staff.

## 5.2. Questionnaire Survey

### 5.2.1. Change in DBD-13 Total Scores

The trends in the DBD-13 total scores of the subjects are listed in **Table 3**. The DBD-13 total scores of all three subjects reduced by approximately 30% in period I, which was the period immediately after the introduction of PARO. For Nos.5 and 8, the scores reduced during periods with PARO and increased in periods without PARO. The scores of No.7 were not as clear as those of Nos.5 and 8, i.e., they displayed a reducing tendency when PARO was present.

The representative values and dispersions of the DBD-13 total scores with and without PARO are listed in **Table 4**. The medians for the periods with PARO ranged between 11.0 and 16.0, while those for periods without

**Table 3.** Transition of short version of the Dementia Behavior Disturbance Scale (DBD-13) scores.

| | | | | | (Score) |
|---|---|---|---|---|---|
| | | | No5 | No7 | No8 |
| Up to June 14 | Before introduction | Without PARO | 10 | 23 | 21 |
| June 15-July 4 | Period I | With PARO | 7 | 16 | 14 |
| July 5-15 | Period II | Without PARO | 11 | 19 | 17 |
| July 16-August 5 | Period III | With PARO | 9 | 19 | 14 |
| August 6-17 | Period IV | Without PARO | 16 | 18 | 21 |
| August 18-September 1 | Period V | With PARO | 13 | 11 | 16 |
| September 2- October 17 | Period VI | Without PARO | 14 | 19 | 19 |
| October 18-January 10 | Period VII | With PARO | 13 | - | 14 |

Note: No.7: Moved to another facility for period VII.

**Table 4.** Representative values and dispersions of DBD-13 total scores with and without PARO.

| | With PARO | | | Without PARO* | | |
|---|---|---|---|---|---|---|
| | No5 | No7 | No8 | No5 | No7 | No8 |
| Average | 10.8 | 15.3 | 14.5 | 13.3 | 19.0 | 19.0 |
| Median | 11.0 | 16.0 | 14.0 | 13.0 | 19.0 | 19.0 |
| Minimum | 7.0 | 11.0 | 14.0 | 11.0 | 17.0 | 17.0 |
| Maximum | 14.0 | 19.0 | 16.0 | 16.0 | 21.0 | 21.0 |
| Dispersion | 7.0 | 8.0 | 2.0 | 5.0 | 4.0 | 4.0 |

*: Does not include scores before the introduction of PARO.

PARO ranged between 14.0 and 19.0; all three subjects displayed a higher median when PARO was absent. The minima ranged from 7.0 to 14.0 with PARO, and from 11.0 to 18.0 without PARO; again, all three subjects displayed higher minima without PARO. The maxima also showed a similar pattern.

### 5.2.2. Trend of Raw Scores for Individual DBD-13 Items and Their Appearance Rates

**Tables 5–7** list the transitions of the raw scores for individual DBD-13 items (hereafter referred to as "DBD-13 raw scores") for subject Nos.5, 7, and 8, respectively. **Figs. 7–9** show the corresponding trends of the appearance rates of the DBD-13 raw scores.

In the case of No.5 (**Table 5** and **Fig. 7**), the appearance rate of "$\geq$ 2: sometimes or more" reduces when PARO is present and increases when PARO is absent. In particular, the appearance rate was 0% during periods III, V, and VII, when PARO was present, indicating that the presence of PARO improved behavioral disorders that occurred frequently (on a daily basis). Meanwhile, the score of "0: never" was 46.2% of the DBD-13 scale before the introduction of PARO, and quickly increased to 61.5% in period I (with PARO), although it subsequently reduced regardless of the presence or absence of PARO, falling to 0% from period IV onward, thereby indicating that the occurrence of behavior disorders increased with the passing of time. The score "1: rarely" was 30.8% before the introduction of PARO, which then reduced to 23.1% during period I (with PARO), retained a constant level during pe-

**Table 5.** Transition of raw scores of individual DBD-13 questions: Subject No.5.

| Item No. | Item | Before Intro. | Period I | Period II | Period III | Period IV | Period V | Period VI | Period VII |
|---|---|---|---|---|---|---|---|---|---|
| | | Up to June 14 | Jun 15-Jul 4 | Jul 5-15 | Jul 16-Aug 5 | Aug 6-17 | Aug 18-Sep 1 | Sep 2- Oct 17 | Oct 18-Jan 10 |
| | | Without PARO | With PARO | Without PARO | With PARO | Without PARO | With PARO | Without PARO | With PARO |
| No1 | Asks the same question repeatedly. | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 |
| No2 | Loses, misplaces, or hides things. | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 |
| No3 | Shows lack of interest in daily activities. | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 |
| No4 | Wakes up at night for no obvious reason. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| No5 | Makes unwarranted accusations. | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| No6 | Sleeps excessively during the day. | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 1 |
| No7 | Paces up and down. | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| No8 | Repeats the same action repeatedly. | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| No9 | Is verbally abusive, curses. | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| No10 | Dresses inappropriately. | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| No11 | Refuses to be helped with personal care tasks, such as bathing, dressing, brushing teeth. | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| No12 | Hoards things for no obvious reason. | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| No13 | Empties drawers or closets. | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Total score | 10 | 7 | 11 | 9 | 16 | 13 | 14 | 13 |
| | Score for "Never: 0" | 6 | 8 | 6 | 4 | 0 | 0 | 0 | 0 |
| | % | 46.2% | 61.5% | 46.2% | 30.8% | 0.0% | 0.0% | 0.0% | 0.0% |
| | Score for "Rarely: 1" | 4 | 3 | 3 | 9 | 10 | 13 | 12 | 13 |
| | % | 30.8% | 23.1% | 23.1% | 69.2% | 76.9% | 100.0% | 92.3% | 100.0% |
| | Score for "Sometimes: 2" | 3 | 2 | 4 | 0 | 3 | 0 | 1 | 0 |
| | % | 23.1% | 15.4% | 30.8% | 0.0% | 23.1% | 0.0% | 7.7% | 0.0% |
| | Score for "Frequently: 3" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | % | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| | Score for "All the time: 4" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | % | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |

**Table 6.** Transition of raw scores of individual DBD-13 questions: Subject No.7.

| Item No. | Item | Before Intro. | Period I | Period II | Period III | Period IV | Period V | Period VI | Period VII |
|---|---|---|---|---|---|---|---|---|---|
| | | Up to June 14 | Jun 15-Jul 4 | Jul 5-15 | Jul 16-Aug 5 | Aug 6-17 | Aug 18-Sep 1 | Sep 2- Oct 17 | Oct 18-Jan 10 |
| | | Without PARO | With PARO | Without PARO | With PARO | Without PARO | With PARO | Without PARO | With PARO |
| No1 | Asks the same question over and over again. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| No2 | Loses, misplaces, or hides things. | 1 | 1 | 1 | 1 | 1 | 0 | 0 | - |
| No3 | Shows lack of interest in daily activities. | 4 | 2 | 1 | 4 | 3 | 1 | 2 | - |
| No4 | Wakes up at night for no obvious reason. | 3 | 2 | 3 | 1 | 2 | 1 | 1 | - |
| No5 | Makes unwarranted accusations. | 2 | 1 | 1 | 1 | 1 | 1 | 3 | - |
| No6 | Sleeps excessively during the day. | 1 | 1 | 1 | 2 | 1 | 2 | 1 | - |
| No7 | Paces up and down. | 3 | 2 | 3 | 3 | 2 | 1 | 2 | - |
| No8 | Repeats the same action over and over again. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| No9 | Is verbally abusive, curses. | 2 | 1 | 1 | 0 | 2 | 1 | 3 | - |
| No10 | Dresses inappropriately. | 1 | 1 | 1 | 0 | 0 | 0 | 0 | - |
| No11 | Refuses to be helped with personal care tasks, such as bathing, dressing, brushing teeth. | 2 | 1 | 3 | 3 | 2 | 2 | 3 | - |
| No12 | Hoards things for no obvious reason. | 1 | 1 | 1 | 1 | 1 | 0 | 1 | - |
| No13 | Empties drawers or closets. | 1 | 1 | 1 | 1 | 1 | 0 | 1 | - |
| | Total score | 23 | 16 | 19 | 19 | 18 | 11 | 19 | - |
| | Score for "Never: 0" | 0 | 0 | 0 | 2 | 1 | 4 | 2 | - |
| | % | 0.0% | 0.0% | 0.0% | 15.4% | 7.7% | 30.8% | 15.4% | - |
| | Score for "Rarely: 1" | 7 | 10 | 10 | 7 | 7 | 7 | 6 | - |
| | % | 53.8% | 76.9% | 76.9% | 53.8% | 53.8% | 53.8% | 46.2% | - |
| | Score for "Sometimes: 2" | 3 | 3 | 0 | 1 | 4 | 2 | 2 | - |
| | % | 23.1% | 23.1% | 0.0% | 7.7% | 30.8% | 15.4% | 15.4% | - |
| | Score for "Frequently: 3" | 2 | 0 | 3 | 2 | 1 | 0 | 3 | - |
| | % | 15.4% | 0.0% | 23.1% | 15.4% | 7.7% | 0.0% | 23.1% | - |
| | Score for "All the time: 4" | 1 | 0 | 0 | 1 | 0 | 0 | 0 | - |
| | % | 7.7% | 0.0% | 0.0% | 7.7% | 0.0% | 0.0% | 0.0% | - |

Note: Data for period VII are not available as the subject moved to a group home.

riod II (without PARO), drastically rose to 69.2% during period III (with PARO), and subsequently gradually increased to a range of 92.3%–100% during periods V, VI, and VII. The trends in the appearance rates of scores 0 and 1 indicate that, although the behavioral disorders increased with the passage of time, the appearance rate was low, and the disorders were mild.

In the case of No.7 (**Table 6** and **Fig. 8**), the appearance rate of "$\geq$ 2: sometimes or more" was 46.2% before the introduction of PARO, reduced drastically to 23.1% during period I (with PARO), then maintained its level for a short period, after which it increased gently, reaching 38.5% during period IV (without PARO), and reduced to 15.4% during period V (with PARO). However, it increased again to 38.5% in period VI (without PARO). Although this appearance rate was lower than the 46.2% before the introduction of PARO, the subject was moved to a group home in the latter half of period VI. Although it is not very clear, the trend of the $\geq$ 2 score indicates that items showing high occurrence of behavioral disorder in-

**Table 7.** Transition of raw scores of individual DBD-13 questions: Subject No.8.

| Item No. | Item | Before Intro. | Period I | Period II | Period III | Period IV | Period V | Period VI | Period VII |
|---|---|---|---|---|---|---|---|---|---|
| | | Up to June 14 | Jun 15-Jul 4 | Jul 5-15 | Jul 16-Aug 5 | Aug 6-17 | Aug 18-Sep 1 | Sep 2- Oct 17 | Oct 18-Jan 10 |
| | | Without PARO | With PARO | Without PARO | With PARO | Without PARO | With PARO | Without PARO | With PARO |
| No1 | Asks the same question over and over again. | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 |
| No2 | Loses, misplaces, or hides things. | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| No3 | Shows lack of interest in daily activities. | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| No4 | Wakes up at night for no obvious reason. | 2 | 1 | 1 | 1 | 2 | 1 | 3 | 1 |
| No5 | Makes unwarranted accusations. | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 2 |
| No6 | Sleeps excessively during the day. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| No7 | Paces up and down. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| No8 | Repeats the same action over and over again. | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| No9 | Is verbally abusive, curses. | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 |
| No10 | Dresses inappropriately. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| No11 | Refuses to be helped with personal care tasks, such as bathing, dressing, brushing teeth. | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 |
| No12 | Hoards things for no obvious reason. | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 1 |
| No13 | Empties drawers or closets. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Total score | 21 | 14 | 17 | 14 | 21 | 16 | 19 | 14 |
| | Score for "Never: 0" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 7.7% |
| | Score for "Rarely: 1" | 5 | 12 | 9 | 12 | 6 | 10 | 8 | 10 |
| | % | 38.5% | 92.3% | 69.2% | 92.3% | 46.2% | 76.9% | 61.5% | 76.9% |
| | Score for "Sometimes: 2" | 8 | 1 | 4 | 1 | 6 | 3 | 4 | 2 |
| | % | 61.5% | 7.7% | 30.8% | 7.7% | 46.2% | 23.1% | 30.8% | 15.4% |
| | Score for "Frequently: 3" | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 7.7% | 0.0% | 7.7% | 0.0% |
| | Score for "All the time: 4" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | % | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |

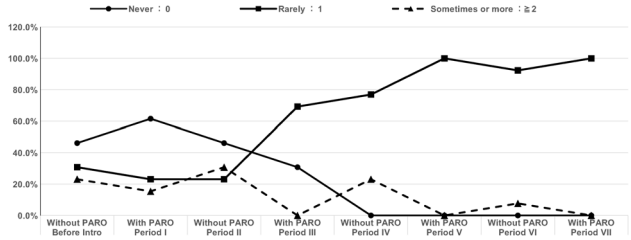


**Fig. 7.** Transition of frequencies of short version of the Dementia Behavior Disturbance Scale (DBD-13) item raw scores: Subject No.5.

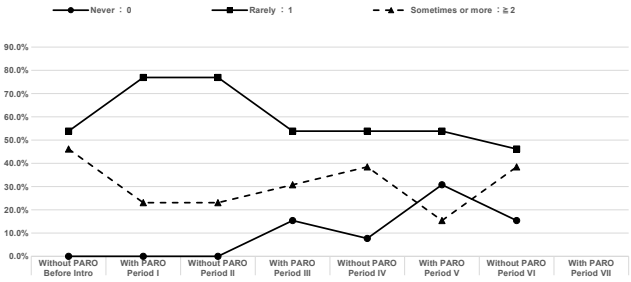


**Fig. 8.** Transition of frequencies of DBD-13 item raw scores: Subject No.7.

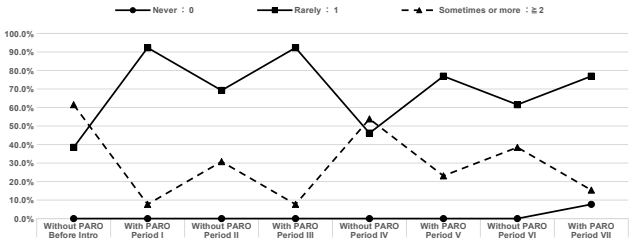


**Fig. 9.** Transition of frequencies of DBD-13 item raw scores: Subject No.8.

creased when PARO was absent, and improvements were observed when PARO was present.

Meanwhile, items scoring "0: never" were nonexistent before the introduction of PARO; however, in period III and thereafter, the value increased when PARO was present (15.4%–30.8%) and reduced when PARO was absent (7.7%–15.4%), indicating that certain signs of behavioral disorders disappeared when PARO was present, but reappeared when PARO was absent. Items scoring "1: rarely" was 53.8% before introduction of PARO; however, the value rose to 76.9% and was maintained at this value in periods I (with PARO) and II (without PARO). The appearance rate decreased to 53.8% during period III (with PARO), and subsequently remained at the same level (46.2%–53.8%) regardless of whether PARO was present or absent.

In the case of No.8 (**Table 7** and **Fig. 9**), the appearance rate of items that scored "$\geq$ 2: sometimes or more" was 61.5% before the introduction of PARO; however, it drastically reduced to 7.7% during period I. Subsequently, their appearance rate rose when PARO was absent (30.8%–53.8%) and reduced when PARO was present (7.7%–23.1%). As in the cases of Nos.5 and 7, items indicate behavioral disorders increased when PARO was absent but decreased when PARO was present. Meanwhile, the rate of items scoring "1: rarely" was 38.5% before the introduction of PARO, but it drastically increased to 92.3% during period I. Subsequently, their appearance rate reduced when PARO was absent (46.2%–69.2%) and increased when PARO was present (76.9%–92.3%). The change in appearance rate of items scoring "1: rarely" relative to the presence or absence of PARO was opposite to that of items scoring "$\geq$ 2: sometimes or more" as an improvement in an item that had scored 2 or more would result in a score of 1 (**Table 7**). Items that scored

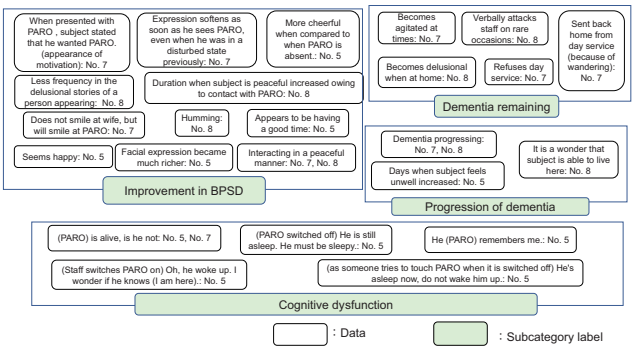


**Fig. 10.** Changes in dementia symptoms of the three subjects (PARO present).

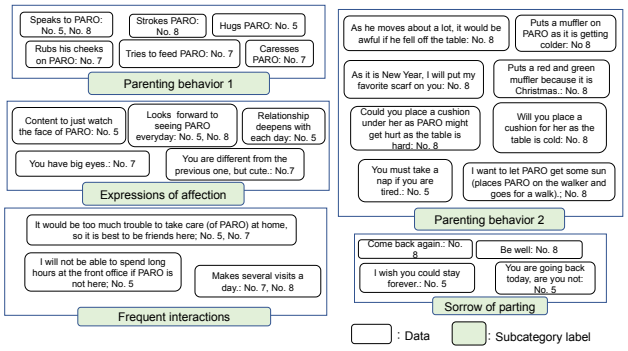


**Fig. 11.** Formation of attachment with PARO among the three subjects (PARO present).

"0: never" did not appear during most of the observation period, except for period VII, when the appearance rate was 7.7%.

## 5.3. Analysis of Report and Interview Results

### 5.3.1. Periods When PARO Was Present

For the first stage of the KJ method, we extracted expressions from the perspective of "changes that occurred in the subjects when PARO was present" and wrote them down on individual cards. Similar cards were placed in groups, which were assigned subcategory labels. These labels were again divided into groups, which were assigned labels. Thus, nine subcategories were extracted, which were divided into two groups. These groups were labeled "changes in dementia symptoms of the three subjects" (**Fig. 10**) and "formation of attachment with PARO among the three subjects" (**Fig. 11**). The former group consisted of four subcategories: "improvement in BPSD," "dementia remaining," "progression of dementia," and "cognitive dysfunction." The latter consisted of five subcategories: "parenting behavior 1," "parenting behavior 2," "expressions of affection," "sorrow of parting," and "frequent interactions."

For the second stage, the extracted subcategory labels were again grouped into categories from the perspective of "events that occurred in periods when PARO was present," which were assigned labels. Then, the

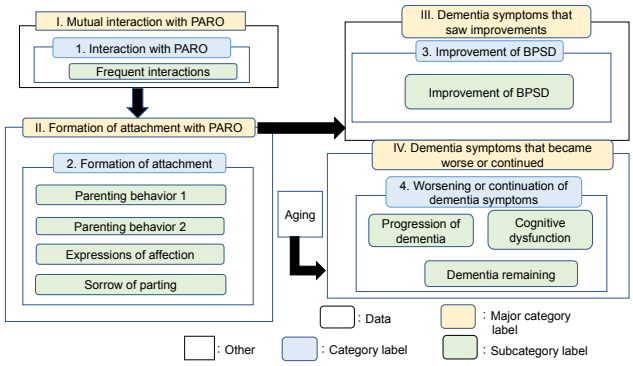


**Fig. 12.** Events that occurred during periods when PARO was present.

cards with subcategory and category labels were grouped again to form major categories, which were labeled. This resulted (**Fig. 12**) in four major categories: "I. Mutual interaction with PARO," "II. Formation of attachment with PARO," "III. Dementia symptoms that saw improvements," and "IV. Dementia symptoms that became worse or continued." "I. Mutual interaction with PARO" consisted of the category "1. Interaction with PARO," with one subcategory. "II. Formation of attachment with PARO" consisted of the category "2. Formation of attachment," with four subcategories. "III. Dementia symptoms that saw improvements" consisted of the category "3. Improvement in BPSD," with a single subcategory. "IV. Dementia symptoms that became worse or continued" consisted only of the category "4. Worsening or continuation of dementia symptoms," which consisted of three subcategories. The relationships between the subcategories, categories, and major categories were indicated by arrows, as shown in **Fig. 12**.

Thus, "I. Mutual interaction with PARO" resulted in "II. Formation of attachment with PARO," which then led to "III. Dementia symptoms that saw improvements." Meanwhile, "IV. Dementia symptoms that became worse or continued" were most likely the effects of aging, unaffected by the presence of PARO.

### 5.3.2. Periods When PARO Was Absent

Then, we extracted expressions from the perspective of "changes that occurred among the subjects when PARO was absent." From this procedure in the first stage, six subcategories were extracted, which were then divided into two groups: "changes among the three subjects due to the loss of PARO" (**Fig. 13**) and "deterioration in dementia symptoms in the three subjects" (**Fig. 14**). The former group consisted of four subcategories: "loneliness due to absence of PARO," "changes in the frequency of visitation to front office," "reminiscences of PARO," and "changes in the work duties of the staff." The latter consisted of two subcategories: "appearance of BPSD" and "progression of cognitive symptoms."

For the second stage, the categories and subcategories were grouped again from the perspective of "changes that

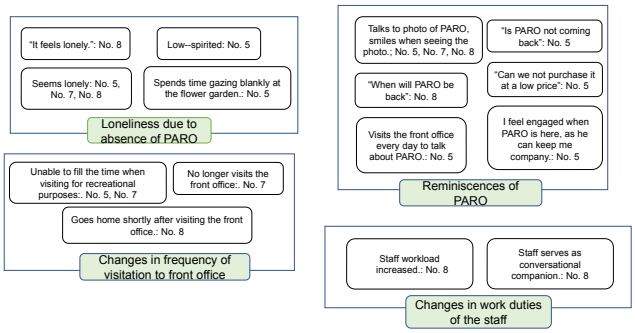


**Fig. 13.** Changes among the three subjects due to the loss of PARO (PARO absent).

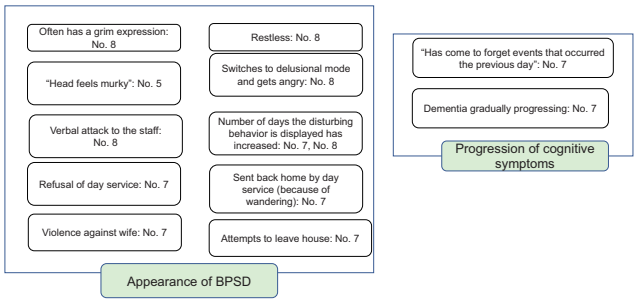


**Fig. 14.** Deterioration of dementia symptoms of the three subjects (PARO absent).

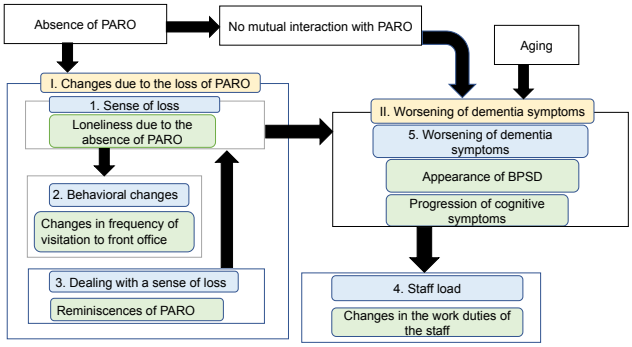


**Fig. 15.** Changes that occurred owing to the absence of PARO.

occurred due to the absence of PARO" (**Fig. 15**), which produced two major categories: "I. Changes due to loss of PARO" and "II. Worsening of dementia symptoms." The former consisted of four categories: "1. Sense of loss," "2. Behavioral changes," "3. Dealing with a sense of loss," and "4. Staff load," each of which consisted of a single subcategory. The latter consisted of the category "5. Worsening of dementia symptoms," and two subcategories. Finally, the relationships among the subcategories, categories, and major categories were connected by arrows, which can be observed in **Fig. 15**.

Owing to the absence of PARO, the subjects were no longer able to mutually interact with PARO, which resulted in "II. Worsening of dementia symptoms." This, in turn, led to an increase in "4. Staff load." Meanwhile,

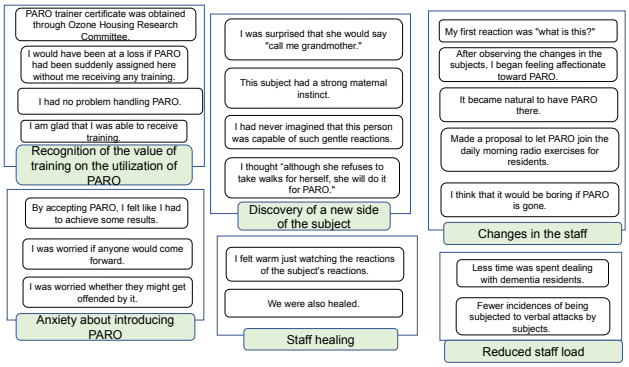


**Fig. 16.** Staff perceptions and their changes.

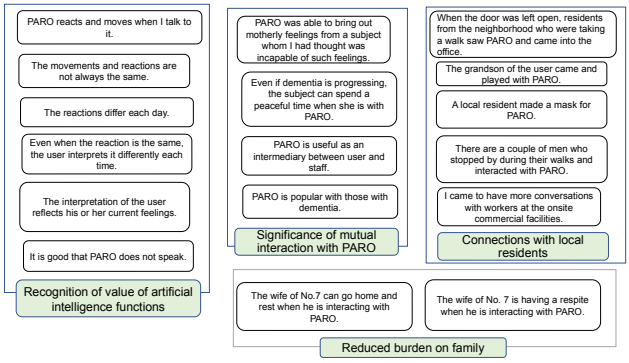


**Fig. 17.** Staff assessment of PARO.

the absence of PARO resulted in "I. Changes due to loss of PARO." In particular, the category "1. Sense of loss" manifested in "Changes in frequency of visits to the front office," that is, there was a reduction in the number of visits. While considering the category "3. Dealing with their sense of loss," the subjects reminisced about PARO; however, this did not resolve their "1. Sense of loss," and along with aging, led to "II. Worsening of dementia symptoms."

## 5.4. Analysis of Staff Perception

Expressions were extracted from the perspective of "staff perceptions and their changes" and were written on individual cards. The first-stage process resulted in 13 subcategories, which were divided into three groups: "staff perceptions and their changes" (**Fig. 16**), "staff assessment of PARO" (**Fig. 17**), and "factors of success and obstacles to the introduction of PARO" (**Fig. 18**). "Staff perceptions and their changes" (**Fig. 16**) consisted of six subcategories: "recognition of the value of PARO training," "anxiety about introducing PARO," "discovery of a new aspect of the subject," "staff healing," "changes in the staff," and "reduced staff load." The category "staff assessment of PARO" (**Fig. 17**) consisted of four subcategories: "recognition of value of artificial intelligence functions," "significance of mutual interaction with PARO," "reduced burden on family," and "connections with local residents." "Factors of success and obstacles to the introduction of PARO" (**Fig. 18**) consisted of three

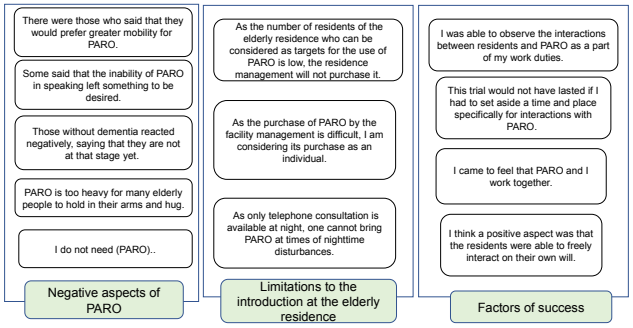


**Fig. 18.** Factors of success and obstacles to the introduction of PARO.

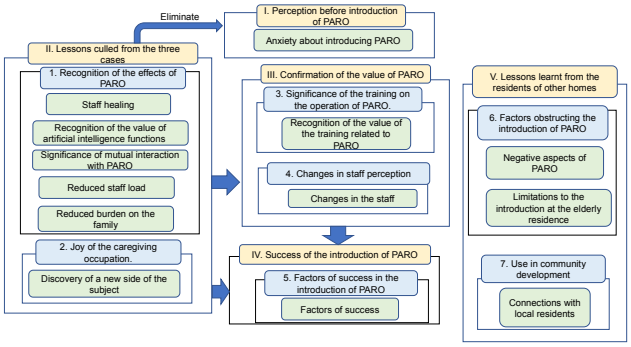


**Fig. 19.** Effects that the introduction of PARO had on staff.

subcategories: "negative aspects of PARO," "limitations of the introduction at the elderly residence," and "factors of success."

For the second stage, the extracted subcategories were divided into groups from the perspective of "effects experienced by the staff after the introduction of PARO" (**Fig. 19**), which produced five major categories: "I. Perception before the introduction of PARO," "II. Lessons culled from the three cases," "III. Confirmation of the value of PARO," "IV. Success of the introduction of PARO," and "V. Lessons obtained from the occupants of other residences." "I. Perception before the introduction of PARO" consisted of a single subcategory: "anxiety about introducing PARO." "II. Lessons culled from the three cases" consisted of two categories: "1. Recognition of the effects of PARO" and "2. Joy experienced in the caregiving occupation," which consisted of five and one subcategories, respectively. "III. Confirmation of the value of PARO" consisted of two categories: "3. Significance of PARO training" and "4. Changes in staff perception," each of which consisted of a single subcategory. "IV. Success of the introduction of PARO" consisted of one category "5. Factors of success in the introduction of PARO" and a single subcategory. "V. Lessons obtained from the occupants of other residences" consisted of two categories: "6. Factors obstructing the introduction of PARO" and "7. Use in community development," which consisted of two and one subcategories, respectively. The relationships among the major categories, categories, and subcategories are shown by arrows, as illustrated in **Fig. 19**.

Thus, "1. Recognition of the effects of PARO" and "2. Joy experienced in the caregiving occupation," which were a part of the major category "II. Lessons culled from the three cases," resulted in eliminating the "anxiety about introducing PARO," which was a category under "I. Perception before the introduction of PARO." Moreover, it also resulted in "III. Confirmation of the value of PARO." Experiences pertaining to the categories "II. Lessons culled from the three cases" and "III. Confirmation of the value of PARO" led the staff to possess a sense of fellowship toward PARO that "PARO and I work together" (**Fig. 18**), which resulted in "IV. Success of the introduction of PARO." In "V. Lessons obtained from the occupants of other residences," we identified the category "6. Factors obstructing the introduction of PARO" to contain the "negative aspects of PARO," expressed by statements such as "those without dementia reacted negatively, saying that they are not at that stage yet" (**Fig. 18**), and "limitations of the introduction at the elderly residence," such as "because the number of residents of the elderly residence who can be considered as targets for the use of PARO is low, the residence management will not purchase it" (**Fig. 18**). In addition, as PARO was initiated as part of a community development effort, we identified that the activities involving PARO extended to area residents and were not limited to merely residents of the elderly residence (**Fig. 17**).

## 6. Discussion

The objective of this case study was to identify the effects of the intermittent introduction of PARO over a period of approximately seven months at an elderly residence on elderly residents with cognitive dysfunctions and the care-providing personnel. By analyzing the data consisting of the staff report, DBD-13 questionnaire response, and results of an interview with the staff worker, we were able to identify the behavioral changes of the subjects of the case study and the changing perceptions of staff personnel regarding PARO.

### 6.1. Case Study Subjects

Of the 76 residents of the elderly residence, 9 participated on the first day when PARO was introduced (**Table 2**), of which 3, who exhibited cognitive dysfunctions, stayed on to engage in long-term interactions with PARO. These subjects constituted 3.95% of the total residents. This low figure is related to the fact that the majority of residents of the elderly residence with services were self-reliant. Conversely, approximately 30 residents were certified as requiring long-term care, of which the subjects constituted 10%, which could be said to be relatively high among the certified residents. As the number of residents who were certified as requiring care is likely to increase as the resident population ages, we can expect that the potential demand for PARO will grow in the future.

We identified that the DBD-13 total scores (**Table 3**) and the appearance rate of "≥ 2: sometimes or more" (**Figs. 7–9**) reduced during the periods when PARO was present and increased when PARO was absent. Furthermore, the averages, medians, maxima, and minima of the DBD-13 total scores of the three subjects were all higher during periods when PARO was absent when compared to periods when PARO was present (**Table 4**). This suggests that interactions with PARO improved dementia-related behavioral disorders, while the absence of PARO caused them to deteriorate. Qualitative analyses also indicated similar results regarding BPSD (**Figs. 10**, **12**, **14**, and **15**). These results are similar to those of previous studies based on RCTs with PARO [3–7], which reported improvement in BPSD. Note that the intervention was repeated four times in the present study to compare periods with and without PARO. As there are no previous studies on PARO based on alternating periods with and without the utilization of PARO, we believe that the present study presents valuable data, although the evidence level is low [8] (Appendix E).

The appearance rate of "1: rarely" remained high in subject Nos.5 (**Fig. 7** and **Table 5**) and 7 (**Fig. 8** and **Table 6**) throughout the study period regardless of the presence or absence of PARO, which suggests that dementia symptoms either remained or worsened even when PARO was present. This finding is similar to that of our previous study on in-home care [23]. Qualitative analysis (**Figs. 10** and **12**) also indicated that dementia symptoms deteriorated with time. However, as indicated by the statement of worker A that "even if dementia is progressing, the subject can spend a peaceful time when she is with PARO (we need more times like these)" (**Fig. 17**), although the progress of dementia cannot be stopped, we believe that the value of using PARO lies in creating an environment in which people can live peacefully, which can contribute to improving the quality-of-life of the dementia patient.

Sharkey et al. [24] applied the capability approach (CA) as a framework for evaluating the effects of an eldercare robot on the human dignity of elderly people. The CA consists of 10 capabilities: 1. life, 2. bodily health, 3. bodily integrity, 4. senses, imagination, and thought, 5. emotions, 6. practical reason, 7. affiliation (A) (B), 8. other species, 9. play, i.e., being able to laugh and play, and 10. control over the environment (A) (B). Of these 10 capabilities, the mutual interactions between PARO and the subjects that result in increased opportunities to form attachments, engage in a dialog, laugh, play, and partake in recreational activities with PARO (**Figs. 10–12**) can be considered to expand the capabilities of the following: 7. affiliation (A), 5. emotions, and 9. play (**Fig. 20**). Affiliation (A) implies "being able to live with and for others, to recognize and show concern for other humans, to engage in various forms of social interaction."

We note that BPSD of subject No.7 worsened during period VI (when PARO was absent), which placed a greater burden on his wife; consequently, he was moved to a group home. Subject No.7 had refused day service even before PARO was introduced, which prevented his wife

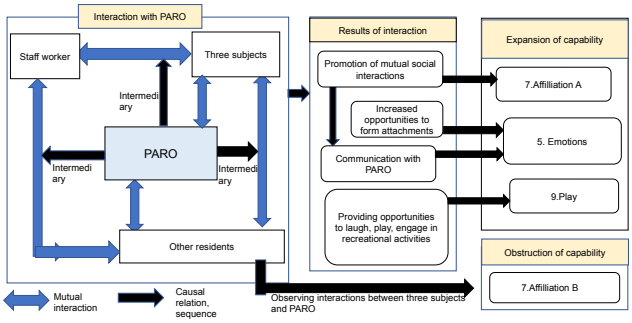


**Fig. 20.** Expansion and obstruction of capabilities in the capability approach of the three subjects.

from gaining any respite (**Fig. 5**); consequently, she had been feeling considerably exhausted. However, she was able to go home and rest when No.7 interacted with PARO during periods when PARO was available (**Fig. 17**); therefore, the time that No.7 spent interacting with PARO helped her recuperate and was therefore preferred over the day service. Although No.7 was placed in a group home during period VI, when PARO was absent, we believe that the intermittent use of PARO reduced the physical and psychological burden of his wife and extended the period of in-home care. The fact that No.7 was moved to a group home during the period when PARO was absent lends support to this possibility. Further, in the case of No.8, the comment of the care worker that "it is a wonder that subject is able to live here" (**Fig. 10**) suggests that the use of PARO may have served to extend her period of in-home care as well.

A further note regarding No.7 is that, during period VI when he was moved to a group home, his DBD-13 total scores and appearance rate appear to be unsupported by the information presented by qualitative analysis. According to the interview with worker A, the situation surrounding his move to the group home was such that "routine failures based on memory impairment increased, which led to quarrels with his wife whenever she pointed them out or reprimanded him, and he would often rush out of the house to avoid his wife. On these occasions, his wife would try to stop him as he would invariably get lost if he left the house, which led to more quarrels and occasional violence against his wife. Because her fatigue increased to an unbearable level, she decided to place No.7 in a group home."

However, the DBD-13 total scores and appearance rate of No.7, although higher than the previous period (V), are not so high as to suggest placing him in a group home. Although the DBD-13 score (**Table 3**) increased by 8 points from period V to 19 points, it was measured to be 19 points in periods II and III as well, and still below the value of 23 points as measured before the introduction of PARO. Meanwhile, the appearance rates (**Fig. 8** and **Table 6**) show that although "0: never" decreased from 30.8% during period V to 15.4% during period VI, it was higher than that in periods I, II, and III, where

it was 0%, suggesting that the behavioral disorders saw some improvement. The scores of "1: rarely" also decreased by just 7.6% points during period VI from period V, staying at approximately the same level; however, it was lower than the 76.9% of period I, thereby indicating an improvement. Meanwhile, although the appearance rate of the scores of "$\geq$ 2: sometimes or more" increased from 15.4% in period V to 38.5%, it was the same as that in period IV, and lower than the 46.2% measured before the introduction of PARO.

It is more likely that this disparity between the DBD-13 total scores and qualitative analysis occurred because DBD-13 included no items pertaining to violence and worker A filled the DBD-13 questionnaire based on information gained during her work duties. The elderly residence in which PARO was introduced provides monitoring and life-support services as stipulated in the Law Concerning Stable Housing for the Elderly. However, it did not provide direct support services because any elderly residence is classified as a private residential home if it provides either meals, nursing care, household work, or health monitoring, and comes under the jurisdiction of the Act on Social Welfare for the Elderly (Appendix B). Therefore, it was possible to comprehend the conditions of the subjects only based on the assessments conducted during their visit to the front office or during consultations. Worker A states that "it was only possible to know the situation at home from what his wife told us" (which was not included as data), suggesting the limitations of such an undertaking in elderly residences. While the questionnaire survey only yielded findings related to the question items, we feel that we were able to assess the situation by combining it with the report and interview results.

While the qualitative analysis suggested that dementia symptoms worsened during periods when PARO was absent as it was no longer possible to interact with PARO, we suspect that the sense of loss of PARO also contributed to deterioration in the dementia symptoms (**Fig. 15**). Pet loss is a type of object loss, and it has been indicated that closeness [25] and attachment [26] to the pet are predictive factors of the sadness that follows loss. Because all three subjects had formed close relationships with PARO, they experienced grief over the loss of PARO, which we believe had an effect on their dementia symptoms. As pet loss is generally devalued in comparison to human death [27], the grief of the owner is often not understood, and this perceptional difference with others can yield a sense of isolation [28].

However, these three subjects experienced an environment where they could visit the front office to talk to staff personnel about their sadness or loneliness concerning the absence of PARO, and we feel that this was useful for alleviating the grief accompanying the loss of PARO and led to dissolving their sense of isolation.

### 6.2. Staff Personnel

The staff workers were surprised and pleased by the unexpected reduction in BPSD owing to PARO (**Figs. 10** and **12**) and how it had drawn out the human qualities that the subjects inherently possessed (**Figs. 16**, **17**, and **19**). Furthermore, not only did the improvement of BPSD reduce their burden, but they themselves felt that they had been healed by observing the interactions between PARO and the subjects (**Fig. 16**). They felt that the introduction of PARO was successful, even though only three cases were involved (**Fig. 18**). We feel that the factor of success lay in the natural setting in which PARO was employed as a part of daily life, for both the subjects and staff personnel, as suggested when worker A said that "I was able to observe the interactions between residents and PARO within my work duties," "this trial would not have lasted if I had to set aside a time and place specifically for interactions with PARO," or "the residents were able to freely interact on their own will."

However, even though the staff had experienced the effects and had started to feel that "PARO is a part of the staff," the facility management decided not to purchase it. The reasons were economic, i.e., the high price of 400,000 yen per unit of PARO, and the fact that the beneficial effects had been demonstrated with only 3 of the 76 residents of the elderly residence (**Fig. 18**). As mentioned earlier, the majority of the residents at the elderly residence consisted of self-reliant healthy people, and the potential users of PARO were limited. Consequently, it is probably necessary to consider economic benefits such as reduced labor costs by lessening the burden on staff spending time caring for residents with BPSD.

### 6.3. Toward the Construction of Evaluation Criteria of Case Studies

In case studies in nursing, the indices of medical outcomes and qualitative outcomes are used to evaluate nursing practices. The former consists of medical diagnosis and clinical examination data used to assess the pathological conditions of patients, and the latter consists of qualitative data used to assess the psychological or social aspects or living conditions. In this study, we employed DBD-13 results as the medical outcomes and the analysis results based on the KJ method were the qualitative outcomes.

#### 6.3.1. Selection of Medical Outcome Index

As this study focused on the introduction of PARO in an elderly residence that offers services rather than a hospital or nursing home, we had no access to medical diagnoses or clinical examination data. This is because the elderly residence is a facility that provides monitoring and life-support services (Appendix B) to residents and does not maintain the information supplied by the attending physician of the residents or the services covered by the long-term care insurance system. Furthermore, it was challenging to continually observe the dementia-related behavioral disorders in a systematic manner and document them in the form of a written report or interview as worker A, who was not medically qualified, was responsible for observing the subjects. Thus, we felt that it was necessary to

employ, as the medical outcome, an existing scale using which a person with no medical expertise would be able to record dementia-related behavioral disorders in a systematic manner.

While selecting the scale, we decided to employ a single scale to minimize the physical and psychological burdens on worker A. This was because we speculated that it is likely that a survey that entailed a large burden would create negative feelings regarding the introduction of PARO and result in a refusal, based on earlier experiences with HN activities. While seeking a scale whose reliability and validity have been verified, and which has relatively fewer question items and is used widely as a scale of dementia-related behavioral disorders, we selected DBD-13.

While we plan to conduct further case studies in the future using PARO for in-home care as well as for various facilities and in hospitals, the medical outcome index will have to be varied according to the field of survey. For instance, the ratio of mild to moderate dementia cases will be high in the cases of in-home care and elderly residences with services, in which case the questions included in DBD-13 will suffice; conversely, in facilities such as nursing homes, the number of severe dementia cases will be high, in which case the original (complete) version of DBD with 28 items will be more appropriate. In such cases, the additional use of medical data stored by a facility would be useful.

#### 6.3.2. Significance and Validity of the Usage of DBD-13

Although the qualitative data yielded evidence of the improvement (**Figs. 10** and **12**) or deterioration (**Figs. 14** and **15**) in BPSD linked to the presence or absence of PARO, no information was gained about the degree of such changes and the corresponding periods. However, we were able to objectively assess these changes, identified through qualitative analysis, in numerical terms by using DBD-13, and visualize them by presenting them using graphs, which we feel increased its persuasive power. For example, we were able to numerically present the decrease and increase in the appearance rate of "$\geq 2$: sometimes or more" when PARO was present and absent, respectively (**Figs. 7–9** and **Tables 5–7**).

Moreover, the qualitative data yielded the finding of "dementia gradually progressing" among the subjects with the passing of time (**Figs. 10**, **12**, **14**, **15**), but not the manner in which this occurred. Although we asked for specific changes during the interview, we were only able to obtain the vague answer "somehow." However, we feel that, by employing DBD-13, we were able to numerically show the deterioration of dementia, which had been observed qualitatively, from the aspect of behavioral disorders, and objectively capture the conditions of the subjects. For instance, in the case of No.5, the appearance rate of "0: never" reduced while that of "1: rarely" increased with the passing of time regardless of the presence or absence of PARO (**Fig. 7** and **Table 5**). This indicates an increase in the number of items representing behavioral disorders as well as the items that occurred infrequently while measuring on a daily basis, which can effectively capture the manner in which the behavioral disorders deteriorated over time.

#### 6.3.3. Qualitative Outcome Index: KJ Method

In this study, we were able to sort out a vast amount of data without being buried and identify the effects and causal relationships by extracting expressions from documented records of the perceptions of the staff worker from the perspective of "what happened to the subjects and staff workers by introducing PARO?" and exploring the data using the KJ method (**Figs. 10–20**). The KJ method is a method of organizing a chaotic body of assorted data to assess the current status and seek solutions to the presented problem, by allowing the "data to speak for themselves" [29, 30]. Consequently, we felt that a qualitative analysis based on the KJ method would be an effective way to examine the case study in terms of exploring solutions to issues at the site by the use of PARO.

## 7. Limitations

In the present study, PARO was loaned free of charge by HN as part of its community development efforts, during the periods when it was available for the advocacy activities of HN, and the use of PARO was not based on an independent study design. Consequently, the periods were not of the same length. Moreover, the data are based on the recollections of worker A, consisting of information obtained during the course of her work duties; however, no information was collected from the subjects or their family members for the specific purpose of this study. Consequently, the study may have aspects that lack objectivity or reliability. There have been criticisms of case studies [31] indicating that, even when individual experiences are expressed as objective facts, it is difficult to identify the process of verifying those facts; moreover, it was indicated that the observed data are not necessarily objective or that the obtained results are difficult to recreate. Fineout-Overholt et al. [8] also assigned a low ranking for evidence obtained from a single descriptive study, such as a case study, i.e., a ranking at the sixth level in a seven-tiered hierarchy was assigned when questioning the effectiveness of interventions. However, they assigned a relatively high ranking, i.e., the second level of a seven-tiered hierarchy, when assessing evidence to answer clinical questions regarding the meaning. Thus, we plan to accumulate further case studies in the future and explore ways to construct a methodology of intervention based on PARO.

## 8. Future Issues

The results of the present study suggest that the effects of PARO on patients with dementia can be assessed using

DBD-13. Therefore, it is necessary to accumulate further cases in the future and evaluate the effects of the use of PARO on behavioral disorders based on DBD-13 and verify whether behavioral disorders have improved. Further, as it was shown in a previous study that DBD-13 is useful for assessing the nursing burden [21], we must verify whether an improvement in behavioral disorders due to the usage of PARO does indeed result in a reduction in the nursing load.

While the present study focused on three subjects with dementia, observations of the six residents (of the ten listed in **Table 2**) who had short-term interactions were also recorded in the interview and reported. These subjects expressed the sentiment that the interaction with PARO violated human dignity, which can be noted by their statements such as they were "not at that stage yet" or "it is unnecessary for me" (**Fig. 18**), when they witnessed the interactions between subjects with dementia and PARO, which can be interpreted as inhibiting the capability of "7. affiliation (B)" as presented in the report by Sharkey et al. [26] (**Fig. 20**). This indicates the necessity of investigating ethical issues such as the dignity of elderly people associated with the use of robotic pets such as PARO.

## 9. Conclusions

This paper presented the results of a questionnaire survey based on DBD-13, and the report and interview results presented by worker A, which were based on her recollections on the intermittent use of PARO over a seven-month period in a distributed elderly residence with services, where the collected data were organized using association charts, which are often used in the field of nursing, and the KJ method. It was determined that three subjects with cognitive dysfunctions formed attachments with PARO, their BPSD varied based on the periods when PARO was present or absent, their residence period may have been extended by the introduction of PARO, the load on staff workers was reduced, the experience had a healing effect on the workers, and they experienced a renewed recognition of the value of PARO. Furthermore, the results suggested that the interaction with PARO extended the capabilities of "affiliation (A)," "emotions," and "play" in the CA scheme proposed by Sharkey et al.

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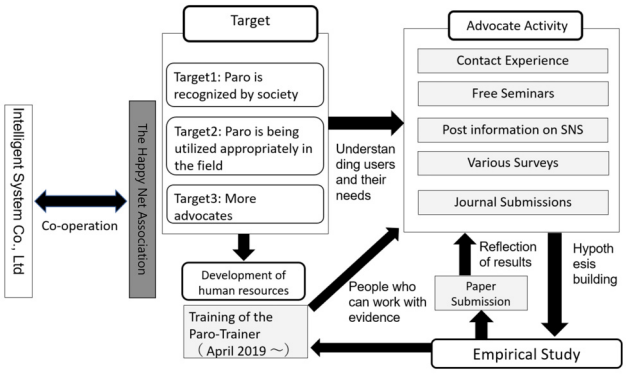


**Fig. 21.** Advocacy activities related to PARO.

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## Appendix A. Happy Net Association

The HN, founded in May 2015, has a membership of approximately 120 people, consisting of specialists such as care workers, certified social workers, nurses, and common citizens. In collaboration with the Intelligent System Co., Ltd., advocacy activities have been conducted, as shown in **Fig. 21**, including the hosting of experiential workshops in which participants can interact with PARO. To advocate implies to plead or argue in favor of something; however, in marketing terminology, it refers to a sense of strong loyalty to a particular brand or product. Thus, Philip Kotler defines an advocate as someone who recommends his favorite brand to others without being asked. This concept, which is proposed in his book Marketing 4.0, presents the ultimate goal as bringing the customer from the state of awareness to recommendation.

## Appendix B. Elderly Residences with Supportive Services

This category was established when the Law Concerning Stable Housing for the Elderly, which is under the jurisdiction of the Ministries of Land and of Health, Labour and Welfare, was amended in 2011, and registration began in October 2011. It was established to promote housing in which the elderly can securely live. By implementing the physical requirements, such as room areas, facilities, and barrier-free requirements, as well as monitoring and life-support services by care-providing professionals, they provide an environment in which the elderly are able to lead a secure life. To obtain registration, certain physical requirements (size, facilities) suitable for the elderly and monitoring services must be provided, and contractual standards must be satisfied.

To provide monitoring services, a care-providing professional must always be present in the building, at least during the daytime hours, to provide monitoring and life-consultation services. The introduction of PARO to elderly residences, which provided the field of this study, was undertaken in the context of monitoring services. The care-providing professional must be one of the following: 1) employee of a social welfare service corporation, medical corporation, or organizer of designated in-home service providers, 2) physician, 3) nurse, 4) care worker, 5) certified social worker, 6) long-term care manager, or 7) a person who has undertaken the initial training seminar as a long-term care worker.

If, in addition to the mandatory monitoring services, the elderly residences with supportive services provides 1) meals, 2) nursing care, 3) household work, or 4) health-monitoring facilities, it is classified as a private residential home and is subject to oversight under the Act on Social Welfare for the Elderly (https://www.kaigokensaku.mhlw.go.jp/publish_sumai/).

## Appendix C. Types of PARO

1. Pet type

With emphasis placed on its capability to behave like a living animal, the internal state varies according to various stimuli from the environment, including the user, and it behaves such that the interacting person feels as if it has emotions. In addition, it exhibits a circadian rhythm (not throughout the 24 h, but for periods of approximately 20 min), where it simulates sleepiness by presenting slower reactions, and momentarily falls asleep when the stimulus is weak during the night hours.

2. Therapeutic type

This version was produced based on the feedback from a user conference in Denmark. The main objectives are to enliven or reassure the people who interact with PARO and for therapeutic usages to provide robot therapy whenever necessary. To this end, it was modified such that it does not display any angry reactions against an excited person; therefore, it displays a tolerant nature such as submitting to being hit. Furthermore, it does not follow a circadian rhythm; therefore, it can be used whenever the therapist wishes to use it to reassure a patient. This change was incorporated based on requests from therapists that it is preferable if PARO does not fall asleep because the in-

teracting person feels less stimulus when PARO is asleep.

Although the therapeutic model has been advocated for use with dementia patients as their reactions to the therapeutic effects, such as reduction of BPSD, are more readily observable, it can be used extensively by those with non-dementia symptoms as well.

## Appendix D. Training for PARO

Training on the use of PARO was provided by the "PARO trainer training course (intermediate level)" hosted by the HN. It is a 6 h training divided into lectures and practical sessions.

[Lecture content]

I. Background material on the use of PARO

1. Relation between the HN and PARO
2. Why robots?
3. Review of overseas and domestic cases of the usage of PARO

II. Robotic functions and therapeutic effects of PARO

1. PARO as a fusion of art and technology
2. Research literature on PARO

III. Roles of a PARO trainer

[Practical training]

1. Experiencing the sensor functions of PARO

① Moving PARO

② Playing with PARO

③ Practice in robot-assisted activities using PARO

2. Maintenance of PARO and methods of infection control

## Appendix E. Evidence Level

Overholt classified evidence into those pertaining to the effectiveness of specific treatments or interventions (**Fig. 22**) and those pertaining to the meaning in clinical practice (**Fig. 23**). In the former category, case studies fall under the sixth level in the seven-tiered hierarchy, indicating a low evidence level. In the latter, they fall under the second level in the seven-tiered hierarchy, indicating a high evidence level.

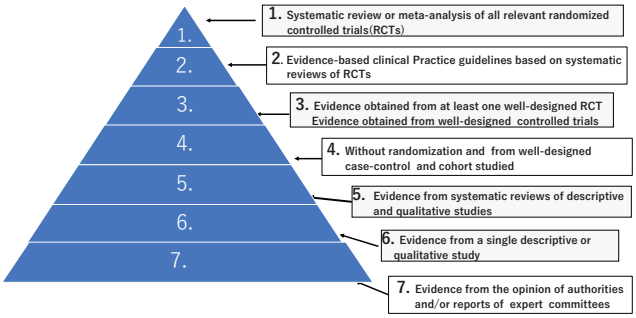


**Fig. 22.** Levels of evidence for answering clinical questions about the effectiveness of interventions. Quoted and partially modified from "Health Care from the Inside Out: Advancing Evidence-Based Practice in the 21st Century."

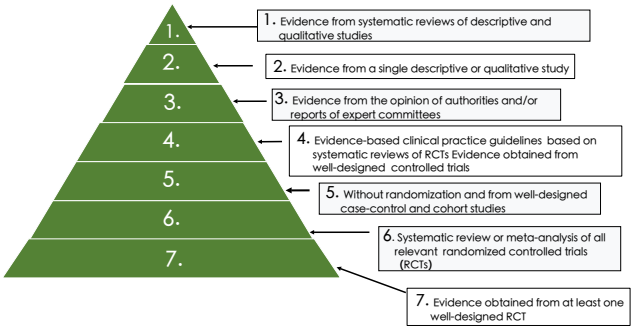


**Fig. 23.** Levels of evidence for answering clinical questions about meaning quoted and partially modified from "Health Care from the Inside Out: Advancing Evidence-Based Practice in the 21st Century."

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• "Case study of PARO use by family caregivers responsible for long-distance care and multiple care," Proc. of the 11th Int. Symp. on Robot Therapy with Seal Robot, PAR, pp. 33-45,2019.
• "Estimated value for reducing drug costs for dementia by using seal-type robot Paro," Proc. of the 10th Int. Symp. on Robot Therapy with Seal Robot, PAR, pp. 34-42, 2018.

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**Main Works:**
• "Relationships between the eligibility process, trust in the U.S. health care system, and patient satisfaction with the Houston Veterans Affairs Medical Center," Mil. Med., Vol.172, No.8, pp. 818-823, 2007.
• "Factors relating to doctors' desire to change hospitals in Japan," Int. J. Health Care Qual Assur., Vol.25, No.1, pp. 19-40, 2012.
• "Japanese healthcare: Fostering competition and controlling costs," Healthc. Manage. Forum, Vol.30, No.4, pp. 175-180, 2017.

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• M. Kobayashi, "Patient Safety 2nd edition," Gakken, 2018.

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• "A Comparative study on the expectation of active seniors in nursing care between Japan and China," ICMHI, 2021.
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**Main Works:**
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• Y. Okamoto, "Housing and Welfare, and Construction of Living Capital," Minerva Shobo, 2007.
• Y. Okamoto, "A Comparative study of homelessness in the United Kingdom and Japan," J. of Social Issues, Vol.63, No.3, pp. 525-542, 2007.

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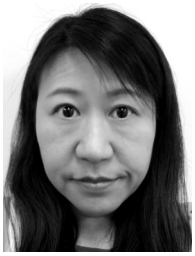

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