The influence of technological tools on Instrumental Activities of Daily Living and Quality of Life in older adults with a cognitive impairment: A single group pretest-posttest

Master thesis

Author	Menting, Mireille (6111165)
Course	Research internship
Program	Nursing science
Education	Master Clinical Health Science, UMC Utrecht
Potential journal	Journal of Caring Sciences
Lecturer	Dr. S. Weldam
Supervisor	Dr. B. van Gaal
Internship setting	HAN University of Applied Sciences
Place	Nijmegen

Version	Final
Words abstract	300 (English) and 295 (Dutch)
Words article	3410
References	Vancouver reference style
Transparent reporting following:	Consolidated Standards of Reporting Trials (CONSORT)
Date of submission	19 June 2020

English abstract

Title: Influence of technological tools on instrumental activities of daily living and quality of life in older adults with a cognitive impairment

Background: The growing number of older adults is accompanied with an increase in mild cognitive impairment (MCI) and dementia**.** In independent living, the ability to perform Instrumental activities of daily living (IADL) is critical and has an impact on the experienced quality of life (QOL). Technological tools could support in maintaining IADL and QOL.

Aim: This study determined the influence of technological tools after one year of use on IADL and QOL in older adults with MCI or mild dementia living at home.

Method: A pre-experimental, pretest-posttest, study was performed using data from another study. Used data was collected at the participants' home with questionnaires. With the Wilcoxon Signed-rank test IADL and QOL was compared between pretest and posttest.

Intervention: Participants used one or more technological tools of preference in the categories orientation, day structure, social contact or safety.

Results: Fifty participants were included in pretest and seven participated in posttest. No statistical significant difference was found in the demographic characteristics between the pretest group and the group who had a posttest. The participants (n=7) had a statistical significant decline in IADL performing in comparison to pretest (p=.042). The results on QOL showed no statistical significant difference (p=.866).

Conclusion: A decline in performing IADL can be seen as a normal process in MCI and dementia and not necessarily caused by technological tools. The experienced QOL remained almost the same and is not in line with the normal decline in QOL in MCI and dementia. The findings suggest that people with MCI and dementia are likely to benefit using technological tools in daily practice.

Recommendations: Further research with larger sample sizes is recommended. Including a control group could exclude other influences like regular care in the Netherlands.

Keywords: Cognitive impairment, Instrumental Activities of Daily Living, Quality of Life, technological tools, pretest-posttest

Nederlandse samenvatting

Titel: De invloed van technologische hulpmiddelen op Instrumentele Algemene Dagelijkse Levensverrichtingen en kwaliteit van leven bij ouderen met cognitieve problemen.

Achtergrond: Het groeiende aantal ouderen gaat gepaard met een toename in mild cognitieve stoornis (MCI) en dementie. In het zelfstandig wonen is de uitvoering van Instrumentele Algemene Dagelijkse Levensverrichtingen (IADL) een noodzaak en van invloed op kwaliteit van leven (KvL). Technologische hulpmiddelen lijken ondersteunend zijn in het behoud van IADL en KvL.

Doel: Deze studie stelde vast of het gebruik van technologische hulpmiddelen voor een jaar invloed had op IADL en KvL in thuiswonende ouderen met MCI en milde dementie.

Methode: Een pre-experimentele studie met voor- en nameting was uitgevoerd met gebruik van gegevens uit een andere studie. Gegevens waren bij de participant thuis verzameld middels vragenlijsten. De voor- en nameting op IADL en KvL was vergeleken middels de Wilcoxon Signed-rank toets.

Interventie: Participanten gebruikten één of meer technologische hulpmiddelen van voorkeur in de categorieën oriëntatie, dag-structuur, sociaal contact en veiligheid.

Resultaten: Vijftig participanten hebben een voormeting afgenomen en zeven hebben een nameting afgenomen. Er was geen statistisch significant verschil zichtbaar in de demografische gegevens tussen de participanten van de voormeting en de participanten van de voor- en nameting. De participanten (n=7) lieten een statistisch significante achteruitgang zien in IADL in de nameting (p=.042). De resultaten in KvL gaven geen statistisch significante verandering in de nameting (p=.866).

Conclusie: Achteruitgang in IADL is normaal in mensen met MCI en dementie en niet per definitie veroorzaakt door technologische hulpmiddelen. Het gelijk blijvende KvL is niet in lijn met de normale achteruitgang in MCI en dementie. De bevindingen concluderen dat mensen met MCI en dementie profiteren van het gebruik van technologische hulpmiddelen in het dagelijks leven.

Aanbevelingen: Meer onderzoek met een grotere steekproef en controle groep is aangeraden in toekomstig onderzoek.

Trefwoorden: Cognitieve stoornis, Instrumentele Activiteiten van het Dagelijks Leven, Kwaliteit van Leven, technologische hulpmiddelen, voor- en nameting.

Introduction

In the Netherlands, the number of people aged 65 and older, hereafter referred to as older adults, has increased from 0.3 million in 1900 to 3.2 million in 2018 and will further increase to 4.7 million in 2040(1). Older adults prefer to stay at home as long as possible while living a pleasant and meaningful life(2,3). As a response, the government of the Netherlands will invest more than €340 million in the next years to improve the quality of life of the growing number of older adults living at home(4). The government aims to stimulate self-care and management of the daily lives of older adults at home with support from their social environment(2).

The growing number of older adults is accompanied by an increase in cognitive impairment cases(3). Mild Cognitive Impairment (MCI) represents a state of cognitive impairment between the cognitive changes of aging and early stage of dementia (5,6). The prevalence of MCI in older adults is between 3% and 22%(5). Eight to 15% of all people with MCI will develop dementia(6). Dementia is a collective name for over 50 diseases and is characterised as an irreversible neurodegenerative disease with impairment in cognitive function(7,8). In the Netherlands, the prevalence of dementia will increase to more than half a million in 2040(9). Approximately 70% of all people with dementia is currently living at home(9). Mild dementia represents itself in mild memory disorders, while moderate dementia is better and faster visible in daily practice(7,8).

Impairment in basic activities of daily living (ADL), such as eating, bathing or walking, are one of the key clinical criteria for diagnosis of dementia(10). Instrumental activities of daily living (IADL) are more complex daily activities which demand higher neuropsychological processing like financial capacities, telephone use and finding things at home which is visible in a small cognitive decline and can therefore be present in both dementia and MCI(10-12). The ability to perform IADL is critical to independent living; as it eases the pressure on informal caregivers, reduces the need of professional caregivers (and costs associated with it) and delays admission to a nursing home(10). Losing the ability to perform IADL impacts the quality of life (QOL) as it makes a person more depending on their community and complicates the maintenance of social contacts(12). The World Health Organisation defines QOL as “an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns”(13).

Technological tools could support older adults while performing IADL and improve their QOL, allowing older adults to live in their domestic environment as long as possible(14-16). The use of technology to compensate for impairment in cognition is recommended by the standard of care for dementia in the Netherlands(16). The standard of care includes technological tools for supporting memory (e.g. date clocks), orientation (e.g. GPS trackers),

communication (e.g. communication books), maintaining social contact (e.g. easy to use phones), taking medication (e.g. smart medicine dispensers) and safety (e.g. domotics). Research showed that the perception of the use on technology by older adults depends on their personal, social and physical context; the usability of tools and needs of older adults should be taken into account(17-19). Older adults with a cognitive impairment have a decreased ability to manage technology causing a decrease in the ability to perform everyday activities accompanied by the technology(20,21).

In 2017, a pilot study with a qualitative design was conducted in which participants with moderate dementia were able to use a technological tool of their choice(22). Results showed that the tools were easy to use, but only for a short time due to advancing dementia(22,23). In 2018, a larger study started which is called Dementia: Technology in Everyday Life (TIEL) and follows participants for two years aiming to test the influence of self-chosen technological tools on outcomes like IADL and QOL. As part of the TIEL study, this study is conducted to seek knowledge into the influence of self-chosen technological tools on IADL and QOL after one year of use.

Aim

This study aims to determine the influence of technological tools after one year of use on instrumental activities of daily living and quality of life in older adults with mild cognitive impairment or mild dementia living at home.

Method

Design

This study was a pre-experimental, pretest-posttest analysis, using existing data from the TIEL study(24-26). Used data was collected with questionnaires from one single group before start of the intervention and after one year of use. Since only one experimental group and no control group was included a pre-experimental design was suitable(27). This paper is constructed according to the CONSORT guidelines(28).

Population and setting

In order to be eligible to participate in this study, a participant also took part in the TIEL study and was therefore (1) 65 years or older, (2) diagnosed with MCI or mild dementia, (3) living at home in one of the four participating municipalities in the Netherlands, (4) able to speak and understand Dutch and (5) mentally competent.

Sampling

No sample size calculation was applied since all participants who participated in the TIEL study were included. Therefore, the participant needed to be visited by the project coordinator (an occupational therapist) for a pretest measurement. In total, 50 participants were included in this study.

Procedure in the TIEL study

In the TIEL study, the potential participants were informed about the possibility to participate in the study in different meetings (i.e. dementia networks or cultural cafes), the website and through district nurses. After registration, the project coordinator contacted the potential participant to give more detailed information of the study, checked the inclusion criteria and made an appointment at the participants' home. During the visit, an informed consent form was signed and the technological tool was chosen.

Intervention of the TIEL study

Participants could use one or more technological tools of preference which was suitable with the wishes of the participant. The choice for the best suitable tool was made with the support of the project coordinator. The eleven possible tools were categorized according to the standards of care for dementia (i.e. social contact, day structure, safety, orientation) (table 1)(16). All tools are registered tools which are already introduced in daily practice before the start of the intervention(16,29). A more detailed description of these tools with examples is given in Appendix A.

[Insert Table 1 Possible technological tools and corresponding categories]

Data collection in the TIEL study

The data used for this study was collected in the TIEL study from December 2018-February 2020.

Pretest consisted of two measurement moments. At first, the project coordinator visited the participants' home to support in the choice of the technological tool(s) and measure the severity of the cognitive impairment, learnability and first baseline characteristics. The Mini Mental-State Exam (MMSE) instrument, a widely used instrument, was used in measuring the cognitive function(30). A score of <24 gives a strong indication for dementia (range 0-30). The Allen Cognitive Level Screen (ACLS) instrument, an evidence-based screening assessment, was used in measuring learnability(31). A score of 5.0 and higher means that the participant is able to learn new things independently (range 3.0-5.8). The chosen tool(s) and first baseline characteristics (birth date, gender, residence and living situation) were registered by the project coordinator. At the second pretest moment, the bachelors nursing students visited the

participants' home to conduct a questionnaire. The used questionnaire belongs to a group who does regular research in this population with the purpose to obtain a national uniform dataset in the Netherlands; namely The Older Persons and Informal Caregivers Survey Minimum DataSet (TOPICS-MDS), a publicly and national data repository(32). Among other things, the questionnaire consisted of baseline characteristics (e.g. educational level, health status and perceived homecare) and a measurement instrument for IADL and QOL. Health status was measured with a score between 0 and 10, in which 10 means a participant scored their health as perfect.

At posttest, the bachelor nursing students revisited the participant to access the follow-up measurement with the same questionnaire as used in the pretest. The same questions were included except for the baseline characteristics, these questions were not asked for a second time.

Primary outcome IADL

The primary outcome IADL was measured with the questionnaire at pretest and posttest using the in the Netherlands validated Groningen Activity Restriction Scale (GARS-4) instrument(33,34). The GARS-4 instrument consists of 18 items with a 4-point scale from 1. 'the participant can practice the activity independently' to 4. 'the participant can only practice the activity with support of others'. Seven of the eighteen items in this instrument measure IADL and eleven items measure ADL. In the used questionnaire, two of the seven items of IADL were included and two items were added from another instrument. The two added items had the same 4-point scale as the GARS-4 instrument. The four items combined led to a continuous sum score (range: 4-16). A higher sum score indicated a decline in performing IADL independently.

Secondary outcome QOL

The secondary outcome QOL was measured with the questionnaire at pretest and posttest using the in the Netherlands validated EuroQol five-dimensional questionnaire (EQ-5D-5L) instrument(35-37). This instrument includes five items about aspects of health status with a 5-point Likert scale from 1. 'I have no problems performing the activity' to 5. 'I am unable to perform the activity'. In this study, these items combined led to a continuous score (range: -0.285-1). A higher continuous score indicated a better experienced QOL.

Data analysis

In this study, pretest and posttest were analyzed using IBM SPSS Statistics 24 from February-May 2020(38). In order to prevent measurement bias, all participants with a pretest

and posttest were included for analyzing, regardless if and for how long the participant used the technological tool (i.e. intention-to-treat analysis)(25).

The baseline characteristics were presented with means and standard deviation (SD) in case of normal distribution, or with medians and interquartile range (IQR: P_{25}-P_{75}) in case of not normal distribution. Categorical variables were presented with a number of participants and percentages. To analyze if there was a difference on baseline characteristics between the pretest group and the group who had both pretest and posttest, the baseline characteristics of both groups were presented. Therefore, the participants participating in posttest were included in the baseline characteristics of both groups. Analysis was done with the Mann-Whitney U test and Fisher Exact Test. Two-sided p-values ≤ 0.05 were considered statistically different.

The primary and secondary outcomes were continuous parameters which were checked on a normal distribution with histograms. To analyze the difference in level of IADL and QOL at pretest and posttest, the non-parametric Wilcoxon signed-rank test was used. The Wilcoxon signed-rank test was suitable since there was a small sample size and there were repeated measurements within one participant(38,39). Outliers were included in the study, since such errors can occur in daily practice and the Wilcoxon signed-rank test is robust against outliers. There were no missing values. Two-sided p-values ≤ 0.05 were considered statistically different.

Ethical issues

This study does not fall under the scope of the Medical Research Involving Human Subjects Act (WMO) due to the use of existing data and was conducted according to the principles of the Declaration of Helsinki(40). The TIEL study does have an ethical approval.

The data conducted in this study was saved in a data management system at the HAN University of Applied Sciences which guarantees patients' privacy and complies with the EU General Data Protection Regulation (GDPR)(41). The data remains in the property of the HAN University of Applied Sciences.

Results

Sample and baseline characteristics of the participants

In the TIEL study, 50 participants were included and visited by the project coordinator for the first pretest measurement moment. Nine participants dropped out before the second pretest measurement was obtained. Reasons for dropping out were admission to a nursing home (n=2) or aphasia disorder (n=1). Six participants did not give a reason or the reason was not registered. The second pretest measurement was postponed in 12 participants due to COVID-19 virus, leaving a total of 29 participants with both pretest measurements. Four participants stopped participating in the TIEL study between pretest and posttest. Reasons

were not being satisfied with the easy to use telephone and key finder tool (n=2) or participating was too exhausting (n=1). One participant did not give a reason for dropping out or the reason was not registered. Eighteen participants have not participated in the posttest yet due to the COVID-19 virus and a continuous inclusion process, leaving a total of seven participants with both a pretest and a posttest.

In total, 25 of the 50 participants participating in pretest were male (50%) (table 2). The median age was 78 (IQR:74-85). Twenty-eight participants (54%) lived at home with others and 26 participants (48%) lived in the same residence. The median MMSE score was 22 (IQR: 19-24) and the median ACLS score was 4.2 (IQR: 3.8-4.5). Fourteen participants (48%) had a vocational education. The median scored health status was 7 (IQR: 6-8) and 16 participants (55%) received homecare within the last 12 months. Educational level, health status and received homecare was scored in 29 participants instead of 50 since these variables were asked in the second pretest measurement. In the participants (n=7) who participated in both pretest and posttest, four participants were male (57%) (table 2). The median age was 75 (IQR: 72-77). Five (71%) participants lived at home with others and three participants (43%) lived in the same residence. The median MMSE score was 23 (IQR: 19-24) and the median ACLS score was 4.4 (IQR: 4.1-4.6). Five participants (71%) had a vocational education. The median scored health status was 6 (IQR: 5-7) and four participants (57%) received home care within the last 12 months.

The baseline characteristics were analysed to test whether a difference was visible between the pretest group and the group who had both pretest and posttest, see table 2. No statistical significant difference was found on the baseline characteristics between both groups.

[Insert Table 2 Baseline characteristics of the participants]

Used technological tools

A total of eleven tools were used by the seven participants (table 3). At maximum, three tools were used at the same time by one participant and one participant did not use any tool. The most chosen tools were from the category social contact (n=4), followed by orientation (n=3), day structure (n=3) and safety (n=1). The simplified digital tablet, easy to use telephone, date clock and key finders were the most chosen technological tools (n=2 for each tool).

[Insert Table 3 Used technological tools]

Main findings

Primary outcome IADL

At pretest, the participants (n=7) scored a median level of IADL of 11 (IQR: 4-11), after which in posttest also a median level of 11 (IQR: 9-13) was scored (table 4). The IQR increased with 5 on P_{25} and 2 on P_{75} in comparison with pretest.

Analysis showed a statistical significant difference of the level of IADL between pretest and posttest (p=.042).

Secondary outcome QOL

At pretest the participants (n=7) scored a median level of QOL of 0.80 (IQR: 0.57-0.80), whereas at posttest a median level of 0.72 (IQR: 0.66-0.94) was scored (table 4). The median decreased with 0.08 and the IQR increased with 0.09 on P_{25} and 0.14 on P_{75} in comparison with pretest.

Analysis showed no statistical significant difference of the level of QOL between pretest and posttest (p=.866).

[Insert Table 4 Analysis of main outcomes]

Discussion

This pretest-posttest study aimed to determine the influence of technological tools on IADL and QOL in older adults living at home with MCI or mild dementia. The results suggested that technological tools influenced the performing in IADL. A significant decline in IADL was found after using a technological tool for one year. The results on QOL remained almost the same, which can indicate that technological tools did not influence the experienced QOL.

A decline in performing IADL, as seen in this study, is normal in people suffering from MCI or dementia(42-44). In 2013, Hesseberg et al. described the severity of MCI or dementia as a significant predictor of the deterioration in IADL functioning(45). Thirty-four percent of people with MCI was independent in IADL, whereas in people with dementia it was 12%(45). The found decline in performing IADL is not in line with other experimental studies with the same population and category of tools. One experimental study, including a system for support in memory, social contact and feeling safe, found no significant differences on performance of daily activities between pretest and posttest(46). Another experimental study, using various technology, found a positive correlation between activity involvement and everyday technology(47) . Therefore, the conclusion can be made that the found decline in IADL is not necessarily caused by using a technological tool.

In this study, the QOL almost remained the same. This can be interpreted as a good result, since a reduction in QOL is normal in people suffering from MCI or dementia(42,48). In 2008, Missotten et al. found a significant decrease of experienced QOL in people with dementia in comparison to people with MCI(48). People with MCI gave a mean score of 83% for the experienced QOL, whereas in people with dementia it was 66%(48). In addition, the findings in QOL of this study are in line with other reviews in which technological tools have a positive influence on maintaining QOL for people living at home(49,50).

This study was strengthened by the longitudinal design of one year. The participant had the opportunity to learn and manage the preferred technological tool for a long period(23). This made it more likely that the purpose of the tool was fully experienced and could result in a positive influence on the primary and secondary outcome. Another strength of this study is the possibility to compare the data with other studies due to the use of a questionnaire which belongs to a group who does regular research in this population. Finally, this study is of great value for the TIEL study. Analysis and outcomes of this study gave valuable insights in potential problems, like deficiencies in the measurement of IADL with the GARS instrument or the potential selection bias due to drop outs. Also, preliminary data was collected and analyzed in which the adequacy of the measurement instruments and analysis methods were tested.

This study was limited by the small sample size at posttest (n=7). The large drop out was mainly caused by the COVID-19 virus, what resulted in the postponing in pretest and posttest measurements for several participants. However, sub analyses showed no statistical difference between the pretest group and the group who had both pretest and posttest. Selection bias was not present and the group with a posttest was a good reflection for the pretest group. Therefore, the findings on IADL and QOL were representative for the pretest population. Secondly, the small sample size undermines the external validity of this study, after which the results and conclusion cannot be generalized(51). A third limitation was the absence of a control group. It was not possible to exclude other influences like occupational therapy or physiotherapy. Finally, there was no distinction made between the different items of the IADL scale. As a result, it was not possible to see in which areas within IADL the significant decline was visible and if the chosen technological tool could support this specific area. Further exploring the data could provide additional information, after which it is possible to look at the needs of the participants and which technological tools could fit these needs.

According to the information listed above, no conclusive implications can be given for clinical practice. Further research should focus on the influence of technological tools on IADL and QOL for longer than one year with a larger sample size. Also, It is recommendable to include a control group without a technological tool to exclude influences other than the technological tool like the regular care in the Netherlands.

Conclusion

This study obtained preliminary conclusions about the influence of technological tools on IADL and QOL in older adults living at home with MCI and dementia. The decline in performing IADL can be seen as normal, and not necessarily caused by using a technological tool. In addition, the experienced QOL remained almost the same, which is in line with previous research about technological tools. The findings suggest that people with MCI and dementia are likely to benefit using a technological tool in daily practice, but no conclusive implications could be given for clinical practice.

References

(1) RIVM. Ouderen in 2018. 2019; Available at: https://www.volksgezondheidenzorg.info/onderwerp/bevolking/cijfers-context/vergrijzing#node-totaal-aantal-ouderen. Accessed Sep 8, 2019.

(2) Ministerie van volksgezondheid, welzijn en sport. Programma langer thuis. 2018; Available at: https://www.rijksoverheid.nl/onderwerpen/zorg-en-ondersteuning-thuis/documenten/rapporten/2018/06/15/programma-langer-thuis. Accessed Sep 21, 2019.

(3) Campen vC, Iedema J, Broese van Groenou M, Deeg D. Langer Zelfstandig. 2017; Available at: https://www.scp.nl/Publicaties/Alle_publicaties/Publicaties_2017/Langer_zelfstandig. Accessed Sep 21, 2019.

(4) Rijksoverheid. 340 miljoen voor thuiswonende ouderen: zelfstandig oud worden in vertrouwde omgeving. 2018; Available at: https://www.rijksoverheid.nl/actueel/nieuws/2018/06/18/340-miljoen-voor-thuiswonende-ouderen-zelfstandig-oud-worden-in-vertrouwde-omgeving. Accessed 21-9-, 2019.

(5) Sanford A. Mild Cognitive Impairement. Clinics in Geriatric Medicine 2017 Aug 1,;33(3):325-337.

(6) Petersen RC. Mild Cognitive Impairment. The New England Journal of Medicine 2016 Apr 9,;2(22):2227-2234.

(7) de la Rubia Orti, J E, Garcia-Pardo MP, Iranzo CC, Madrigal JJC, Castillo SS, Rochina MJ, et al. Does Music Therapy Improve Anxiety and Depression in Alzheimer's Patients? J Altern Complement Med 2018 January 01;24(1):33-36.

(8) Alzheimer Nederland. Wat is dementie? 2019; Available at: https://www.alzheimer-nederland.nl/dementie. Accessed Sep 8, 2019.

(9) Alzheimer Nederland. Cijfers en feiten over dementie 2019; Available at: www.alzheimer-nederland.nl. Accessed Sep 8, 2019.

(10) Jekel K, Damian M, Storf H, Hausner L, Frölich L. Development of a Proxy-Free Objective Assessment Tool of Instrumental Activities of Daily Living in Mild Cognitive Impairment Using Smart Home Technologies. Journal of Alzheimer's disease : JAD 2016;52(2):509-517.

(11) Lindbergh C, Dishman R, Miller L. Functional Disability in Mild Cognitive Impairment: A Systematic Review and Meta-Analysis. Neuropsychol Rev 2016 Jun;26(2):129-159.

(12) Tulliani N, Bissett M, Bye R, Chaudhary K, Fahey P, Liu KPY. The efficacy of cognitive interventions on the performance of instrumental activities of daily living in individuals with mild cognitive impairment or mild dementia: protocol for a systematic review and meta-analysis. Systematic reviews 2019 Aug 28,;8(1):222.

(13) World Health Organisation. WHOQOL: Measuring Quality of Life. 2019; Available at: https://www.who.int/healthinfo/survey/whogol-qualityoflife/en/. Accessed Nov, 4, 2019.

(14) Reeder B, Meyer E, Lazar A, Chaudhuri S, Thompson HJ, Demiris G. Framing the evidence for health smart homes and home-based consumer health technologies as a public health intervention for independent aging: A systematic review. International Journal of Medical Informatics 2013;82(7):565-579.

(15) Peetoom KKB, Lexis MAS, Joore M, Dirksen CD, De Witte LP. Literature review on monitoring technologies and their outcomes in independently living elderly people. Disability and Rehabilitation: Assistive Technology 2015 Jul;10(4):271-294.

(16) Meerveld J. Zorgstandaard dementie. 2013; Available at: https://www.vilans.nl/producten/zorgstandaard-dementie. Accessed Sep 8, 2019.

(17) Schmidt LI, Wahl H. Predictors of Performance in Everyday Technology Tasks in Older Adults With and Without Mild Cognitive Impairment. The Gerontologist 2019 Jan 9,;59(1):90-100.

(18) Yusif S, Soar J, Hafeez-Baig A. Older people, assistive technologies, and the barriers to adoption: A systematic review. International Journal of Medical Informatics 2016;94:112-116.

(19) Venkatesh V. Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model. Information Systems Research 2000 Dec 1,;11(4):342-365.

(20) Hedman A, Nygård L, Almkvist O, Kottorp A. Patterns of functioning in older adults with mild cognitive impairment: a two-year study focusing on everyday technology use. Aging & Mental Health 2013 Aug 1,;17(6):679-688.

(21) Malinowsky C, Almkvist O, Kottorp A, Nygård L. Ability to manage everyday technology: a comparison of persons with dementia or mild cognitive impairment and older adults without cognitive impairment. Disability & Rehabilitation: Assistive Technology 2010 Nov;5(6):462-469.

(22) Banken LJM, Blijderveen GS, Adriaansen MJM. Technologie Trolley Rheden
Een onderzoek naar het gebruik van technologische hulpmiddelen bij 65-plussers met MCI of dementie. 2017 Jan 16,.

(23) Hedman A, Kottorp A, Almkvist O, Nygard L. Challenge levels of everyday technologies as perceived over five years by older adults with mild cognitive impairment. Int Psychogeriatr 2018 October 01;30(10):1447-1454.

(24) Grobbee DE, Hoes AW. Clinical Epidemiology . : Jones And Bartlett Publishers, Inc; 2014.

(25) Bouter LM, Dongen, van M. C. J. M., Zielhuis GA. Epidemiologisch onderzoek. 6th ed. Houten: Bohn Stafleu van Loghum; 2010.

(26) Dimitrov DM, Rumrill PD. Pretest-posttest designs and measurement of change. Work 2003;20(2):159-165.

(27) Bouter LM, Dongen, van M. C. J. M, Zielhuis GA. Epidemiologisch Onderzoek: opzet en interpretatie. 6th ed. Houten: Bohn Stafleu van Loghum; 2010.

(28) CONSORT group. CONSORT 2010 checklist of information to include when reporting a randomised trial. 2010; Available at: http://www.consort-statement.org/. Accessed May 28, 2020.

(29) Leeuw vdJ, Cornelisse L. Infographic technologie dementie thuis. 2019; Available at: https://www.vilans.nl/producten/infographic-technologie-dementie-thuis. Accessed Oct 25, 2019.

(30) Alzheimer Nederland. MMSE Test. Available at: https://www.alzheimer-nederland.nl/dementie/diagnose-en-behandeling/mmse-test. Accessed Sep 8, 2019.

(31) Deane B. McCraith. ACLS-5 and LACLS-5 Test: Psychometric Properties and Use of Scores for Evidence-Based Practice. the Allen Cognitive Group/ACLS&LACLS Committee 2016 Dec 9,:1-12.

(32) Lutomski J, Baars M, Schalk B, Boter H, Buurman B. The Development of the Older Persons and Informal Caregivers Survey Minimum DataSet (TOPICS-MDS): A Large-Scale Data Sharing Initiative. PlosOne 2013 Dec 4,;12(8).

(33) Engelen van E, Grondal JB, Wawrzynek I, Rickenbach A. Groningen Activiteiten Restrictie Schaal (GARS). ZUYD 2014 juli.

(34) Rickenbach A, Wawrzynek I, Grondal JB, Engelen van E. Uitgebreide toelichting van het meetinstrument GARS. ZUYD 2014 jul.

(35) Swinkels - Meewisse I, Bokhorst M. EuroQol 5D (EQ 5D). ZUYD 2017 Dec.

(36) EuroQol. EQ-5D-5L User Guide. Rotterdam: EuroQol Research Foundation; 2019.

(37) M. Versteegh M, PhD, M. Vermeulen K, PhD, M. A. A. Evers, Silvia, PhD, de Wit, G. Ardine, PhD, Prenger R, PhD, A. Stolk E, PhD. Dutch Tariff for the Five-Level Version of EQ-5D. Value in Health 2016;19(4):343-352.

(38) Vocht dA. Basishandboek SPSS 20. 2nd ed. Utrecht: Bijleveld Press; 2012.

(39) Field A. Discovering Statistics using IBM SPSS. 5th ed. New York: Sage Publications Ltd; 2017.

(40) De Minister van Volksgezondheid W. en S. Wet medisch-wetenschappelijk onderzoek met mensen. 2019; Available at: https://wetten.overheid.nl/jci1.3:c:BWBR0009408&z=2019-04-02&g=2019-04-02. Accessed Sep 12, 2019.

(41) European Council & European Parliament. VERORDENING (EU) 2016/679 VAN HET EUROPEES PARLEMENT EN DE RAAD. 2016; Available at: https://www.autoriteitpersoonsgegevens.nl/sites/default/files/atoms/files/verordening_2016_-_679_definitief.pdf. Accessed Oct 20, 2019.

(42) Teng E, Tassniyom K, Lu P. Reduced Quality of Life Ratings in Mild Cognitive Impairment: Analyses of Subject and Informant Responses (P04.208). Neurology 2012 Apr 25,;78(Meeting Abstracts 1):P04-P04.208.

(43) Tulliani N, Bissett M, Bye R, Chaudhary K, Fahey P, Liu KPY. The efficacy of cognitive interventions on the performance of instrumental activities of daily living in individuals with

mild cognitive impairment or mild dementia: protocol for a systematic review and meta-analysis. Systematic reviews 2019 Aug 28,;8(1):222.

(44) Christiansen L, Sanmartin Berglund J, Lindberg C, Anderberg P, Skär L. Health-related quality of life and related factors among a sample of older people with cognitive impairment. Nursing Open 2019 Jul;6(3):849-859.

(45) Hesseberg K, Bentzen H, Ranhoff AH, Engedal K, Bergland A. Disability in instrumental activities of daily living in elderly patients with mild cognitive impairment and Alzheimer's disease. Dementia and geriatric cognitive disorders 2013;36(3-4):146-153.

(46) Hattink BJJ, Meiland FJM, Overmars-Marx T, de Boer M, Ebben PWG, van Blanken M, et al. The electronic, personalizable Rosetta system for dementia care: exploring the user-friendliness, usefulness and impact. Disability and Rehabilitation: Assistive Technology 2016 Jan 2,;11(1):61-71.

(47) Hedman, A., Nygård, L., Malinowsky, C., Almkvist, O., & Kottorp, A. Changing everyday activities and technology use in mild cognitive impairment. British Journal of Occupational Therapy 2016;79(2):111-119.

(48) Missotten P, Squelard G, Ylieff M, Di Notte D, Paquay L, De Lepeleire J, et al. Quality of life in older Belgian people: comparison between people with dementia, mild cognitive impairment, and controls. International Journal of Geriatric Psychiatry 2008 Nov;23(11):1103-1109.

(49) D'Onofrio G, Sancarlo D, Ricciardi F, Panza F, Seripa D, Cavallo F, et al. Information and Communication Technologies for the Activities of Daily Living in Older Patients with Dementia: A Systematic Review. Journal of Alzheimer's disease : JAD 2017;57(3):927-935.

(50) Holthe T, Halvorsrud L, Karterud D, Hoel K, Lund A. Usability and acceptability of technology for community-dwelling older adults with mild cognitive impairment and dementia: a systematic literature review. Clinical interventions in aging 2018;13:863-886.

(51) Faber J, Fonseca LM. How sample size influences research outcomes. Dental press journal of orthodontics 2014 Jul;19(4):27-29.

Tables

Table 1 Possible technological tools and corresponding categories

Category	Technological tool
Social contact	1. Simplified digital tablet 2. Easy to use phone
Day structure	1. Date clock 2. Social bot 3. Alarm clock with light and natural sounds
Safety	1. Sensors 2. Smart floor light 3. Mobile alarm
Orientation	1. Key finder 2. Alarm system with GPS tracker 3. Care belt

Table 2 Baseline characteristics of participants

Baseline characteristics of participants	**Pretest n[1]=50**	**Posttest n=7**	**P-value[2]**
Age (years) median (IQR[3])	78 (74–85)	75 (72-77)	.159
Male N (%)	25 (50%)	4 (57%)	1.00
Living situation N (%)			.687
Independently, alone	22 (42%)	2 (29%)	
Independently, with others	28 (54%)	5 (71%)	
Residence N (%)			.820
Arnhem	24 (48%)	3 (43%)	
Doesburg	9 (18%)	1 (14%)	
Rheden	5 (10%)	0 (0%)	
Overbetuwe	12 (24%)	3 (43%)	
MMSE[4] score (0-30)[5] median (IQR)	22 (19-24) [6]	23 (19-24)	.681
ACLS[7] score (3-5.8)[5] median (IQR)	4.2 (3.8-4.5)[8]	4.4 (4.1-4.6)[9]	.442
Educational level N (%)			.617
Primary education	5 (17%)[10]	0 (0%)	
Vocational education	14 (48%)	5 (71%)	
Higher education	10 (35%)	2 (28%)	
Health status (0-10)[5] median (IQR)	7 (6-8)[10]	6 (5-7)	.089
Participants with homecare in the last 12 months N (%)	16 (55%)[10]	4 (57%)	1.00

1 n: number of participants. 2 tested with Mann-Whitney U test and Fisher Exact test 3 IQR: interquartile range ($P_{25} – P_{75}$). 4 MMSE: Mini-Mental State Examination. 5 The minimum and maximum number to score. 6 n total = 44 of 50. 7 ACLS: Allen Cognitive Level Screen. 8 n total= 45 of 50 9 n= total 6 of 7. 10 n total = 29 of 50

Table 3 Used technological tools

Category and technological tools	**User numbers (n[1]=11)[2]**
Social contact	*n = 4*
1. Simplified digital tablet	n = 2
2. Easy to use telephone	n = 2
Day structure	*n = 3*
1. Date clock	n = 2
2. Social bot	n = 1
3. Alarm clock with light and natural sounds	n = 0
Safety	*n = 1*
1. Sensors	n = 1
2. Smart floor light	n = 0
3. Mobile alarm	n = 0

Orientation	*n = 3*
1. Key finders	n = 2
2. Alarm system with GPS tracker	n = 1
3. Care belt	n = 0

1 n: number of tools used by the seven participants. 2: At maximum one participant used 3 different tools at the same time and one participant did not use any tool.

Table 4 Analysis of main outcomes

Outcomes measuring instrument	**Pretest**	**Posttest**	**P-value[1]**
IADL *median (IQR[2])*	11 (4-11)	11 (9-13)	.042
QOL *median (IQR)*	0.80 (0.57-0.80)	0.72 (0.66-0.94)	.866

1: Tested with the Wilcoxon Signed Ranks test. 2 IQR: Interquartile Range (P_{25} – P_{75}).

Appendix A: List of technological tools

Tool	Category	Example	Description
simplified digital tablet	Social contact		A simplified digital tablet specially made for older adults. The functions of internet and (video) calling and other functions reduce loneliness and supports in maintaining social contacts.
Easy to use phone	Social contact		An easy to use telephone where the older adult can easily call a social contact by pressing the photo or name. It reduce loneliness and supports in maintaining social contacts.
Date clock	Day structure		A clock with a date and time in order to stay up to date. There are extensions where it is also possible to present appointments on the clock.
Alarm clock with light and natural sounds	Day structure		An alarm with the actual time presented. It has natural sounds and light to support the older adult in waking up calm and slowly and maintain day and night routine.
Social robot	Day structure		A social robot which supports maintaining day and night structure for the older adult. The robot can offer structure in day-to-day life by delivering spoken verbal reminders, suggestions, and music. In addition, the care robot has a social function and can act as a friend or react to silence.
Sensors	Safety		The use of sensors gives the older adult self-confidence in daily activity and reduces fear of falling. The sensor alarms or warns someone if it detects movement. In addition, it gives insight in the movement pattern.

smart floor light	Safety		A floor light which gives light when movement is detected. It lights the floor allowing the older adult to move safely through the night.
Mobile alarm	Safety		With one press on the button of the mobile alarm communication is possible with acquaintances or the emergency centre.
Key finder	Orientation		A wireless key finder in which lost keys can be found quickly. A key ring can be attached to the bunch of keys so it can always be found with a channel.
Alarm system with GPS tracker	Orientation		With this alarm system an older adult can be found by the GPS tracker. The older adult caries a GPS transmitter which can be followed on the system. With this, an older adult with cognitive problems does not have to be restricted in his living environment.
Care belt	Orientation		The Care Belt is a small device that a person carries with him in his belt. It is equipped with a GPS transmitter that can be traced and located. With this, an older adult with cognitive problems does not have to be restricted in his living environment.