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Original Study

Suitability of Healthcare Robots for a Dementia Unit and Suggested Improvements

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A B S T R A C T

Objectives: To investigate the suitability of a new eldercare robot (Guide) for people with dementia and their caregivers compared with one that has been successfully used before (Paro), and to generate suggestions for improved robot enhanced dementia care.
Design: Cross-sectional study. A researcher demonstrated both robots in a random order to each staff member alone, or to each resident together with his/her relative(s). The researcher encouraged the participants to interact with each robot and asked staff and relatives a series of open ended questions about each robot.
Setting: A secure dementia residential facility in Auckland, New Zealand.
Participants: Ten people with dementia and 11 of their relatives, and five staff members.
Measurements: Each robot interaction was video-taped and coded for the number of times the resident looked at, smiled, touched, and talked to and about each robot, as well as relative interactions with the resident. Qualitative analysis was used to code the open ended questions.
Results: Residents smiled, touched and talked to Paro significantly more than Guide. Paro was found to be more acceptable to family members, staff, and residents, although many acknowledged that Guide had the potential to be useful if adapted for this population in terms of ergonomics and simplification.
Conclusion: Healthcare robots in dementia settings have to be simple and easy to use as well as stimulating and entertaining. This research highlights how eldercare robots may be adapted to have the best effects in dementia settings. It is concluded that Paro's sounds could be modified to be more acceptable to this population. The ergonomic design of Guide could be reviewed and the software application could be simplified and targeted to people with dementia.

Demographic projections of a growing aging population[1] represent a large concern for elderly care services in the future.[2] Associated with this large aging population is the increase in the number of people developing age-related illnesses such as dementia.[3] The progression of the illness affects memory, thinking, language, judgment, and behavior as a result of a degenerative loss of brain functioning. As dementia worsens patients become less able to function without care and often require help when it comes to performing basic daily activities.[4] Additionally, patients may become increasingly agitated, socially withdrawn, and depressed making the illness very difficult to deal with personally and for the people around the individual. Unsurprisingly, the behavioral and psychological symptoms of dementia cause a great deal of stress for family caregivers,[5–7] meaning that people with dementia often need to be institutionalized transferring such stress onto care staff.[8] At present there is no cure for dementia, but a number of medications and therapies have been developed to treat and manage the behavioral and psychological symptoms of dementia in the hopes of improving quality of life for both the person with dementia and the carer.[9,10] However, despite the literature about interventions for people with dementia the number of controlled studies is still small and more research needs to be conducted in this population to establish the effects of interventions aimed at better care.[11] In light of the growing number of people expected to be diagnosed with dementia and needing long term care, this research will help meet the challenges of the future. Additionally, alternative interventions need to be considered to determine which therapies suit this population, in terms of effectiveness, efficiency and practicality, to achieve the highest quality care for elderly people with dementia.

Healthcare robots are primarily concerned with helping users improve or monitor their health. Advancements in this field have

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seen the development of a variety of robots from non-interactive surgical and rehabilitative robots to interactive humanoid and animal-like robots.[12] The potential benefit that robots offer the elderly population is largely unknown. For those with dementia, these advancing technologies represent a new potential for improving quality of life. However, special considerations have to be made for this population to ensure that healthcare robots are acceptable and appropriate.[13] As people with dementia have reduced cognitive capacities and may find new technologies difficult to use, robots should be simple to use. At the same time, such robots should be cognitively and socially stimulating as such interventions have been found to reduce decline and psychological distress in people with dementia.[14,15]

Previous trials with people with dementia focus primarily on companionship robots, which take the form of a pet or animal. For people with dementia, contact with animals may give social attention and affection, providing missed physical contact. In addition, the presence of an animal may give caregivers and patients a common topic to discuss and may engage reminiscence of animals that one had previously owned.[16] Overall, it has been found that animal therapy can reduce the behavioral and psychological symptoms of dementia often encountered in nursing home settings.[17] Companion robots such as Paro (a baby harp seal robot) draw on the principles of animal therapy and research conducted predominantly in Japan has found that Paro improves patients' moods,[18] facilitates social interactions,[19] and in general leads to higher quality of life for people in retirement care, particularly those with dementia.[20] Furthermore, research suggests that use of Paro can stimulate brain function in people with dementia particularly those who liked Paro.[21] However, more research is needed exploring the effects of Paro with more robust and longitudinal research designs with larger sample sizes and in different cultures.[22,23]

Healthcare robots, aside from providing companionship, may have other features and functions. Many people with dementia may benefit from music therapy[24] and reminiscence therapy[25] or by participating in meaningful and engaging activities.[26] Hence, robots which have the capability to interact with users and offer music and photographs may represent a new way of facilitating reminiscence, providing cognitive stimulation, and decreasing behavioural problems. There are several robots currently in development,[27,28] which offer not only entertainment and games but also have the ability to monitor health, remind residents to take medication, perform helpful tasks, and guide residents around their environment, overall offering an improvement in quality of life.[29] Preliminary research has found that a robot capable of greeting elderly users, taking vital signs, telling a joke, playing a music video, and asking about medication management is highly rated as acceptable to cognitively capable users.[30] However, more research is needed to develop applications on such robots for elderly populations, and little research has focused on those with dementia.

Overall, healthcare robots that facilitate communication, stimulate attention, and help staff care for patients to the best of their abilities may be very useful. However, for such robots to be successful people have to be motivated and capable of using the robot as well as comfortable with the robot.[13] The aim of this exploratory research is to introduce two robots (Paro and Guide) to people with dementia, their caregivers, and relatives in the setting of a dementia long-term care facility to determine if the robots are acceptable and if not to understand what it is about each robot that could be improved for this setting. Guide robot was designed for cognitively capable older people and has not been used with people with dementia before making this the first exploratory study with a robot with these capabilities. Paro has been used in Japan, Italy, and the US with people with dementia where the comments and behavior of the residents has been analyzed and video recorded on being introduced to Paro.[16, 31–33] No studies to date have sought the opinions about the suitability of the robot for people with dementia from relatives of residents or from caregiver staff, although in Japan some research has been conducted with occupational therapists for the elderly where their opinions about Paro were analyzed after they introduced to the robot.[34] The aim of this research, therefore, to is to explore reactions to two healthcare robots to determine how robots may be made more useful for patients with dementia and their caregivers.

Methods

Setting

The study was conducted at a retirement home, in Auckland, New Zealand, in a secure dementia care unit housing up to 16 residents (there were 15 residents at the time of the study). As part of a large ongoing research trial, the managers of the retirement village and the dementia unit were approached by the researchers to see if they would be willing to participate in a short exploratory study. All of the study sessions were conducted over 1 week to minimize the disruption to the facility. Ethics approval was obtained from the University of Auckland Human Participants Ethics Committee and written informed consent obtained.

Participants

Participants were 10 residents (five males, age range 71–93 years), 11 of their family members (seven males, age range 42–88 years), and five female staff members (age range 45–66 years, length of employment 4 months to 14 years).

Procedure

This was a cross-sectional study. Each participant took part in one study session, which took approximately 1 hour. During this session Paro and Guide Robot were introduced by the researchers in a randomized order to the participants in the lounge of the dementia unit, with the first half of the session dedicated to the first robot and the second half dedicated to the second robot. Staff sessions were held individually, while each resident was accompanied by their family members. Participants were given a brief, 5-minute demonstration on how to interact with each robot before being encouraged to interact with each robot by themselves for 10 to 15 minutes. When introducing Guide to the participants, the researcher demonstrated how to register her name on the robot, then explained how to make a phone call on the robot, how to access the retirement village website, how to take blood pressure, how to access the health diary, how the games on Guide worked, and the other entertainment aspects of the robot (playing a song, looking at historical pictures, funny pictures, and quotes). The researcher returned to the welcome screen and invited the participants to use the robot to try some of the functions. She assisted the participants if they needed help and suggested a function they may like to try if they were unsure of what to do. When introducing Paro, the researcher held Paro so the participants could see it. The researcher explained the capabilities of the robot and told the participants that the robot was designed to be comforting and interesting like a pet and overseas research has found this to be the case. She then invited the residents to touch and hold Paro. A 15-minute semi-structured interview for staff and relatives followed the use of each robot. For each robot, the participants were asked eight questions: what they thought about the robot, how the robot made them feel, what they liked and disliked about the robot, what they thought about the size and look of the robot, whether they thought the robot was useful, how the robot could be made better,

and what would be most useful for any robot to do this in setting. The interactions with the robot were video recorded by a research assistant, and the videos were reviewed and transcribed verbatim by the lead author at the University.

Paro

Paro is an advanced interactive robot developed by the Intelligent Systems Research Institute (ISRI),[35] a leading Japanese industrial automation pioneer (see Fig. 1a). Paro is modeled after a baby Canadian harp seal and is covered in white fur. It weighs approximately 2.7 kg. Paro has four senses; sight, sound, balance, and touch meaning that Paro responds to contact, as well as to other stimuli in its environment by moving or imitating the noises of a baby harp seal. Paro operates by using the three elements; its internal states, sensory information from its sensors, and its own diurnal rhythm to carry out various activities during its interaction with people.

Guide Robot

Guide Robot is a 1.6 meter tall robot manufactured by ED Robotics Company in Seoul, Korea (see Fig. 1b). It has a head and a large touch screen for interaction. The robot interacts with the user by speaking, displaying messages/images/video/text on a touch screen and accepting user input on the touch screen. Guide can be programmed with software applications, which currently include: the ability to take vital signs (such as blood pressure) and store them in a database, entertainment (music videos, quotes, photographs), telephone calling to phone numbers using Skype, and brain fitness games. The feedback from this research may give guidance to improve the software applications for use in dementia care.

Analysis

The videos of the residents' behavior were analyzed by the lead author with a stop watch where the amount of time the resident performed certain behaviors (touching, looking and smiling at the robot) over the total interaction was collated and a percentage was obtained for the total amount of time the resident performed certain behaviors. The number of residents out of 10 who touched and talked to each robot was also noted. Other behaviors were counted to see how often they occurred during this period (number of times the resident talked to the robot, number of times the resident talked about the robot to others, the number of times the relative commented on the robot to the resident and the percentage of times the resident responded to them and the number of times the relative encouraged the resident to interact in some way with the robot and the percentage of times the resident did what was suggested). Additionally, the overall time spent with each robot was timed.

To compare the two interactions matched paired *t*-tests were used for parametric data and Wilcoxon signed ranked tests were used for non-parametric data. McNemar χ^2 test was used to compare the number of residents who did or did not perform certain actions with each robot.

The first author thematically coded the interview responses of the relatives and staff members for each robot, and the last author reviewed these themes. The dominant recurring themes that emerged from all questions related to acceptance and suggestions for improvement. The overall acceptability of the robot was predominant when participants commented about what they thought about the robot, how it made them feel, what they liked about the robot, whether they thought it was useful and whether they thought the appearance of the robot was acceptable. The improvements theme was predominant in response to questions about what aspects of the robot could be made better in general and in terms of what they disliked, the appearance, shape and functionality of the robot and what they thought a useful robot in a dementia setting should do.

Results

Resident Reactions

Table 1 and Figure 2 show the results of the resident interactions with each robot. Residents responded to Paro by smiling, touching, and talking to the robot significantly more often than to Guide. Guide robot was used for longer than Paro overall, which reflects the amount of time it took the researcher to explain and demonstrate all the applications on Guide.

Furthermore, all of the 10 residents touched Paro (100%) where as only four touched Guide (40%) (X^2 (1, N = 10) = 6, P = .031). Six residents talked to Paro (60%) but only two residents talked to Guide (20%) but this was not significant when tested using McNemar χ^2 (χ^2 (1, N = 10) = 2.67, P = .219).

Staff and Relative Perspectives

Overall Impression of Robots

Relatives expressed amazement at the capabilities of Paro and made more enthusiastic, positive comments about Paro in

Fig. 1. (A) Paro. (B) Guide robot.

Table 1
Comparison of interactions with Paro and Guide

	Paro	Guide	t/z value	*P* value	r
	Mean (SD)	Mean (SD)			
Interaction time					
Time robot is in use including demonstration in seconds	962 (549)	1250 (450)	t = −2.45	.04*	0.63
Time of resident and relative interaction in seconds	846 (557)	730 (450)	t = 0.30	.77	0.10
Relative and resident interactions					
Number of encouragements from relative	12 (17)	12 (17)	z = −0.31	.76	0.07
Number of positive response to encouragement	3.4 (2.5)	5.4 (8.4)	z = −0.06	.95	0.01
Number of comments by relative about robot to resident	23 (25)	34 (25)	z = −1.12	.26	0.25
Number of resident responses to relative's comment	15.4 (16.8)	20.7 (16.5)	t = −6.81	.51	0.22

*Difference is significant at the 0.05 level (2 tailed).

comparison to Guide. Comments about Paro centered on how the robot was beautiful looking and had especially lovely eyes, was lifelike, tactile, and they could see the robot being used in this setting:

> Relative 4: "I think it's a good concept. Particularly, um, suited to a place like a dementia unit. Because it's tactile and its, it's an animal."

> Relative 8: "I think the concept and the reality of Paro is really successful. I can see Paro having lots of um, positive, and affirmative benefits in, a community, a dementia community as well as elderly in general."

Staff members also gave Paro a warm reception and could see it as a tool they could use in this setting:

> Staff Member 4: "I think this is ideal."

> Staff Member 5: "This I could see here."

However, some relatives did comment that interaction with Paro was reliant on how the resident bonded with Paro. One relative after observing his father with Paro commented that his father was not an animal person, nor was he the type to cuddle soft toys. Similarly, another relative commented about Paro:

> Relative 5: "I think it's great. And I think if it is for the right person, like if there is a connection, like if Mum liked it then it would be fantastic for her, but I guess it just depends on the individual and how they react to it."

Overall, Paro was praised as a stimulus, which would keep people entertained. Specifically, Paro was thought to be useful because it could calm residents down if they were upset. This was observed when a staff member was interacting with Paro and a resident came into the lounge crying. After the resident sat with Paro on her lap, she became visibly calmer and the staff member commented that it would usually have taken much longer to handle that situation. Other comments centered on how Paro would be useful because it is comforting, amusing, creates interest, and interacts with residents like an animal but will not try to escape the resident like a real animal might:

> Staff Member 4: "Because it's almost real, whereas if it was real it wouldn't sit there. It'd be gone and... You know like the cat, won't stay put. It takes off and...Whereas this one will stay with them. And the fact that it reacts with its voice and what have you, it um makes them think it's real."

> Relative 6: "I think that it's ah, gets them all focused and thinking about something else, which is going on around here. Especially in this particular unit...It'll have a big impact because they will all feel attached to it."

In contrast, although family and staff members evaluated positively and recognized the potential benefits of Guide, it was thought to be unsuitable for people with dementia:

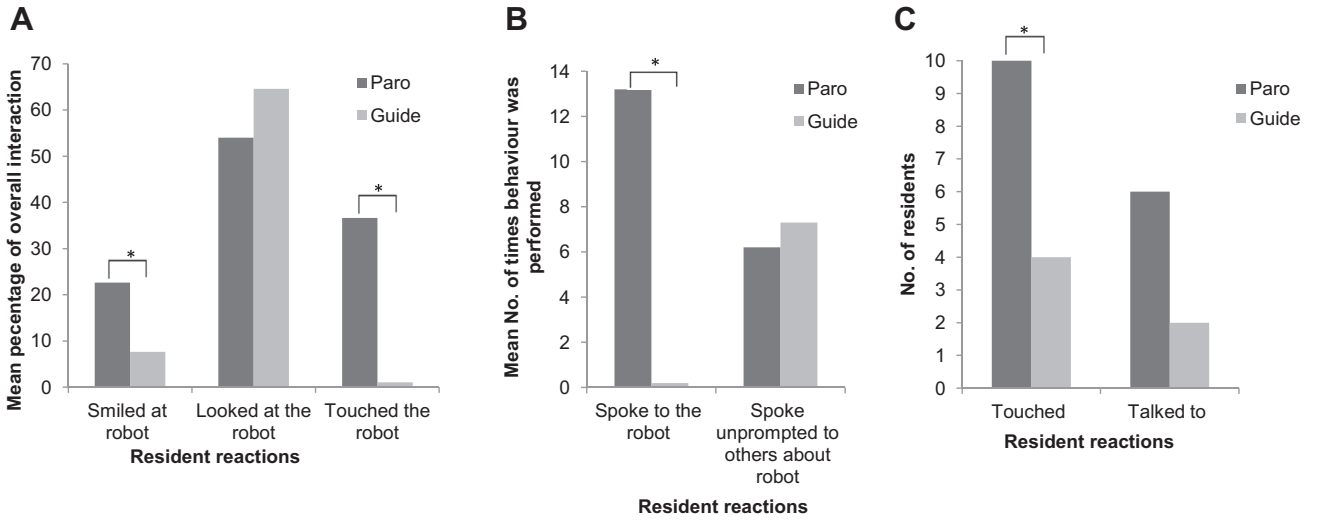

Fig. 2. Differences in resident reactions to Paro and Guide. (A) Differences in resident reactions to Paro and Guide as shown as a percentage of the total interaction time. Significant differences found using matched paired tests are indicated by * ($P < .05$). (B) Differences in resident reactions to Paro and Guide as shown the number of times the residents performed behaviors. Significant differences found using are indicated by * ($P < .05$). (C) Differences in resident reactions to Paro and Guide as shown the number of residents who engaged with the robot. Significant differences are indicated by * ($P < .05$).

Relative 1 "It, it, it's got merit. I suspect from my little knowledge of the dementia side of things that you're probably going to struggle for it to be...suitable for patients"

Staff Member 5 "I think it's a good idea but I can't see our residents using it. With the, the way they are, they wouldn't remember. Some of them I think still can't...well they've got to the stage where they can't read...um. But... hmm, I think for other parts of the village, yea fine. But for this specific area here, this one here, no I can't see them using it."

However, to one staff member this did not pose a problem as she viewed herself as using the robot with a group of residents as an activity and it did not matter if they were not directing the robot as they would still be involved. Thus, it could be a tool to facilitate activities:

Staff member 3 "It's useful because there are lots of things in there, to do in there so you don't get bored. Sometimes, you know, you think what is next to do in your activities with the residents. This is helping. Just press it and 'Oh yep, let's go to this.'"

Many relatives and staff commented Guide could use further development so it could be more suitable for residents and caregivers. Despite this, they also reasoned that Guide would be useful because it has a variety of functions that it would be used differently by each person meaning it could be personalized to the resident's wants which would be advantageous:

Staff Member 2 "Well, for here the activities are individual. That you can interact with one resident and do an individual program that's geared at them that is interesting to them rather than um, entertaining the whole room. It's quite beneficial"

Relative 2 "It's quite nice being able to...to sort of have a personalized have one on one, you know and bring up the stuff you want to see, you know and play a game or whatever."

From the comments collected, it can be deduced that entertainment would be the main function of a robot like Guide with many praising the music as well as the photographs and games sections because it would stimulate interest, keep residents focused, and prompt conversations as was observed during many interactions.

Improvements to Robots

Overall, both robots had the potential to be useful in a dementia setting. However, there were a number of suggestions as to how the robots could be adapted so that they would be better suited to people with dementia. Both staff and relatives though that although it was good that Paro could make noises, but seven relatives and two staff members commented that the noise it makes may be distressing for residents as well as a worrying noise for staff:

Staff Member 4 "Just work on the sound I think...that's the only thing that I can think would be a down. Cos you know, it's nice for the ones who are holding him but the ones in the background and they, you know they... sort of gets on their nerves. Cos um, certain noises do affect people with dementia."

Relative 6 "I think maybe his calls might sound a bit distressing for these guys and they feel a little bit stressed by it...Probably sounds too real, you know. That's probably exactly what they sound like... Sounds like he doesn't want to get eaten by a polar bear."

Consequently, five relatives and two staff members commented that it would be nice if Paro purred and because many people would not know what an authentic baby seal sounded like people would not have expectations about how it should sound. An animal that purred would be more soothing for the resident and may give more meaning to the interaction. Other common suggestions to improve Paro involved making it slightly smaller as five relatives and three staff members thought it appeared to be too bulky for some residents. Lastly, three relatives and one staff member thought that Paro should be easier to wash especially since Paro is white it would get dirty quickly.

Guide was also criticized by four relatives and two staff members for being large with relatives commenting that Guide would be better as a smaller computer touch screen application, such as a laptop or I-pad:

Relative 4 "Well it seems awfully big for the capabilities in terms of you know, you could have an I-pad or a big touch screen that would do the same things as this does. Really all this is just supporting it..it's not actually doing anything is it?"

However, four relatives and two staff members commented that Guide was better being bigger because people would not overlook Guide and many people could gather around the robot. However, the ergonomics of Guide was disliked by nine relatives, because in being tall and having a screen which is tilted backward it was difficult for people sitting in front of Guide to see and touch the screen:

Relative 5"I think the reflection on the screen is a bit...you know it makes it difficult for people to see."

Relative 10 "I think maybe it is a bit big or if it could be put forward a bit more so it's straight up and down. It could be closer to Mum then she could do it all herself. But if she leant forward now she would probably fall out of her chair."

Apart from the design of Guide, there were also a variety of comments about how the applications could be made better. Overall, the entertainment applications on Guide were enjoyed by all participants. The music was particularly liked with all the relatives and three staff members playing songs for residents. However, six relatives and three staff members had suggestions as to how the entertainment applications could be improved. Suggestions included enlarging pictures, making the games more generation appropriate and slower, having more personalized information, and having Guide say the quotes. The use of the blood pressure device was an application, which had debatable use as two staff liked that Guide robot could measure blood pressure but never measured their own blood pressure. Of the three staff members who did take their blood pressure, two expressed their concern about the length of time it took and the tightness of the cuff and the other staff member thought the application was fine to use but not appropriate for a dementia ward. Relatives also had a varied reaction to the blood pressure function with three saying it seemed unnecessary and that residents could not use it whilst six others thought it was a good function. Lastly, Guide was criticized by eight relatives and four staff members for being too complicated, especially when registering one's name, meaning that Guide needs to be simplified so residents can use it despite many people commending the robot in being easy to use:

Staff Member 4 "If it could be adapted to people with dementia it would be good. But didn't know how you'd... adapt it anymore you know...It's simple but you know it's just they've got two choices where they've got...You know, there's a lot of choices on there for which button to press and that would throw them."

Finally, one important point was raised by a relative reflecting the purpose of this study. Robots in a dementia ward have to further enhance the setting by offering service over and above what is already available and which is useful for the staff and residents in the dementia unit:

Relative 8 "It's that question of whether what, what lack does it fill? What purpose is it filling which is really lacking and really needed in the community."

Discussion

The main results of this study are that residents looked, smiled, and talked to Paro more than Guide. Relatives and staff thought Paro was more appropriate in a dementia setting and that Guide needed to be refined to make it more simple and ergonomic for people with dementia. This confirms the need for Guide's applications to be tailored for dementia care, rather than the current design which is intended for cognitively capable older people.

At present, similar technologies for people with dementia are being developed and trialed, focusing on the benefits of music therapy and reminiscence therapy. For example, research trialing a multimedia reminiscence package on an LCD touch screen which displays photographs, songs, video clips and music has been successful although using items of personal relevance would make the system better and more engaging.[36] All of the patients were able to use the touch screen application with the help of caregivers suggesting that if ergonomic changes were made to Guide residents would be able to use the robot touch screen. Similar packages have been trialed with people with dementia by other researchers,[37, 38] which have found that such systems had a favorable impact on engagement with others, stimulated positive affect, and communication. Research such as this, combined with the feedback about Guide, suggests that such systems could be useful in decreasing caregiver burden as well as stimulating residents and even giving them a sense of autonomy and control in choosing what they listen to or look at. Such empowerment is thought to be important to older people[39] and as noted by one relative may be important for people with dementia who have very little control over activities in their lives. Intellectual stimulation has been found to decrease cognitive decline[15] meaning that Guide may have many benefits if properly adapted.

In comparison to Guide, Paro was very warmly received. Residents had a favorable reaction to Paro, specifically touching, smiling, and talking to Paro significantly more than Guide indicating that residents were able to relate to Paro and form an attachment to it. Research has found that there are physical health benefits to stroking animals[40], particularly those one has an attachment with,[41] and experimental research looking at the tactile aspect of Paro found that the texture of the fur has positive effects on the mood of participants.[42] Over a longer period of time, Paro may have health benefits for people similar to how people who interact with animals report benefits in psychological and physical well being.[43] Not only does Paro have to be beneficial for residents but when considering using Paro in such settings, it is important that staff are willing to use Paro and have a positive attitude toward the robot. In this research, it can be seen that staff are receptive towards Paro after using it, however, they do have some concerns, which have not been brought to attention in past research. In this small sample many participants disliked the noise the robot made but similar comments have been highlighted in just one previous study.[34] It is suggested that Paro is reprogrammed to sound more content and less distressed by enabling the robot to purr. As Paro is purposefully designed to be an unfamiliar animal,[31] people will have few expectations as to how it should behave, feel, or look, and it follows that people will not have expectations of how it should sound so by making the seal sounds less distressing it may increase the positive effects of the robot. This research is notable in contrast to other research as, although Paro has been used with success in rest homes,[20] the opinions of relatives and staff have not been explored, and it can be seen that they have valid concerns and suggestions. Future research should address these concerns to develop a robot appropriate for a dementia setting. In addition, future research needs to consider whether Paro is helping to address problems in the environment and whether other technologies with different functions would be more appropriate. In comparing Paro and Guide, this research shows what is wanted and needed in a dementia ward and would be useful for staff and residents.

This research has several limitations. It was conducted with a small sample and is cross-sectional; it is not known if the robots would evoke the same reactions as time goes on. At times, Guide had a programming error where the robot unexpectedly took the user back to the registration screen and the user would have to register their details again before continuing. This affected how long people used Guide for as many people stopped using Guide when faced with the re-registration process. Lastly, because the resident and their relatives were together during the robot interaction there was no condition to determine how the resident would interact with the robot if left to use it by themselves. Often the relatives decided when the robot should be turned off rather than the resident. The aim of this study was to explore reactions to two healthcare robots to determine how robots may be made more useful for patients with dementia and their caregivers. Results showed that there were differences in reactions to the two kinds of robots, and the dominant themes that emerged from the interviews related to both how acceptable they were and suggestions for improvements. These two themes appeared to naturally link together. We consider that these results support the validity of our approach. The design and analysis were performed by researchers who had no proprietary interest in either robot. The study focused on the positive and negative aspects of both robots, and was therefore not biased in either direction.

Conclusion

Overall healthcare robots have the potential to help meet the needs identified by staff and relatives for people with dementia in being entertaining, stimulating, and calming, making life better for both staff and residents. More development is needed with input from this target population to refine robotic interventions with robots designed specifically for patients with dementia. It is concluded that a revision of the sound and size of Paro should be considered to make it more acceptable. For Guide to be suitable for people with dementia a number of aspects of the robot have to be altered as the ergonomic design of Guide may not be suitable for older people, and the software applications could be simplified and more targeted to people with dementia. Guide should have larger pictures, more entertainment, games targeted to people with dementia, personalized information, simplified registration, and overall improved usability.

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