

## A personal assistant for dementia to stay at home safe at reduced cost

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**Purpose** This paper presents the results of an evaluation of the commercially available PAL4-dementia system, a supportive touch screen for people with dementia. The main purpose was to study the advantages and disadvantages of the system from the perspective of the client, family and professional caregiver and the potentials to upscale its use. **Method** The evaluation was conducted over 9 months with 16 clients of 2 healthcare organizations in the Netherlands. A mixed-method design was used in this pilot, involving log files of system use, interviews with family caregivers, a focus group made up of professional caregivers, observations of project group meetings and a cost analysis. **Results** Clients and family caregivers reported good support of daily life activities. They thought the system could help the client to live at home for a longer period of time. The cost analysis showed monthly savings per client as compared to living in a nursing home ranging from around € 820 (10 clients) to € 860 (50 clients). Despite these positive results, numerous problems were detected: (i) interruptions of technology, (ii) insufficient operation knowledge of professional caregivers, (iii) insufficient active involvement of family caregivers, and (iv) limited user friendliness of the lay-out.

**Keywords:** eHealth, dementia, touch screen, cost analysis, care delivery

The use of eHealth for people with dementia has received substantial attention in recent years due to the rapid rise in the number of people with dementia and the challenges of developing technology to support clients with dementia. Worldwide, an estimated 35.6 million people suffered from dementia in 2010, with this figure expected to rise by 115.4 million by 2050. In 2010, the global costs attributed to dementia were 604 billion US dollars<sup>1</sup>. A change in the care for people with dementia is clearly necessary in order to control costs and to improve quality of care.

### TECHNOLOGY AND DEMENTIA

Technology applied effectively can allow people with dementia to live at home longer, resulting in improved quality of life, social interaction and significant cost-savings<sup>2-7</sup>. Nijhof et al.<sup>2</sup> conducted a literature review to investigate how different technologies can support dementia care most effectively. Monitoring and signalling technology appeared more suitable for people in a severe stage of dementia and provides a feeling of safety, both for them and their families. Social contact technology is most useful when it is

used for people at the early stages of dementia and can be used to improve their quality of life<sup>2</sup>. Technology can help clients stay at home longer which is often a more cost-effective and convenient option than admission into a nursing home<sup>3</sup>.

Research on the application of social contact technology has shown that it is engaging and enjoyable for people with dementia and caregivers, and may encourage people with dementia to remain actively engaged and participating in their normal lives with friends and family<sup>4</sup>. Furthermore, social contact technology might also increase the caregiver's enjoyment of the interaction<sup>4,5</sup>, which could also improve the quantity and quality of social interaction. In terms of other features, one study, that of Meiland et al.<sup>6</sup>, found that useful functionalities for people with dementia for a touch-screen interface included the capability to set reminders, the ability to navigate a phone directory by photographs, support for leisure activities, and safety warnings for when, for example, the front door was not closed. These findings were based on literature research, workshops and interviews.

Generally, there is a lack of scientific evidence about the overall impact of eHealth in health-care in general<sup>8,10,11</sup> and it is in this context that the present research was conducted.

## Aim of the study

This paper presents the results of an evaluation of one care technology, the commercially available PAL4-dementia system (PAL4 BV, Driebergen-Rijsenburg, the Netherlands). Its main purpose is to investigate the advantages and disadvantages experienced by clients and caregivers and to identify possible improvements. Insights from the study of this system have implications for eHealth home care systems in general, because of the similarities in implementing an eHealth technology.

The following research questions were asked: (i) Which activities are undertaken for introduction of the system? (ii) What uptake has this system in relation to usage and usability? and (iii) What impact has the system upon health care delivery, well-being and cost savings?

## METHODOLOGY

To address these questions we used a mixed method design to gain a rich picture of the effectiveness of the system. For the evaluation of an eHealth application a mixed-method approach is often the best option, since it combines both qualitative methods and quantitative methods<sup>9,12-15</sup>. The data from the different sources can complement one another to provide a broader view<sup>15</sup>. For example, details about the results of usage log files can be asked during in-depth interviews. To answer the questions, the usage log files, interviews with family caregivers, a focus group made up of professional caregivers and observations of the project group meetings have been used. To assess cost savings, we carried out a quantitative cost analysis comparing the costs of living at home and using the system with the costs of living in a nursing home.

## Theoretical framework

The successful development and deployment of eHealth technologies requires a rich and multi-faceted approach to the design and evaluation of these technologies. In particular, van Gemert-Pijnen et al.<sup>16</sup> have proposed the CeHReS-roadmap as a holistic approach for the research and development of eHealth technology moving from contextual inquiry, value specification, design, operationalization to summative evaluation. The main topics measured for uptake are: usage behavior and usability. Impact in this study is related to the influences of the system on healthcare delivery, well-being and how it affects the costs. The well-being measured in this study is perceived well-being. For the clients' well-being subjects related

to leisure, doing things independently and staying home for a longer period of time were asked. The well-being of the family caregiver was measured by support and reduce from burden of care. For health care delivery we looked into detail about the way professional caregivers used the system, as related to the impact on their work process. The cost savings were measured by comparing the costs of technology and homecare with staying in a nursing home (on a monthly basis).

Since PAL4-dementia was already an operational system, a summative evaluation was conducted. This means that the evaluation could only be started from the point of introducing the system to the client, implementation, and subsequently, through to the operation and maintenance of the system. Since the introduction and implementation of such a system has a strong effect on its impact<sup>17</sup>, these phases are of particular interest. In addition the usability results will be used to optimize the system to users' needs.

## Describing PAL4-dementia

The system is used as a supportive and social contact technology<sup>2</sup>, and provides daily organizer functions, specific 'PAL4 features', and video contact with caregivers or family. It can be obtained as a general assistant for healthy elderly clients, or as a specific one, such as the PAL4-dementia used in this study. The features used in PAL4-dementia were chosen and decided by several experts in the field of dementia care: a nursing home doctor and two homecare nurses with expertise in caring of people with dementia<sup>18</sup>. The features were built by PAL4 BV employees.

The basic system has been sold in the Netherlands to approximately 1000 older adults, while the dementia version is currently in use by around 50 people<sup>19</sup>. In the dementia version, a touch screen is used which shows people an agenda of their day, a diary, a life album and a 'PAL4 button'. Pressing the PAL4 button opens a menu with memory games to play, information about dementia, and information for the client about their own village where they live. The system also provides two-way video contact with family or professional caregivers. PAL4-dementia was specially designed to be less complicated and easier to learn than the system for healthy older adults. Its purpose is daily use to improve the well-being of clients by doing daily activities independently, improving the well-being of family caregivers by supporting them in their care to create less burden, and with this all let people with dementia live home for a longer period of time.

The interactive touch screen consists of a touch screen and so-called Bidi box, which is a little box creating the secured two-way video con-

nection. The touch screen first shows the start-up screen (*Figure 1a*). The first line of text is used for entering the program (PAL4 button), the second line is used for making video contact with a professional caregiver, the third line is used for video contact with a family caregiver, and the last line is used for television. This PAL4 TV button may access live television broadcasts, for example a church service that people can watch live. This feature was not assessed in this study. Touching the PAL4 button, the PAL4 Dementia features become available. It shows the agenda, life album, diary and PAL4 (*Figure 1b*).

The button agenda (*Figure 1c*) shows all the appointments till 15:00h, after 15:00h the screen will refresh itself and show the appointments after 15:00h. In the agenda a pictogram of the activity can be seen, an analog clock of the start and end time of the activity, and a personal message. On the side, the actual time, day, date and season (with a pictogram) can be seen.

The life album (*Figure 1d*) has four options: watching pictures, reading your personal history story, watching movies and listening to music.

The diary (*Figure 1e*) itself can be used for writing the diary or reading it. Persons with dementia, family caregivers and professional caregivers are allowed to write and read in this diary.

Touching the last button, PAL4 (*Figure 1f*), reveals information about their own village, health and housekeeping, shopping (online shopping features), leisure (for example playing memory games), and family and contact (watching movies from other PAL4 members or meal preparation videos).

On the family caregiver website caregivers can enter appointments in the agenda, create a personal history story, upload pictures in the life album or read and write in the diary. The website can be reached from a family caregivers' own computer by internet through a specific password. There is no limit of the number of family caregivers who connect. The touch screen itself also offers the option to access this website, a feature developed because several clients had a family caregiver who was a partner living in the same house and did not have a computer. The website for the family caregivers has been made in the same easy-to-use style as PAL4 itself because family caregivers generally tend to be seniors, with less experience with computers.

To install the system, a basic internet connection (512 kb/up) is necessary. If people did not have this connection the healthcare organization would pay for its installation and use. The system

itself was paid for by the healthcare organization with financial aid from the Dutch Healthcare Authority (supervisory body for all the healthcare markets in the Netherlands).

## Installation of the system

The PAL4-dementia system was installed by a technician who made an appointment by phone and on a specific date and time went over to the clients' house. The procedure took around three hours and included the explanation of how the system works. The technician would leave a paper manual at the person's home; a short manual with the four buttons, the description of what was behind these buttons, and a more extensive manual with all the information people could find behind the buttons. One or two days after the installation an occupational therapist would come by to explain the system further and help the client work with it in daily life. For questions or interruption of service, people were able to phone to or make video contact with the service desk of the company that was only open during office hours. If an interruption of service occurred, the technician would log into the system and first try to resolve the problem online. If this did not work s/he had to visit the client to solve the problem.

## Study participants

Two homecare organizations participated in this study. None had used the PAL4-dementia system earlier.

The project group consisted of 11 members (9 females, 2 males): 2 nursing home physicians, 5 nurses, 2 project managers, 1 occupational therapist and the first author. None of them had prior experience with using touch screens for people with dementia. The members consented to observation during their meetings.

The clients for this study were selected by professional caregivers of the participating homecare organizations. To be included in the study, a client (i) had been diagnosed with dementia or had shown signs of being more forgetful than most people of their age, (ii) was likely able to continue to live at home for at least 9 more months, (iii) needed care from one of the participating homecare organizations, (iv) spoke and read Dutch, and (v) was considered capable of using the system. Clients with other cognitive disabilities, for example Parkinson's disease, were excluded. In total 16 clients participated, eight from each homecare organization. An informed consent declaration was signed by the client or responsible relatives to allow for using the log files of the client.

10 female and 6 male clients participated. The age from the clients ranged from 58 to 86 years, with a

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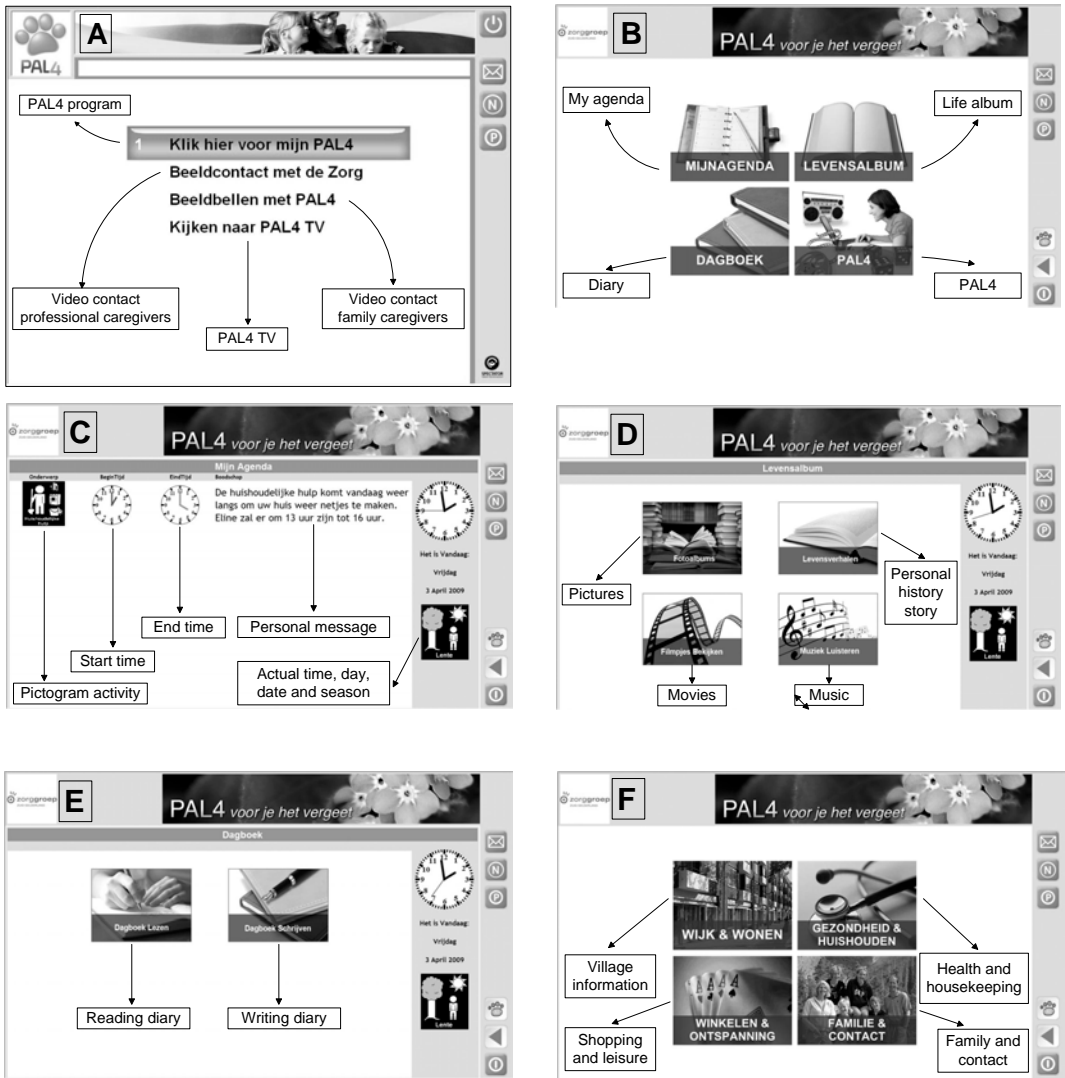


Figure 1. Client's interface; a: Opening screen; b: PAL4-dementia program; c: Agenda; d: Life album; e: Diary; f: General program

mean of 78 years. Their Mini-Mental State Examination (MMSE) results ranged from 13 to 29 with a mean of 22 (1=severe dementia and 30=no dementia)<sup>20</sup>, with 1 missing score (because the caregivers found testing too upsetting for the client).

The family caregivers' age ranged from 35 to 79, with a mean of 58 years. The relationships between client and family caregiver differed: seven daughters, four sons and five partners. The number of years caring for the client varied from 2 to 12 years, with a mean of 4.5 years. For 9 clients there was no family caregiver. 4 family caregivers had a low-level education (high school), 4 had mid-level education (college) and 9 completed a high-level education (university). Selected clients would be invited, together with their family car-

egiver, to have the system installed in their home and use it, as well as to be interviewed.

After several months of using the system, a focus group was organized by the first author. The main reason for installing this focus group was to gain more insight from the perspective of the professional caregiver in relation to the uptake (usage and usability) and impact (well-being and healthcare delivery). It consisted of two nurses who trained the clients at their home in using the system (from one participating organization), and the project manager and occupational therapist (of the other organization). In age they ranged from 39 to 46 years, with a mean of 44 years. Two members had a mid-level education and the other two a high-level education.

## Study design

A field observation was conducted between August 2008 and December 2010. The first health-care organization started project-group meetings in the fall of 2008, while the other started at the end of 2009. The actual installation of the system followed a few months later in both cases. The log files were analyzed from the first nine months of a person using the system. The interviews and focus group meetings took place at the end of 2010. The clients started to use the system at different times. This is the reason for the broad range of time for collecting data.

## Data collection

### *Project group meetings*

In total, 24 project group meetings were held, ranging from approximately one to two hours in length. These project groups gave insight in the introduction, uptake and impact of the system. The first author made reports of these meetings. At the start of the projects these meetings were about introduction issues (how to start up the project, who should be involved, how to recruit clients), later on the subjects changed to actual experiences and problems with using the system.

### *Log files*

For each client the log files of system use were collected for the first nine months of use. They showed the total number of clicks a client made at each level of the system. The following limitation became obvious: to use a game a client had to click on three buttons in succession: 'PAL4', 'shopping and leisure', 'games', before s/he could select a specific game to play.

To answer the question related to usage the focus was on the total usage of the different features, the time of use and the amount of use. Because of the different users with different personal characteristics a more specific analysis was done for the use of the different features by these users.

### *Interviewing family caregivers*

In each case family caregivers were interviewed by the end of this study to answer questions related to introduction, uptake (usage and usability) and impact (well-being and healthcare delivery). Sometimes the client presented some comments during these interviews. These comments have been included in the transcripts. Questioning the clients with dementia alone about the system was not considered a valid option for data collection because of their cognitive impairment.

### *Focus group of professionals*

The focus group meeting took about 90 minutes, and consisted of a structured set of topics related to the research questions, whereby the researcher

had the function of moderator. The focus group comments were summarized by the moderator.

### *Cost analysis*

One of the main purposes of this study was to get more insight in the direct cost of living at home with the system in comparison to living at a nursing home (impact related to costs). All costs related were collected in Euros. Depreciation of investment (purchase and installation of equipment) was calculated over 5 years:

- (i) Living in a nursing home (in the Netherlands there is a legally fixed price for the expenses of a person with dementia living in a nursing home);
- (ii) Touch screen and installation;
- (iii) Subscription for the use of the system and internet connection
- (iv) Homecare for the clients
- (v) Monthly fee for services, such as trouble shooting
- (vi) Monthly expenses for the professional caregivers to use the system, including house visits and video contact (number of hours per month multiplied by the wages of the caregivers)

## Data analysis

Overall the interviews, focus group and project group meetings were used to answer the questions related to uptake (usage and usability) and impact (well-being and healthcare delivery). The log files were used to gain insight in the usage of the system. At last the cost analysis was used to answer the question related to the impact and specifically the cost aspect.

The interviews with the family caregivers were coded in a coding scheme related to the full range of research questions: usage, usability, healthcare delivery and well-being. The transcripts were read by the first author several times to capture the experiences of the family caregivers, and to aid in the development of the coding scheme. A research assistant also coded the interviews to overcome potential researcher-related bias and improve reliability. The focus groups with the professional caregivers and the project group meeting reports were coded in the same coding scheme. Again, the transcripts were read several times in their entirety to capture the experiences of the caregivers to aid in identifying the coding scheme.

In total there were 7 complete 9-months log files and 7 incomplete files. 5 persons used the system for 8 months, 1 person for 4 months and 1 person for 3 months. For 1 person the log files were missing, because the person quit earlier in the project and the log files were not saved due to regular clean up actions by PAL4 employees. For another person there were no log files, be-

cause the PAL4 system was not used by the client and removed after about 3 weeks. Therefore only 119 months of logs of using the system became available for analysis.

Overall the log files were used to get insight in the general moments and features of use and specifically to see different patterns for different persons. The first analysis consisted of sorting the number of button presses in the morning (6:00-12:00h), afternoon (12:00-18:00h), evening (18:00-24:00h) and night (0:00-6:00h). Secondly, the number of clicks on the start screen was sorted by the main button pressed. In case of the PAL4-button the underlying buttons were taken into account: shopping/leisure, health/housekeeping, village information and family/contact, as well as the clicks of family caregivers to fill in the agenda. After these general analyses of the logs, the information was split up for every person to see the percentage of days each client used the system and the personal average of the clicks per day on use days. Finally an analysis of the logs was done for differences in use for every feature separately and differentiated per user.

For the cost analysis these calculations were made: (i) Total governmental or health insurance expenses for someone living at home with the system; (ii) Total governmental or health insurance expenses for someone living in a nursing home; and (iii) Comparison between living at home with the system and living in a nursing home (for 10 to 150 clients in steps of 10 clients; for 1 to 12 months in steps of 1 month; for an increasing amount of home care).

## RESULTS

### System introduction

The interviews, focus group and project group meetings indicated that the way the system was introduced to users needed to be improved in several respects.

First, professional caregivers had to recruit the clients, but having no prior experience with the system, they sometimes had problems explaining it in a clear and concise way. Clients could be recruited by other caregivers not in the project group, but because they did not know much about the system, this did not work out well. Even several family caregivers refused to participate, because they did not think their relative would be capable of using the technology.

Secondly, it was not helpful that the members of the project group changed several times due to sickness, retirement and lack of time. The purpose and working of the technology had to be explained repeatedly.

Thirdly, some of the family caregivers thought the installation of the system was too late in the process of dementia; it would have been easier if clients had been recruited earlier in their disease process, when they were more capable of learning new things. On the other hand, it was stated that higher functioning clients did not really need the system yet and might find it stigmatizing.

In one of the healthcare organizations, the occupational therapist went on long-term sick leave at the beginning of the project, and training had to wait. This was a big drawback according to the family caregivers, because the system was installed in the home but could not be used. A few clients stated that the training by the technician was too quick. They did not have the time to fully understand the system.

### Uptake of use

The system was used most during the afternoon: 44% (14,722 clicks), 31% in the morning (10,534 clicks), 23% in the evening (7,687 clicks, and only 2% (825 clicks) at night. The 'Agenda' was used the most (33%) (5215 clicks), followed by the 'PAL4 button' (28%) (4245 clicks), and below this button the one for 'Shopping and leisure' (24% ) (3680 clicks), then for 'Diary' (4%) (656 clicks), 'Family and Contact' (3%) (446 clicks), 'Life album' (3%) (450 clicks), 'Family caregiver page' (3%) (414 clicks), and 'Village information' (1%) (147 clicks). The 'Health and housekeeping' button was used the least (1%) (143 clicks).

Usage of the system differed among clients (*Table 1*). Clients did not use the system every day. System use varied from 9-96% of the days that the system was present in the home. The average was 48% for the total of 14 clients with log files. Because the system was not used every single day we calculated the mean number of clicks on days of use. It ranged from 4.6 to 46.0, with a mean of 20.2 clicks/day of use for the total of 14 clients with log files.

### Usability

Most interviewed people cited electricity costs as a reason for not keeping the system active all day. In almost all clients' houses, the system was installed at a noticeable, frequently used place, so clients did get a visual reminder to use, but even so, almost half failed to do so regularly. Those people that only started the dementia features when they were actively using the system, decreased its usefulness (according to family caregivers), since the reminder ringtones of the agenda did not work.

Clients regarded the trouble-shooting service as effective. Only one family caregiver mentioned that her relative was so dependent on the sys-

tem that interruptions of service constituted a big problem since the service desk was only open at office hours. In the weekends it could take several days before the service would run again.

Almost all clients and family caregivers considered the system useful. 3 out of 16 clients appeared too advanced in the disease of dementia for effective use. In these cases the relatives stated that the system would have worked when it had come earlier. Other clients, used to their own personal computer, preferred to keep on using that one. Family caregivers would rather enter appointments into the client's agenda over the internet from their own homes, instead of having to go to the clients' house.

Learning to use the system takes time. Some only needed a few learning runs. Most of these clients were familiar with computers. For other clients, less familiar with computers, it could take several weeks before they started to understand the system. None of the clients found using the system intuitive. Five clients had some fear about breaking the system; several reassurances had to be given by the caregivers that pressing any button could do no harm.

Another drawback in usability for clients was the layering of the system, leading to the need to click on a number of buttons in succession. One family caregiver mentioned that her relative could easily find a game on her own computer with icons on the desktop, but failed to do so with the PAL4-dementia system. In addition, games in the system were partly in English instead of Dutch, or in too small print.

## Computer experience

Clients experienced in computer use preferred the mouse over the touch screen. Those wanting to use e-mail through the system requested a separate keyboard instead of the touch keyboard of the PAL4-dementia system. The ringtone for reminders was a source of confusion since it resembled the tone of the telephone.

Family caregivers without computer experience found the user interface easy to use and user friendly. However, family caregivers with computer experience considered the system slow, while making one mistake lets you en-

ter everything again, which was annoying.

Three of the elderly caregivers without computers of their own mentioned that the clients did not use the system much, but that they themselves did. For example, they entered their own appointments, because they had to remember both their own and the client's appointments. They also sometimes enjoyed playing the games for relaxation or looking up information through Google.

## Service interruptions and confusions

Technology interruptions were frequent at the start of the project. Common symptoms: (i) screen freeze, (ii) poor video contact, (iii) slow operation, (iv) opening a website overlapped the whole screen; the only way to exit was turning the system off, and (v) when the healthcare centre was busy and could not take a video call, it would call back later without giving the client the option to accept the call. This last problem was solved later in the project.

The system got a regular update once every few months. With these updates, names and images in the system might change resulting in confusion among the clients. When this update was happening people were asked by the system if the update was "ok" and they had to click "yes". Those confused, immediately turned off the system.

## Professional issues

The knowledge about the system among professional caregivers in the healthcare organization other than in the project group was limited, especially in the beginning of the project, making re-

Table 1. System usage by each client-family caregiver combination in relation to client characteristics and ranked by percentage of use days; n.d.= not done

Client characteristic			System use		
#	Age, Years	MMSE score	Days installed	% Use days	Mean number of clicks /Use day
<b>Women</b>					
1	81	30	247	96	46.0
4	78	24	234	82	21.9
5	76	14	228	75	11.1
12	82	18	73	52	45.4
6	86	25	239	46	26.3
9	88	23	262	19	11.5
10	71	26	255	19	11.8
11	88	23	247	19	7.4
13	79	29	263	9	12.4
15	80	n.d.	258	-	-
<b>Men</b>					
3	58	23	226	95	9.2
2	83	16	254	93	22.4
7	81	17	215	34	4.6
8	65	22	268	25	32.2
14	84	13	114	10	19.9
16	71	25	20	-	-

cruiting clients harder. The professional caregivers in the project group mentioned that they felt a bit like “being alone on the project”. A few months after installation, the homecare nurses who came to the client’s home got to know the system and turned it on in the morning. A small number of professional caregivers coming into the home of clients wrote in the diary occasionally.

The video contact was used rather differently at the two healthcare organizations. At one organization, some house visits were replaced by video contact. The other healthcare organization used video contact as something ‘extra’. One of the clients was even given restrictions about the number of times a day he was allowed to video call the caregivers. Several clients also mentioned that making video contact with a general practitioner would be appreciated.

Related to the well-being of clients several comments were made by both the clients and their family caregivers. For one healthcare organization, video contact with the family and professional caregivers were both possible; for the other organization only the professional caregivers could be contacted by video. The clients appreciated the option of making video contact with their family caregivers, and found it more convenient and enjoyable than making a phone call. But the option of making video contact with professional caregivers was also judged positively. One of the clients mentioned that she preferred having video contact with a professional caregiver instead of all the different persons coming into her house all the time.

## Well-being

For most of the clients, the agenda gave them structure during the day, as they could see the appointments. But for some seeing the day and season of the year was all that was possible, which was also judged positively. Some family caregivers or clients stated that the system had improved the clients’ quality of life.

Family caregivers also saw clients laughing when playing a game at the system and mentioned that the clients did enjoy themselves. They were stimulated by the system.

Also some of the family caregivers said that the system stimulated clients to do things independently, which could help them to stay in their own home for a longer period of time. They also said that admission to a nursing home is mostly prompted by the increasing burden on the family caregiver or a deteriorating home situation. These factors cannot be changed directly by the PAL4-dementia system.

The system did not reduce the burden on the family caregiver, but it does support the lives of clients and indirectly those of caregivers. When family caregivers started using the system, they had to put extra time and effort to enter appointments, content etc., but when this had been done, it could save them time.

A few caregivers mentioned that they liked the option of making video contact instead of going to the clients’ home all the time. One of the caregivers, a partner, also said she had some more time for herself, as the client could enjoy himself with the system.

## Financial aspects

For the quantitative costs analysis, staying at home with support of the system and staying in a nursing home has been compared in relation to cost (Table 2).

If 10 clients live at home with the system one month extra, cost reduction is about € 820/client. A roll-out to 50 clients led to a saving of about € 860/client. However, since the quantity of homecare needed is increasing during the course of dementia, there will eventually be a break-even point at which a nursing home is less expensive. In the Netherlands this point will be reached when the client needs each week 15 hours of homecare, 4 hours of housekeeping service, 3 hours of personal guidance and goes to a day-care centre 20 hours a week; together costing € 5000 (calculation was made in 2010). Only when the client could stay home 11 months longer, would the system be cost-effective (Figure 2).

## DISCUSSION AND CONCLUSIONS

Just like similar systems, the PAL4-dementia system has considerable potential to support persons with dementia<sup>2,4,5,7,17,21-25</sup>. The system in our pilot study has three out of the four features needed<sup>6</sup>: reminding, picture dialing and support for leisure and pleasure. Only safety warnings are missing, for example when someone leaves the gas stove on.

## Technology generation

Technology generation and individual prior experience with computers might explain the large range of usage patterns. Technology generation means that experiences earlier in life with technology (especially until the age of 25) play an important role in using a system. So if a person is into his or her seventies the technology from around 50 years ago plays an important role in how that person deals with technology nowadays<sup>26,27</sup>. Some of our observations correlate with this fact of technology generation. The clients having problems with the usability of PAL4



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were of older age, which correlates with the fact that it is harder for their generation to get used to this kind of interface technologies. For family caregivers there was a difference between partners or children, children (younger of age) had less trouble with using PAL4. The professional caregivers using PAL4 differentiated in age, but also here can be seen that the younger a person, the easier he was able to use PAL4.

In terms of usability, the main finding was that the system is sometimes difficult to understand by the clients. It was not designed together with the target group (clients and family caregivers), and was not tested by the target group prior to implementation. It is currently not possible to individualize the lay-out of the system.

## System impact

The greatest positive impact on the client was on self-care by using the agenda to structure the day. Another positive result came from the leisure feature that brought enjoyment.

For family caregivers the system asked for extra effort and time to learn and use the system. In the long run it could reduce their burden of care, but this was not proven in our study.

The cost analysis showed that it is more cost-effective for clients with dementia to live at home with the system than to stay in a nursing home. Although – as expected- cost-effectiveness increases if more clients stay at home for more months, we do not know for how long staying at home is an option. However, most people in Europe prefer to stay home for as long as possible<sup>3</sup>, but the burden on family caregivers and homecare organizations has a higher limit. If the different stakeholders, like governments and health insurance companies would take into account cost reductions realized by eHealth technologies, their roll-out could be better supported financially.

Going beyond the direct cost reductions, professional caregivers would also save time (and hence costs) by using the system since home visits could be reduced in number without lowering the quality of care.

## Limitations

The above-mentioned criteria are conditions for a new technology to be adopted, but beyond that, having a smooth process for implementing that technology and a good fit between the technology, the users, and the supporting organizations is important. The problems which occurred during this project are the result of a strategy that was technology-driven instead of user centered. A better

Table 2. Direct costs/client for staying one month at home with the system versus staying at a nursing home in the Netherlands (Prices of 2010 are cited); a=Investment

Cost category	Amount, €
<b>Staying at home</b>	
Purchase and installation of the system	2385 <sup>a</sup>
PAL4-dementia service	500
Subscription and internet	51
Homecare	1959
Professional caregiver using the system	146
Depreciation on investment over 5 years	477
Total running costs	3182
<b>Nursing home stay</b>	
All inclusive	5414

approach would be to use the holistic framework of Gemert et al.<sup>16</sup> where the whole process in a healthcare setting starts with involving the stakeholders in the design process and involving them in redesigning technology for their end-users.

The limitations of this study were first of all the inability to prove quantitatively that someone could stay home for a longer period of time in comparison with living in a nursing home.

Another limitation concerns the log files of the system. Who is using the system (client or family care giver) is not recorded. The log files also fail to show the amount of time spent on the system but only show the number of clicks a person made. The amount of time spent with video contact could not be measured either.

The role of the client with dementia is minimal in this research; the focus was on impact on family and professional caregivers and direct costs. Caregivers have a tendency to emphasize care

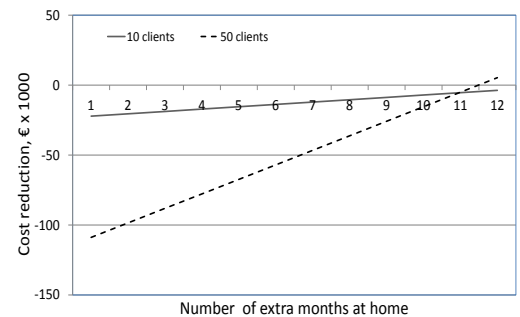


Figure 2. Cost analysis for living at home with a monthly spending on homecare of €5000 for a roll-out to 10 or 50 clients

issues such as the management of IADL (Instrumental Activities of Daily Living, like shopping or meal preparation), ADL and safety issues<sup>22</sup>. Clients with dementia report more often on how difficult it is to find something to do, to sleep or to live with the insecurity that you do not know where you are or what year it is. Consequently, there is a marked difference in the needs of people with dementia and the interests of the family members who provide care or the professional caregivers. In this study, clients were not asked directly about their experiences with the system. Obtaining reliable answers would be a challenge, because of their memory problems.

## Finances

For the cost analysis, we only looked into the cost paid by the Dutch government for taking care of people diagnosed with dementia. We compared the two main options for them. After reaching a certain state of needing care people can either be admitted to a nursing home or receive home care. We only looked at the costs paid by the government, because other costs differ too much among clients. Both sides (nursing home and at home) in this study exclude the mandatory personal financial contribution. And this is where the complex discussion starts. This contribution differs from person to person, as it depends on the amount of care you consume and your income.

We also did not take into account normal living expenses at home like rent, groceries, other shopping, or the qualitative benefits (like higher quality of life because someone can stay home for a longer period of time). Not included were also extra costs created by the burden for a family caregiver. If we were able to catch these additional costs, it would make visible that cost reduction is a complex goal. Our figures are only a crude estimation.

Another issue in the Netherlands nowadays is the way funding for healthcare is organized. The healthcare organizations that invest in new eHealth technologies are usually not the ones that benefit from cost reductions. For example, in this specific case study the healthcare organization invests with the aim of letting their clients live at their own home for a longer period of time. Financially it might be more profitable to transfer these clients to a nursing home organization. The Dutch Healthcare Authority benefits from letting a person live at their own home for a longer period of time.

## Recommendations

Our pilot study needs to be followed by a large scale endeavor to allow for a quantitative assessment of impact and cost reductions. Such a large scale study could also include clients with other conditions besides dementia. This future research should focus more on client perspectives instead of the perspective of family or professional caregivers. In fact a multitude of research methodologies are needed<sup>18</sup>.

Further cost investigation should also consider living expenses, payments by clients, video contacts instead of house visits etc. This could generate more evidence that using technologies in dementia care reduces costs.

Still this pilot showed several possible improvements. This concerns a better education and training of clients and all of their caregivers as to use, structure, aim and working of the system. Systems like PAL4-dementia are most effective when introduced in the early phase of dementia. Efficacy may also be increased by the family caregiver starting to put content into the system before the client starts to use it. When no family caregiver is available, the healthcare organization should find a buddy to do this. The PAL4 Company needs to state more clearly the requirements for the healthcare organization before starting a PAL4-dementia project. This includes the need for an experienced occupational therapist in the project group, who has enough time available for house visits to train clients and family caregivers.

In terms of uptake of the system, several suggestions were made by family and professional caregivers:

- (i) Develop together with the target group and do usability tests.
- (ii) Develop different interfaces for client and partner (the partner wants other information than the client).
- (iii) All buttons should be on the opening page.
- (iv) Install different agenda interfaces, week, full day, or up to 15:00h, refreshing after that time.
- (v) Make games simple, fully in Dutch, in large print, and without a time limit.
- (vi) Replace side icons by words.
- (vii) Make pictures uploadable to the agenda, for instance, a picture of the housekeeping person who is coming.
- (viii) Make the ringtone unlike that of the clients' phone.
- (ix) Include a repetition feature for entering appointments by caregivers.
- (x) Add the option of spoken messages.

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