Journal of Enabling Technologies
User inclusion in health, support, social care and education

Volume 12 Number 2 2018

Design, technology, and engineering for long-term care
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ISBN 978-1-78769-769-0
www.emeraldinsight.com/loi/jet
The number of older adults, worldwide, is increasing rapidly, and this demographic shift puts an increased level of stress onto healthcare systems. The vast majority of older adults wish to age-in-place as independently as possible (van Hoof et al., 2011). Nevertheless, there is a significant group of older people who require long-term care services, including home care, rehabilitation services, or support within an aged-care facility or nursing home. Nursing homes provide an alternative place of residence with 24-hour care and assistance offered by professionals to people who can no longer reside in their own home environment due to increasing need for assistance with activities of daily living, complex health care needs, and vulnerability. Nursing homes, thus, have a dual nature: as a site for delivery of care and as a place to live. With advances in digital and assistive technologies, the domain of engineering and design offers a wide range of solutions for such aged-care facilities that support daily functioning, leisure activities and participation and the provision of healthcare.

Too often, however, end-users of technological solutions are not included, or only consulted in a tokenistic way in the design processes and implementation of technology solutions in practice. On the other hand, studies show that the inclusion of end-users in these processes is paramount to the success of engineers and designers in their efforts to improve aged-care (Nieboer et al., 2014; Peek et al., 2016).

This special issue includes five articles which cover a diverse range of issues related to recent advances in the design of technologies used in aged-care facilities and the built environment in general.

The first paper by Martens and colleagues is based on a small-scale investigation of how bedfast nursing home residents experience their quality of life, and how the bed and connected technology may improve their sense of control, well-being and independence. The work studies a frail group of nursing home residents who experience a self-reported low quality of life due to their physical and mental dependence on others, and the limited control options they are given. Martens and colleagues show that by making technological adjustments to the bed and the person’s direct surroundings, their quality of life can be much improved. Many of these solutions are relatively simple to implement, for instance, the use of modern IT devices to support people to engage in social contacts and to control the bed itself, as well as the environment around the bed. Thus, the proposed solutions included in the paper have important and readily transferable implications for practice which could be achieved relatively easily.

The second paper by Oude Weernink and colleagues provides an overview of real-time location systems (RTLS) in health care. These technologies can help improve process efficiency and the quality of care. Such systems are designed to determine and monitor the location of assets and people in real-time through the use of wireless sensor networks and are often used in hospital settings. The nursing home is a relatively unexplored context for the application of RTLS and offers opportunities and challenges for future applications. Oude Weernink and colleagues describe the specific healthcare applications of RTLS, including asset tracking, patient tracking and personnel tracking. These overviews are followed by a forecast of the implementation of RTLS in nursing homes in terms of opportunities and challenges. By comparing the nursing home to the hospital, the RTLS applications for the nursing home context that are most promising are asset tracking of expensive goods owned by the nursing home in order to facilitate work flow and maximise financial resources, and asset tracking of personal belongings that may get lost by the residents. The paper provides a glimpse of the future of aged-care as an enabling environment.
The third paper by Verkerk and colleagues deals with housing and technology-related needs of older people with dementia. For this special group of older people, various design principles exist. Verkerk and colleagues propose a new approach to such principles, and outline a simple yet sophisticated model, with a firm foundation in neurology, for designing environments for people with dementia. A general design model is presented consisting of three principles: designing for ageing people, designing for a favourable state and designing for beautiful moments. The design principles are translated into design specifications to show what might be possible in practice. Philosophical concepts are introduced which are required to understand the design through a collection of case studies from Dutch nursing homes. These case studies show how the theory of modal aspects of the philosopher Dooyeweerd can be used to map design specifications in a systematic way. This systematic mapping is important because it connects the various aspects of human functioning to actual design solutions, and helps designers identify the best solutions for their target group.

The fourth paper is an opinion paper by van Zaalen and colleagues, discussing the implementation of technology in the delivery of healthcare to older people, and how the least-voiced in society can be heard. As technology has a mediating role in determining the possibilities for quality of life, the concept of assisting older people through the use of technology to avail of health care has enormous potential. However, technology use can also have its downsides and risks, for example in relation to the privacy of the older person. Van Zaalen and colleagues take the reader on a journey along important ethical and judicial themes related to technology and the older adults. Different consecutive phases in technology design and allocation are discussed from a diversity of perspectives, and illustrated using cases from practice. The explorations in the people help designers consider the needs of the most frail and vulnerable of target groups, and help tune design solutions to better suit the end users’ needs.

The final paper in this special issue is by Loy and colleagues on rethinking technology-enhanced aged-care environments. The paper provides an overview of design-led research into digital technology across disciplines for the personalisation of health care environments and is informed by the authors’ ongoing hospital-based research. The work is based on a design anthropology framework providing insight into designing for changing the experience for older patients in current healthcare contexts and future focused strategies, integrating digital technologies and human-centred design across scale and disciplines. The study proposes future care scenarios with technology and human experience as key drivers, in which individualised and personalised solutions cater for diversity. Given the ageing population noted above, and the substantial heterogeneity of needs amongst older adults, such personalised solutions will become ever more important and so this paper makes for vital reading for those working in relevant fields.

In summary, the papers provide an overview of new technologies for long-term care and aged-care, promising a lasting contribution to the domain of enabling technologies, both for the vulnerable end-users in the case of bedfast nursing home residents, and for system engineering in the case of RTLS. This special issue also provides engineers and designers with models and tools to design and implement technology for nursing home residents including those with dementia, older hospital patients, and other people in our society who are among the least-voiced.

As ever, we would like to thank our reviewers who continue to offer timely, insightful and constructive comments to our contributors and to the contributors themselves for their interesting and useful papers.

References


The vision of bedfast nursing home residents of their quality of life and the contribution of technological innovations in and around the bed


Abstract

Purpose – Over 8 per cent of the Dutch nursing home population is bedfast, and this number is slowly increasing. The quality of life (QoL) of this population is lower than that of residents who are still mobile. Little research has been conducted on how to improve the QoL of this bedfast population, particularly through making technological adjustments to the bed and the direct surroundings. The purpose of this paper is to gain insight into the QoL of bedfast residents and how to improve this through technology.

Design/methodology/approach – A mixed-method multi-case study with thematic analysis was conducted in two nursing homes with seven participants based on semi-structured interviews and Short Form-12 questionnaire.

Findings – The major causes of the experienced low QoL were the limited opportunities for engaging in social contacts with others, and coping with the dependency on other people and having limited control. Participants suggested improvements of QoL through the application of modern communication technologies to engage in social contacts and to control the bed itself and environment around the bed.

Practical implications – The results may help improve the design of the bed and the direct environment in order to improve the QoL of bedfast nursing home residents.

Originality/value – The QoL of bedfast nursing home residents has not been studied before in relation to the bed itself and technological solutions that may help improve the QoL and level of control.

Keywords Dependency, Control, Immobility, Technology, Bed-bound, Bed-ridden, Nursing home, Bed, Mattress, Quality of life

Paper type Research paper

1. Introduction

The number of bedfast residents in Dutch nursing homes is increasing. In the year 1995 about 4.6 per cent of the residents were bedfast; in 2011 this number had risen to 5.7 per cent. If these numbers are extrapolated (CBS—Statistics Netherlands, 2007), over 8 per cent of the population is currently expected to be bedfast. This trend matches the recent developments in which only those people with the most complex needs are eligible for nursing home admission. There are many definitions of the term “bedfast”, and—to our knowledge—there is no instrument to determine “bedfastness” or classify the degree of the situation (Zegelin, 2008). Also, the words bed-ridden and bed-bound appear in the somewhat older literature. Someone who is bedfast is limited to his or her bed due to illness or physical impairments (de Klerk, 2005). A person is bedfast if he or she spends the larger part of the day (and night) in bed (Zegelin, 2008). According to Fielding et al. (2011), a bedfast person is not able to get out of bed independently, which leads to the person spending the majority of the day in bed. Based on these three definitions, we assume that someone is bedfast if he or she spends at least 12 h per day in bed, and is unable to get out of bed independently due to illness or a physical impairment.
Research focusing on bedfast nursing home residents is scarce. In general, studies suggest that from a residents’ perspective, being bedfast has a negative impact on the quality of life (QoL). Older people who are bedfast due to physical impairments require assistance with basic activities of daily living, and are at risk of decubitus and developing blood clots (Campbell, 2009). Rubin et al. (2016) studied how 180 hospitalised patients over 60 years of age with serious illnesses evaluated states of cognitive or functional impairment relative to death. Not being able to get of bed was considered worse than death by half of the participants, and slightly less bad than incontinence and having to rely on a breathing tube in order to stay alive. Living in a nursing home was, in itself, considered to be worse than death by about 30 per cent of the respondents. One study from Turkey showed that the QoL of bedfast people is much lower than that of people who are still mobile (Arslantas et al., 2009). Apart from the physical and mental challenges faced by bedfast persons, there are risks associated with lower evacuation times in case of fires (Strating et al., 2015). Furthermore, nursing staff find it challenging to care for residents remaining in bed (Iecovich and Rabin, 2014).

In order to prevent people from becoming bedfast, it is important that residents get stimulated to move as often as possible. However, residents in nursing homes often remain inactive during most of the day, being in a lying or sitting position (den Ouden et al., 2015). Moreover, participation in daily activities itself already helps maintain physical functioning (Bates-Jensen et al., 2004), and is associated with a higher QoL (Edvardsson et al., 2013). Nursing staff have a major role in increasing activity levels of nursing home residents, although practice shows that this is challenging. den Ouden et al. (2017) recently showed that in almost half of the (I)ADL tasks, nursing staff took over activities of residents, for a large part unnecessarily.

In recent times, there has been an increasing focus on the implementation of technology in the nursing home environment in order to support the provision of care by professionals, and improve the QoL, independence and degree of control of residents. Little to no research has been conducted on how technological solutions may help improve the QoL of older people who are bedfast. The domain of research with bedfast participants seems an understudied area, and the research focus is on the prevention and management of pressure sores (Okuwa et al., 2006), for which special treatment protocols and mattresses are used.

The aim of this study is twofold, namely:
1. to gain insight into the experiences of being bedfast and the impact this has on residents’ perceived QoL; and
2. to investigate how the QoL of bedfast nursing home residents can be improved, with a special focus on the impact of the bed and technology.

2. Methodology

A mixed-method study was conducted, comprising of in-depth semi-structured interviews, following a multi-case study approach (Swanbor, 2013).

2.1 Setting and participants

The study was conducted in the wards for residents with physical impairments of two nursing homes in The Netherlands. The principal investigator (IM) engaged in a round of participatory observations prior to the recruitment in one of the nursing homes, where only three bedfast residents lived. This led to the inclusion of a second nursing home, where nine bedfast residents lived. Members of staff assisted in recruiting potential participants, and their initial family carers were also informed about the study through an information letter. The need for ethical approval was waived (Fontys Committee for Ethics in Research) due to the character of the study. A total of 7 participants out of 12 potential participants agreed to take part in the study and signed informed consent (residents, in conjunction with their initial family carers) (Table I). Participants had to be able to speak and communicate in Dutch. Due to late-stage dementia and inability to speak, two residents in the first nursing home and three residents in the second were excluded.
from the study. The participants in this study are either fully bedfast, or seated in a special chair, and fully dependent on a care professional (Table I). The people who were included were classified based on the number of hours they spent in bed and not on the amount of time they spent additionally being seated in a wheelchair or special chair.

The Short Form (SF-12) questionnaire was used in this study. Of the 12 questions, 6 are related to the functional status, such as physical and social functioning, and 4 questions are related to a person’s well-being. The results of the SF-12 are expressed as physical and mental condition of well-being scores (PCS and MCS) (Table I). All seven participants had a very low QoL, and six of them had very low scores on physical well-being. In the domain of mental well-being, three participants had average scores, and three participants had very low scores.

2.2 Interviews and questionnaire

A semi-structured interview was held in the private room of the residents, which lasted for about 45 min. The interviews were held based on a topic list, which was tested with a resident who spent about ten hours per day in bed and who was unable to get out of bed independently. Interviews started by asking general questions, including the number of hours spent in bed, as far as these items were not covered by the SF-12 questionnaire. The two domains were the QoL and the bed and its surroundings. Topics of the first domain included questions about the social, psychological and physical aspects of daily living, such as the frequency and quality of relationships, mood and mental status and physical and sensory impairments. The second domain concerned questions about the bed itself and the mattress (considered as technological solutions given the complex design of these products); the features of the bed; and the position of the bed, the room itself, technologies in the room including home automation, communication devices, alerts and emergency response systems, controls. Supplementary and probe questions were asked, particularly in relation to the bed and the technologies that were already used, or features and technologies that were missed or deemed essential by the participants.

2.3 Data analysis

First, cases were individually described. The presentation of the cases follows the same structure: general data, mental well-being, social functioning, dependency/control and the bed. The interviews were transcribed verbatim, and these transcripts were sent back for member check. During the data analysis, data saturation was reached. Therefore, a six-step thematic analysis (Braun and Clarke, 2006) was conducted by two of the authors. Consensus was reached about the results. In order to provide a more in-depth overview of the cases, the cases are presented as short life stories, which are followed by a thematic analysis of factors related to the use of technology in and around the bed.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age (y)</th>
<th>Sex (M/F)</th>
<th>Self-reported psychological well-being</th>
<th>Self-reported physical well-being</th>
<th>Number of hours spent in bed per day</th>
<th>Nursing home</th>
<th>Duration of residence (mo)</th>
<th>PCS SF-12</th>
<th>MCS SF-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>94</td>
<td>F</td>
<td>Depression</td>
<td>Disturbed equilibrium.</td>
<td>20</td>
<td>1</td>
<td>35</td>
<td>24.0</td>
<td>19.1</td>
</tr>
<tr>
<td>B</td>
<td>83</td>
<td>F</td>
<td>—</td>
<td>Arthritis in knees</td>
<td>14</td>
<td>2</td>
<td>6</td>
<td>23.8</td>
<td>36.1</td>
</tr>
<tr>
<td>C</td>
<td>97</td>
<td>F</td>
<td>Feelings of loneliness</td>
<td>Arthritis in knee, shoulder and hand</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td>33.4</td>
<td>47.4</td>
</tr>
<tr>
<td>D</td>
<td>61</td>
<td>M</td>
<td>—</td>
<td>Amputation of the legs</td>
<td>15</td>
<td>2</td>
<td>1</td>
<td>17.3</td>
<td>50.4</td>
</tr>
<tr>
<td>E</td>
<td>84</td>
<td>M</td>
<td>—</td>
<td>Left-sided paralysis</td>
<td>14</td>
<td>2</td>
<td>30</td>
<td>26.5</td>
<td>26.9</td>
</tr>
<tr>
<td>F</td>
<td>78</td>
<td>F</td>
<td>Depression</td>
<td>Back pains</td>
<td>13</td>
<td>2</td>
<td>60</td>
<td>29.1</td>
<td>18.9</td>
</tr>
<tr>
<td>G</td>
<td>75</td>
<td>M</td>
<td>—</td>
<td>Left-sided paralysis</td>
<td>15</td>
<td>2</td>
<td>6</td>
<td>19.3</td>
<td>54.2</td>
</tr>
</tbody>
</table>
3. Results
First, the cases are described in detail. Second, results of the thematic analyses are presented.

3.1 Case studies

3.1.1 Case respondent A. Respondent A is bedfast mainly because of dizziness, especially when she tries to sit upright. Overall, she does not feel well. The main problem is facing boredom, as she had no hobbies or activities that she can participate in. She feels locked out of the outside world, as she can no longer watch the news or read a paper. She joins other residents for meals, but she is not able to engage and interact with them. This is why she returns to bed around 18:00, so that she can fall asleep and forget about her days. Social interaction with next of kin is limited to a fortnightly visit by a daughter, and there are weekly visits by a friend. She dreads being dependent and wishes to do as many things as possible. She would like to have a remote control to operate the lights and curtains. Her bed is fixed in height and cannot be lowered or raised. Because she thinks the bed itself is too low, she has an extra mattress. She does not need a bed that can be positioned electronically. She compares a nursing home bed to a hospital bed. Because of the dizziness, she does not want her bed to have a head-end that can be raised. Being able to raise the mattress at the leg-end is not considered necessary, as she uses a little pillow to lift one of her knees.

3.1.2 Case respondent B. Respondent B has a low expectation of the day to come when she wakes up, as her life is boring. She has no activities that she enjoys, she has little interest in things around her and takes no initiative. One daughter visits on a daily basis. The social interactions with other residents are very limited, but sufficient. At the same time, she indicates that she does not like sitting alone in her room all day long. Sometimes she goes to a communal room to engage with others. She wished she was able to conduct tasks independently like getting out of bed without the use of a hoist, which frightens her. From the bed, she is able to control the front door. She would like to control the lighting from her bed or wheelchair, too. Instead she can alert the staff with a push button. The bed itself is fine and lying in bed is not a burden. She is able to lie well during the whole night on a normal mattress. The positioning of the bed in the room and the position the bed is in are satisfactory. She used the positioning functionality to adjust the back-end of the mattress. She cannot adjust the leg-end of the mattress, but this is not a must. The bed rails give her a sense of security when going to sleep. She gets help from staff to adjust these rails.

3.1.3 Case respondent C. Respondent C spends her days in bed mainly because of arthritis. She is not able to walk around independently. Spending her days in bed is not a voluntary choice, but the care professionals make her go to bed at 19:30 after spending time in the living room. She is taken out of bed at 07:30. When in bed, she tends to watch television until midnight. She looks forward to group activities, because it is an opportunity to meet and engage with others. Having no children, she is only visited by a niece and a nephew on a weekly basis, as well as by a neighbour. She lives in a room in the middle of a corridor, so that she can enjoy people walking by if she leaves her door open. She is taken out of bed using a hoist, which illustrates her dependence on others. She likes the fact that she can operate the front door. She also wishes to control curtains and lighting using a remote control, as staff forgot to shut the curtains once. The bed is satisfactory, including the standard mattress. She states that she would have liked to keep her own sheets, as these were brand new when she was admitted to the nursing home. She likes the fact she has different sheets and blankets for each of the seasons. She is fine with the rails of the bed being in the upright position and the positioning of the bed in the room, which allows her to look through the window. She has problems operating the buttons of the remote control. One time, this made her leg-end go up all the way, and she did not know how to make it go down again.

3.1.4 Case respondent D. Respondent D experiences pain all day long and at 19:00 he is administered additional oxygen to cope with the consequences of COPD. He does not mind to be in bed early, even though he is taken out of bed as late as 10:00 in the morning. Respondent D likes to go outside, smoke a cigarette, read a paper and go to the supermarket to do groceries. He has no children, but is visited by nieces. He eats inside his room, as he had some negative
experiences in the communal dining room. He is still a very sociable person who talks a lot to other residents. He does not feel dependent, as he feels he is able to do a lot of things independently. The two things he needs help with is getting in and out of bed and visiting the toilet. Having experienced pressure sores in the past, he sleeps on an inflatable air-mattress. If he ever needs to go to hospital, he only wants to go if he can have an air-mattress too. He is satisfied with the self-adjustment settings of the bed.

3.1.5 Case respondent E. Respondent E deals with the consequences of a stroke which led to a half-sided paralysis. He is put in bed at 19:30 every evening and taken out again around 08:00 in the morning. In the afternoon he also spends about one hour in bed. He actually does not want to be in bed any longer, because he feels that his condition is deteriorating rapidly. Feeling dissatisfied with his life, he sometimes gets angry. He has a hard time dealing with being alone, and reading and watching television are daily pastimes. He enjoys being outdoors, and once in a while he drives around in a mobility scooter. He gets daily visits from one of his children. The social interaction with fellow residents is limited, which he regrets. He enjoys participating in the various activities offered by the nursing home, such as eating together. At present, he operates the light switches with a shoehorn to press the switches. He is not satisfied with the temperature control and the draughty air-based heating and cooling system. Neither is he satisfied with the bed and the mattress, as it makes him perspire a lot. He actually looks forward to getting a new foam mattress. At night, he tells the nurses when he is in a comfortable position. He is rolled, so he lies on his side and he is kept in the desired position by placing two pillows behind his back. The blanket has many frayed ends, which tickle his face. There are times when he feels locked up inside his bed, and he tries to climb out at night, despite the rails being in the upright position. The control buttons of the bed are not very clear, which makes him end up in the strangest of positions.

3.1.6 Case respondent F. Respondent F has back pains, and spends a lot of time in a wheelchair. She is tired of living, and misses the ability to be cheerful. When she goes to bed at 19:30, she is devoid of energy and happy to go to bed. However, she cannot fall asleep, as she is worrying all of the time. One of her sons visits her twice a week. She wishes she had more conversations with others. She says that she is not the ideal person to talk to, because of her wish to die. Because she does not want to spend all day alone in the own room, she decided to spend time in the lounge. When in need for something, she is able to alert using a bell. She has no need for remote controls, as she is already able to operate the automated front door. She can hear the sounds coming from the door, but she has no idea whether the door is actually open or closed. The bed itself is fine as it is, as is the inflatable air-mattress. The staff adjust the bed in the position she wants. She has no need to do the adjustments herself.

3.1.7 Case respondent G. Respondent G deals with the consequences of a half-sided paralysis, delirium and an impaired vision. He is put to bed at 18:45 and taken out again at 07:30 in the morning. In the afternoon, he returns to bed for another two hours. He has problems remaining seated in a wheelchair for prolonged times, which is then tilted in order to shift the pressures on his body. His wife visits every day, and his three children visit on a regular basis. He does not interact often with fellow residents, but he would like to take part in activities. He is reluctant to ask for help by pressing an alert. He is not satisfied with the bed; the bed frame is too large for the small mattress, which makes the pillows fall behind the mattress all the time. The inflatable air-mattress is satisfactory and comfortable. He does not mind if the bed rails are in the upright position, it keeps him secure from climbing out at night. He can adjust the bed himself, but he has trouble understanding how to operate the control buttons. Whenever the care professionals adjust his bed, he asks them about how they did it, and he tries to copy. He thinks that the wire connecting the control device to the bed itself is inconvenient, as it makes the device much heavier. He has suggested instructions be provided for new residents about how to operate the bed. He would like a built-in light in the bed frame, which would allow him to use a dim light without having to switch on the general lighting at night.

3.2 Thematic analysis

Two main themes have come to the fore from the interviews, which are related to technology, namely acceptance of dependency in relation to technology, and innovations to the bed.
3.2.1 Acceptance of dependency in relation to technology. Six out of seven participants are taken out of and put in bed using a hoist, which is seen as a confirmation of being dependent on a care professional for a basic task. Accepting this dependency can be difficult:

[Respondent F]: I can’t do anything by myself anymore. It makes me feel so bad, and it is so hard to cope with. I got depressed when I became totally dependent on others. When they take me out of bed with the hoist, the nurses chat with one another, and not with me. Why don’t they talk to me too? I feel left out!

Four out of seven participants are not only in bed during the night, but also during the afternoon. The other three spend at least 12 h in bed during the night time hours, something that is not of their own choice. All participants spend a part of the day being seated in a wheelchair, although respondent A is able to walk short distances with the use of wheeled walker. Despite these abilities, there seems little time to supervise her during her short walks. And it is also noteworthy that this participant spends the longest time of day in bed, about 20 h:

[Respondent A]: My health is getting worse so fast. I have a wheeled walker, but they won’t let me walk on my own. Only when someone guides me. But they never have the time to walk with me. It would mean the world for me if people practice more with me, so I become independent again. It would mean the world for me if I could only walk once a day.

Six of the participants explicitly stated that they feel dependent on others and that they have problems accepting this feeling. This is also expressed in the overall reluctance to ask for help, for instance, by pushing the alert buttons. Four of the participants stated that they only ask for help if it is truly necessary. When the residents have to visit the toilet, they often alert when it is too late and have already used incontinence material. Three participants explicitly mentioned that they often have to wait for help to arrive for too long:

[Respondent C]: If I push the alert button, I often have to wait for half an hour, before a nurse stops by. The longest I had to wait for was 45 minutes. As I had to hold up my urine for too long, I got a urinary tract infection, and now I have to live with a catheter. I also had to hold up my [faeces]. It gives me bad stomach aches.

In order to regain a sense of control, technological options were mentioned. Five participants expressed their wish to be able to control the lighting from the bed with a remote control. Four participants wanted to operate the curtains from the bed using a remote. And three participants wanted to control automated and operable windows from the bed:

[Respondent E]: I don’t want to wait for half an hour. I would be so happy if I could control the lights, the curtains and the window by remote control. I would make me feel less dependent. And it is more convenient than using a shoe horn for switching off the lights.

The remote itself does not appear to have been well designed for disabled people. Large buttons, a more logical layout and an ergonomic design including a flat back in order to prevent it falling off a surface when it is put down would be helpful:

[Respondent G]: I’d like to have a single remote control for everything; the television, the lights, the window, and the curtains. The remote control needs to be flat on the back side, so that it stays on the bedside table without falling off.

Respondents wanted a quick follow-up when in need for assistance. One option that was mentioned was a so-called toilet-button, which could be used to indicate one has to make a sanitary stop, and which expresses the urgent need for a member of staff:

[Respondent D]: I had to leave my own home for a nursing home, as the home care organisation could not guarantee that they would be at my bed when I had to go to the toilet. I wish I had a button to push.

These controls could be part of a tablet computer, which could also be used for social interaction with loved-ones, for instance, through sharing photos and Skype conversations from the bed:

[Respondent E]: She <his sister> lives in America. I’d like to Skype with her on the computer in my room, but I can’t [operate the device].

3.2.2 Innovations to the bed. The bed, in which a significant amount of time is spent by the participants, is an integral part of daily life. Therefore, it is important that the bed is comfortable,
and can be adjusted to personal preferences. Two of the participants were not satisfied with the bed. One of them stated that the mattress was the source of discomfort. In the other case the size of the bed was too large compared to the size of the mattress, which made the pillows drop in between the bed frame. Four of the participants had a normal mattress and three of them were satisfied with it. The other three had an inflatable air-mattress. The satisfaction with air-mattresses was large:

[Respondent D]: If I ever need to go to hospital, I won’t go lie in a bed if there is no air-mattress.

One of the participants explicitly mentioned the role of the mattress in excess perspiration, which wakes him up at night and impairs his sleep quality. The position of bed was satisfactory for six of the participants, particularly, because if they wished change its position, they had already done so. One participant wished to move his bed in order to have some space for his wheelchair next to the window:

[Respondent E]: The bed should be moved to another place in the room. I’d love to sit in front of the window with the wheelchair.

All seven participants were satisfied with the settings (positioning) of the bed, although in one case the bed could not be adjusted. Five of them managed to adjust their beds themselves, using the control buttons, though three participants found it hard to do so:

[Respondent C]: The buttons all look the same.

One participant mentioned the connection cable to be obstructive and contributed to the weight of the device. In the case of the one bed that could not be adjusted, there was no need for an adjustable bed as such beds that resembled a hospital bed. The look and feel of the bed itself was thus an issue for this participant, who stated that a bed needed to look like a regular bed she had at home. She was also afraid to slide down the mattress if she adjusted the bed in such a position that the head-end was raised up, being in half-seated and half-reclined position. One of the participants valued the help from the nursing staff in adjusting the bed frame. Six participants had bed rails, which helped them to stay in bed and feel secure. Only one of the residents expressed the wish for a built-in night light:

[Respondent G]: I don’t understand these buttons, and the remote control. When the nurse stops by to adjust my bed, I ask her which buttons she used, so I can copy cat her the next time.

4. Discussion

4.1 Strengths and limitations

One of the great strengths of this study is that it explores the actual perspectives of bedfast nursing home residents. Moreover, it makes a contribution to the limited evidence currently available on the QoL of these people and their use of and attitudes towards technology (for instance, Imai et al., 2015). This study has shown that residents who are bedfast in nursing homes have a relatively low QoL, which was related to being confined to bed for prolonged times, experiencing a large degree of dependency on others, limited participation in social and daily life and displayed different ways of adjusting or coping with their situation. Participants in this study indicated that small, but significant, improvements to their perceived QoL could be achieved by the introduction of new technologies to control the bed, to ask for help from nursing staff, to control the room itself (curtains, opening doors) and to engage in social contacts, for instance, through the use of tablet computers. The interviews showed that the limited opportunities for social engagement and social participation, and different styles of coping with being dependent on others are important factors in this low level of experienced QoL.

This study also has some limitations. Despite the predicted percentage of bedfast nursing residents, it was difficult to recruit participants. Many of them have severe psychogeriatric health problems, which meant that they could not be included in the study. The participants of the study are not fully bedfast, and qualify in the lower end of the spectrum of bedfastness. Future research could include participants occupying their beds for a wider range of hours.
4.2 Relation to other studies

There are similarities between the findings of this study and an earlier one by van Hoof et al. (2015), in which professionals explored and generated design concepts for the direct environment of bedfast residents through interdisciplinary participatory design sessions. The stimulation of social relationships was an important theme in eight of the scenarios. The professionals suggested the use of tablet computers in order to stimulate social interaction with relatives, friends and co-residents (van Hoof et al., 2015). Additional features of such tablet computers would be functionalities like the control of lighting and curtains. Participants in this study indicated that such features may help them in improving their sense of control. One issue that emerged from the interviews was the need to go use the toilet. Imai et al. (2015) studied the optimal bed reclining angle for promoting efficient and safe defecation in bedfast patients. They found that higher reclining angles may enable safer and more efficient defecation. In our study, people explicitly indicated that they wanted to physically use the toilet, instead of being assisted defecating in bed.

4.3 Future research

Future research could test the proposed solutions from this study with bedfast residents. The question remains if people, who are bedfast, are actually able to control devices such as tablet computers, as we know little to nothing about the digital capabilities of these people. This would require more in-depth usability and human factors studies, for instance, in terms of dexterity or visual acuity. It is not certain if these suggested improvements do indeed lead to a higher level of perceived independence, control, autonomy and QoL. At least we could accept that not all are able to use these devices but if they can, it might improve their well-being through an enhanced ability to control the immediate environment. Future studies could also differentiate between the various levels of being bedfast and personal coping styles, as these factors may impact the relevance of proposed technological improvements.

5. Conclusions

Bedfast nursing home residents included in this study experienced a low QoL, which partly stems from the dependence on care professionals. Participants found it hard to accept that they are no longer independent, which is also a cause for postponing a call for help for as long as possible. They stated that being able to control features in the room from the bed would improve their independence and autonomy. Overall, participants missed having social interaction with others. The beds themselves were considered comfortable, especially by the participants who had inflatable air-mattresses. Tablet computers or remote controls could be used to adjust beds to personal preferences. Such interfaces should be easy to understand and help people to adjust the bed without finding themselves in unwanted positions that are hard to correct and require assistance from care staff.

References


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Real-time location systems in nursing homes: state of the art and future applications


Abstract

Purpose – In the domain of healthcare, both process efficiency and the quality of care can be improved through the use of dedicated pervasive technologies. Among these applications are so-called real-time location systems (RTLS). Such systems are designed to determine and monitor the location of assets and people in real time through the use of wireless sensor networks. Numerous commercially available RTLS are used in hospital settings. The nursing home is a relatively unexplored context for the application of RTLS and offers opportunities and challenges for future applications. The paper aims to discuss these issues.

Design/methodology/approach – This paper sets out to provide an overview of general applications and technologies of RTLS. Thereafter, it describes the specific healthcare applications of RTLS, including asset tracking, patient tracking and personnel tracking. These overviews are followed by a forecast of the implementation of RTLS in nursing homes in terms of opportunities and challenges.

Findings – By comparing the nursing home to the hospital, the RTLS applications for the nursing home context that are most promising are asset tracking of expensive goods owned by the nursing home in order to facilitate workflow and maximise financial resources, and asset tracking of personal belongings that may get lost due to dementia.

Originality/value – This paper is the first to provide an overview of potential application of RTLS technologies for nursing homes. The paper described a number of potential problem areas that can be addressed by RTLS.

Keywords Dementia, RFID, Nursing home, Tracking, Real-time location systems, Track and trace

Paper type Conceptual paper

1. Introduction

State-of-the-art technologies are available on the marketplace, which tell us our location within narrow margins of error. So-called real-time location systems (RTLS) are applied in a broad spectrum of industries, such as logistics, the food industry, the automotive, aerospace and defence sectors, mining, amusement parks, building and construction, and the retail sector (Malik, 2009; Curran, 2014; Li et al., 2016). RTLS are used to manage the supply chain and monitor inventory (Attaran, 2012), schedule asset maintenance (Roe and Mba, 2009), optimise workflow and processes, increase safety and enhance the customer experience (Malik, 2009). These goals can be achieved by tracking people (personnel, clients and customers) and assets (mechanical parts, packages and equipment).

RTLS have been around for over a decade and found increasing usage in hospital care. Nursing home care is still a relatively unexplored context when it comes to the application of RTLS. In this paper, the potential of the use of RTLS in nursing homes is explored. Existing RTLS applications and technologies are compared to the requirements and opportunities that are identified in the nursing home context. This is done by providing an overview of RTLS, by presenting an outline of
RTLS and their applications in healthcare settings in general, and describing the potential of RTLS for nursing homes by evaluating the processes in nursing homes as well as the needs and challenges of stakeholders.

2. RTLS and the technologies used

RTLS make use of physical tags that can be connected to mobile objects or to people, and sensors and digital middleware (i.e. software that acts as a bridge between an operating system or database and applications, especially on a network) to process information in order to locate people or objects in real time. The signals that the sensors send to and receive from the tags are processed by location engine software, which turns the signals into readable information (Figure 1). RTLS can be applied both indoors and outdoors and cover a limited area, i.e., depending on the size and signal strength of the system. By placing location sensors throughout a building on strategic positions, the location of these tags (and thus the person or object) can be determined and communicated in real time.

Radio Frequency Identification (RFID) and Wireless Local Area Networks (also known as WiFi) are at the basis of most commercial RTLS applications (Wang et al., 2013; Kirov et al., 2015). Other solutions are based on infrared (IR), Ultra-Wideband, BlueTooth and ultrasound (Liu, 2007). In practice, a combination of technologies is often applied. Some of these technologies require the installation of new and separate hardware in a building, which increases the overall costs (Krohn, 2008). Every technology has its own set of advantages and disadvantages. WiFi is relatively cheap and easy to install, but the signal can penetrate walls and can, therefore, not be used to locate at room level (Krohn, 2008). IR is suitable for room-level location but requires a clear line of sight from the tag to the sensor (Kamel Boulos and Berry, 2012). Therefore, an environment has to be carefully analysed to determine which technology works for the requirements that are demanded from a system (Fisher and Monahan, 2012).

There are different types of tags used in RTLS, namely passive, semi-passive and active tags. The difference between these tags lies in their ability to transmit signals. Passive and semi-passive tags are not able to transmit signals and can only be detected by location sensors by returning a signal. Active tags are battery powered and actively send information about their location. This gives them a longer detection range than passive and semi-passive tags. Semi-passive tags use batteries too, but mainly for secondary functionalities, such as emergency push buttons, temperature sensors or accelerometers (Malik, 2009). Information from these sensors is included in the data the location sensors receive, and provide additional contextual information, for instance, whether a device is in use. The ability of a tag to transmit signals or collect additional data influences its price. Battery-powered tags require the replacement of batteries on a regular basis.

Figure 1 Visualisation of the working of a real-time location system
basis, which adds to maintenance costs. There are tags available on the marketplace that only transmit a signal when the tag is being moved, which saves battery power (Shukla et al., 2014). For most applications, the location data do not have to be available 24–7, but only upon request. Often assets are only moved once or a few times a day, or even less frequently. Moreover, tags can be located with different levels of accuracy, from knowing whether a tag is or is not present in a certain area to knowing the exact location of the tag. Different options for locating the tags are: locating at choke points (knowing when a tag passes a door), locating by associating (knowing which tags are close to each other), locating at room level (knowing in which room a tag is), locating precisely (knowing the exact spatial coordinates), and locating at sub-room level (knowing the location of a tag in a smaller area within a room) (Malik, 2009). Strategic placement of the location sensors can optimise the network coverage inside a building (Oztekin et al., 2010; Pietrabissa et al., 2013). In order to determine the position of a tag, various localisation methods are used to determine the distance between the tag and location sensor(s). Subsequently, estimation algorithms calculate the position of the tag (Malik, 2009). More elaborate overviews of RTLS technologies, localisation methods and algorithms are available (Kirov et al., 2015; Liu, 2007; Zekavat and Buehrer, 2011; Goswami, 2012).

3. RTLS: applications in healthcare

Within the domain of healthcare, RTLS are predominantly used in hospitals (Kamel Boulos and Berry, 2012; Fisher and Monahan, 2012), and to a lesser extent in nursing homes (Raza et al., 2013). Within hospitals, RTLS are used to track assets (like equipment, drugs and specimens), personnel and patients (Krohn, 2008; Fisher and Monahan, 2012; Fosso Wamba et al., 2013). The tracking of people is mainly conducted in the USA and not in Europe due to privacy legislation (Ebbers et al., 2017a, b). Within nursing homes, RTLS are mainly used to track residents, for instance, in the case of wandering behaviour. The localisation functionality of such systems is often combined with other monitoring technologies, such as fall detection (Charlon et al., 2013; Doshi-Velez et al., 2012; Lin et al., 2014; Nishimura et al., 2015). Elia and Gnoni (2013) found that numerous RFID projects were undertaken in the healthcare sector, mainly in the domain of asset tracking, as well as patient and staff management. In the following sections, these three applications are described in more detail.

3.1 Asset tracking

Asset tracking is currently the best use for RTLS application in hospitals, because tracking people (staff, patients) leads to resistance and tracking people is often motivated by unconvincing reasons, such as improving efficiency and processes (Fisher and Monahan, 2012). Assets that are being tracked include (medical) equipment and assistive devices like infusion pumps and wheelchairs, and materials and samples, including blood samples, medicines and biopsy specimens (Najera et al., 2011; Iadanza, 2009; Coustasse et al., 2015).

Castro et al. (2013) monitored the infusion pump usage in a Dutch hospital, and identified inefficiencies through the use of RTLS, including inventory shortages, asset sub-utilisation, waste of staff time, service delays, maintenance delays and information silos. Using RTLS for equipment tracking may, thus, fulfill various needs. Hospitals own a plethora of different mobile equipment, and these assets are at risk of becoming lost or mislaid. Inventories are often larger than required and some of this equipment remains unused (Najera et al., 2011). Particularly when equipment is shared between different departments, it is not unusual for personnel to “hoard” equipment so they have enough in stock in their own department (Krohn, 2008). Estimates indicate that hospitals purchase an excess of 10–20 per cent mobile equipment than is required for adequate care (Kamel Boulos and Berry, 2012). This results in unnecessary expenses on purchases, renting and maintenance. Another major cause of unnecessary expenditure is theft. Van Lieshout et al. (2007) estimated a potential annual loss of $3.9bn in US hospitals due to asset theft. Also, medication, blood samples or blood bags could be tracked. Adding intelligence to these processes can help prevent patients from getting the wrong medication or even faulty blood transfusions (Iadanza, 2009; Coustasse et al., 2015). In the case of medication, theft can also be a problem that is caused by both patients and personnel, for instance, due to substance abuse (van Lieshout et al., 2007).
The deployment of RTLS in hospitals for asset tracking can help maintain an overview of the different mobile assets inside the building and alert technicians when maintenance is due or required (Castro et al., 2013). It can help personnel to quickly locate equipment, and thus ensure improved safety and security in case of an emergency. Asset tracking can increase asset utilisation and decrease costs (Castro et al., 2013; Tzeng et al., 2008). Demircan-Yıldız and Fescioglu-Unver (2015) showed that even in a medium-sized hospital, asset tracking through RTLS can significantly reduce asset-to-patient time and the time staff spend on transferring assets. The less time is spent on looking for equipment, the more time can be spent on patient care. This, in turn, increases the efficiency and quality of healthcare processes (Castro et al., 2013).

3.2 Patient tracking

Using RTLS to track patients can help the optimisation of care processes. First of all, it is important to know where patients are inside a facility. Often nurses and other staff spend time looking for their patients. RTLS can simplify the process of finding and identifying patients and requesting (medical) information (Yazici, 2014). Monitoring patient flows can help improve the services and indicate bottlenecks (Vakili et al., 2015). Furthermore, RTLS can be used to associate and disassociate equipment and devices with a patient (Rezaee et al., 2014). RTLS for patient tracking can enhance patient care by optimising patient flows, prevent medical errors and speed up processes (Tzeng et al., 2008). Especially in nursing homes, RTLS are used to monitor wandering behaviour. By combining RTLS with smart actuators on exits, doors can be strategically and automatically locked and prevent residents from going somewhere that might expose them to risk. Finally, RTLS are useful for identifying whether people have been close to infectious sources, such as other infectious people (Swedberg, 2012).

3.3 Personnel tracking

The third common application is the tracking of staff. Many of the tags that are worn by personnel are equipped with emergency push buttons, which can be used in case of an emergency. In other cases, RTLS are used to monitor the adherence to hand hygiene protocols in order to reduce infection risk (Baslyman et al., 2015). In this case, personnel are monitored or alerted whenever they forget to wash their hands at specified moments. Furthermore, RTLS can be used to monitor whether personnel have been in contact with infectious patients (Swedberg, 2012). RTLS have the potential to improve the productivity of staff by reducing mundane and repetitive tasks, for example, by the automatic registration of a call that has been followed up through the presence of the nurse in a patient room (Kamel Boulos and Berry, 2012). RTLS can be used to assess and optimise workflows. The time spent per patient can be measured and the data can be used to improve the logistics (Shukla et al., 2014; Jones and Schlegel, 2014; Puiatti et al., 2014). Additionally, the analysis of walk-rounds of staff has the potential to improve educative processes within the hospital (Ward et al., 2014). Utilising the system in connection with smart actuators can automatically unlock and open doors when personnel are walking through corridors. However, numerous privacy issues often arise when personnel are tracked (Fisher and Monahan, 2012; Ebbers et al., 2017a, b).

4. Analysis of RTLS applications in healthcare

Many insights can be learnt from existing RTLS projects described in the literature. Insights into the (potential) barriers are of particular interest, which include user acceptance, privacy and security, technical issues, financial aspects, and benefits of the technology (Fosso Wamba et al., 2013; Reyes et al., 2012; Lai et al., 2014; Alemdar and Ersoy, 2010). In addition, there are challenges concerning the vendors of RTLS and the types of technologies they offer, such as off-the-shelf solutions.

4.1 User acceptance

User acceptance of technology is an important factor to consider when implementing RTLS in healthcare. In short, care professionals need to be “on board”, as multiple studies have pointed
out (Fisher and Monahan, 2008, 2012; Castro et al., 2013; Yazici, 2014; Zigman et al., 2009; Bowen et al., 2013). Fisher and Monahan (2008) studied the social dimensions of RFID systems in hospitals. The surveillance possibilities of such systems worried the hospital personnel. Staff experienced an intensified work load because maintaining the system was given as an additional task. In a later study, Fisher and Monahan (2012) found that for a successful deployment many organisational barriers must be overcome, including a lack of clarity about the responsibility of use and maintenance of the system and a general sense of resistance. In one of the studies, tags were sabotaged by personnel because it was believed that their clinical activities were surveyed. Often myths arise about the technology, and the information that is being gathered. Especially nurses are concerned that the technology is designed to track their work habits (Kamel Boulos and Berry, 2012; Bowen et al., 2013). In a study by Bowen et al. (2013), both nurses and residents of a long-term care facility were tracked, and both groups developed concerns about the technology. Nurses believed that the frequency and length of breaks were monitored.

Another aspect that influences user acceptance is how well the technology works. Fisher and Monahan (2012) identified underperforming technology as one of the main barriers for successful deployment. Okoniewska et al. (2012) found that staff were generally discouraged to use RTLS due to inaccuracies. Yazici (2014) argued that user acceptance is higher when needs on the work floor are understood. The readiness of staff before the adoption of new technologies plays a significant role in how healthcare facilities can benefit from such systems. Zigman et al. (2009) emphasised that an effective implementation requires understanding, experience and continuous education of staff.

Some researchers have tried to overcome the barriers posed by poor user acceptance. Guédon et al. (2014) presented an RFID-specific participatory design approach in which multidisciplinary user groups were involved throughout the design process. This was an effective approach to implement such RFID technologies. Castro et al. (2013) presented a phased implementation of an RFID-based system for asset management that facilitated getting familiar with the system and improved the acceptability.

Privacy and security

Privacy concerns influence the acceptance of RTLS. When information is collected about the location of a person, secondary information can be obtained, such as how long staff take breaks from work. The tracking of assets can also go together with privacy issues; when a tag is attached to a wheelchair, the location and movement of the user can be determined too (Ebbers et al., 2017a, b). Especially when it comes to people with dementia, it is hard or even impossible to get informed consent required for collecting data. Pervasive technologies can have both beneficial and harmful ethical implications (Detweiler and Hindriks, 2016). Older adults may sacrifice privacy for the sake of remaining independent. When privacy concerns from stakeholders are not properly addressed prior to the implementation of RTLS, staff may refuse to wear the tags or use the system (Kamel Boulos and Berry, 2012). Also, systems should be checked for data security properly before implementation, i.e., that data are not inadvertently or deliberately obtained by an unauthorised individual or organisation. Safeguarding of patient data is a very important obstacle when using RTLS in healthcare (Rosenbaum, 2014). Encryption can help keeping data confidential. An additional challenge is posed by the intrusiveness of visible RTLS. People may only trust non-visible technology because people are unaware of it (Santoso and Redmond, 2015). Several solutions are presented in the literature for overcoming safety, security, privacy and technological issues in relation to RTLS (Najera et al., 2011; Abu Rrub et al., 2012).

Technical issues

Challenges related to technology may arise when RTLS are implemented. A major problem is that various technologies react differently to particular environments and structures. Every space where RTLS are installed should be evaluated individually (Fisher and Monahan, 2012). Sometimes existing networks in the building are utilised, especially WiFi networks, because this can reduce the installation costs. The quality of the network can be decreased by the
“competition” from other applications using the network, and such systems are often less accurate (Castro et al., 2013). Another technological issue is the interference of the RTLS with other devices (Kapa et al., 2011; Iadanza, 2009; Najera et al., 2011), which is an unwanted side effect in healthcare as it may pose a risk to patient safety.

4.4 Commercial RTLS vendors

Numerous commercial enterprises supply RTLS and accompanying services to healthcare organisations (Krohn, 2008). Off-the-shelf solutions are not the way to achieve successful deployment of the systems. The unique environment of a healthcare facility poses such great challenges, that installing a standard system without properly analysing the environment is not viable (Fisher and Monahan, 2012; Iadanza, 2009). Vakili et al. (2015) presented a study on patient flow information in an outpatient clinic that compared a custom-made RFID-based RTLS that requires active swiping by the patient and an IR-based commercially available RTLS. They found that both systems were effective in providing patient flow information and were equally accurate. The custom-made RFID-based RTLS were installed at only 10 per cent of the costs.

5. RTLS applications in nursing homes

The majority of the existing RTLS projects in the domain of healthcare are used in the hospital environment. There are essential differences between hospitals and nursing homes in terms of processes and procedures. In the following paragraphs, the differences between the two context are explored, and current RTLS projects in nursing homes are reviewed.

5.1 Character of hospitals vs nursing homes

Hospitals mainly focus on “cure” and the treatment of patients, nursing homes mainly focus on “care” and have a residential model. The majority of hospital patients stay for a short period of time, usually a few hours to a few days. In nursing homes, residents stay for a prolonged period of time, often months or years. Residents live in the nursing home and are tenants of their own room. Many residents cope with dementia. Whereas hospitals deal with a daily, dynamic patient flow of varying individuals, the nursing home population is well known by staff members.

In both contexts, professionals (including nursing aides and medical doctors) are the main users of care and medical technologies, ranging from expensive, high-tech systems used in operation theatres, to patient hoists and wheeled walkers in nursing homes. There are substantial differences in how accustomed staff are to the use of technologies, which impacts the design of RTLS in terms of interface design, level of complexity, legibility and the functionalities of the system. Hospitals often have highly organised support systems including technicians, ICT support, and sophisticated logistics in comparison with nursing homes. In the case of the Netherlands, there is an increasing amount of outsourcing of such services in nursing homes, which results in an ever-increasing gap between technical support in both contexts. Moreover, hospitals have a much larger gross surface area than nursing homes.

In hospitals, all assets are owned by the hospital organisation itself or leased from specialised companies, apart from some small personal items brought along by the patient or staff. In nursing homes, most of the items inside private rooms are physically owned by the residents. Care technologies and the furniture inside communal living areas are mainly owned by the nursing home organisation.

5.2 Current RTLS in nursing homes

RTLS are used for two main purposes in nursing homes: to ensure the safety of residents and to support personnel in (efficiently) caring for the residents (Charlon et al., 2013; Doshi-Velez et al., 2012).

Risky wandering behaviour is managed by tracking the location of residents and preventing them for wandering off too far, exiting or accessing restricted areas. This can be done by
triggering a nurse call or in combination with automated (un)locking of doors. Doshi-Velez et al. (2012) tracked residents in a residential care setting with an RTLS system. The system increased the safety by alerting when residents left the building, and the operational efficiency due to decreased search times. The average searching time went down from 311 to 111 seconds. Tags for people with dementia can be designed as wearables like shoes (Nishimura et al., 2015), incorporated in wristbands (Bowen et al., 2013) or worn on the body (Charlon et al., 2013). Smartphones are gaining popularity when it comes to the location of older people (Zhao et al., 2012; Casilari et al., 2015), and even real-time communication between staff and residents can be established through these tags (Yu et al., 2015). However, Santos and Redmond (2015) advocated that people with dementia cannot be expected to wear any tags independently.

Most available studies on RTLS in nursing homes focus on tracking residents and staff, rather than on asset tracking. The present application of RTLS in nursing homes stays limited to the improvement of safety of residents and carers, not the efficiency of workflow, minimising of financial losses and inventory inefficiencies.

6. Future applications of RTLS in nursing homes

This section provides an overview of how nursing homes can benefit from RTLS applications. In addition, new applications are presented for tracking assets, residents and personnel (Table I).

6.1 Tracking residents

As stated before, RTLS can be a valuable means of detecting wandering and can be linked to automated doors, depending on the location of residents and their personal accessibility profiles. This provides a greater sense of freedom and independence. Current RTLS applications are still rather linear in the utilisation of location information. Kamel Boulos and Berry (2012) proposed an application of resident tracking where the mobility (such as daily distance walked) of the residents is monitored. This can inform carers about the mobility and well-being of the residents. Such a system can also be used to detect whether residents have left their room or visited the toilet. When data collection takes place in an unobtrusive, non-invasive way, in the home environment that is considered to be a safe haven, one might forget about the implications of data collection and transmission (van Hoof et al., 2007).

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</table>
6.2 Tracking personnel

In the nursing home, the most important opportunity for tracking personnel is in efficiency and optimising processes. Some processes can be automated, for instance, the registration of answered nurse calls, the work time registration and registration of the time spent per resident. This may alleviate staff from doing administrative tasks and increase the time they can spend on actual care and social interaction.

6.3 Tracking assets

Figure 2 describes the different types of assets that can be found within the nursing home, which are either owned by the nursing home or by residents (van Hoof et al., 2016).

6.3.1 Assets owned by nursing home. There are numerous assets that are either owned by the nursing home or leased for an extended period of time from specialised vendors, including medical and assistive devices, and furniture. Sometimes, equipment is “hoarded” by personnel in order to have enough items in stock, equipment gets mislaid for a longer period of time, or residents and their relatives are the cause of objects becoming lost, for instance, residents taking wheelchairs that are not theirs, or relatives bringing chairs from communal living rooms into private rooms without returning them (van Hoof et al., 2016).

Tracking assets owned by the nursing home has organisational benefits, resulting in more efficient workflows for personnel and lower (rental) costs for equipment if smaller stocks are needed due to better traceability. Furthermore, it allows care organisations and enterprises alike to benefit from user data. If information is available on how often and how intensively a bed, hoist or wheeled walker is used, these data show how equipment is being used, whether staff comply with occupational and safety regulations, and when maintenance is required. In addition, RTLS could allow for a better and more balanced use of equipment. When maintenance or repair workers arrive, they also know where to find the equipment they need to work on.

In the Netherlands, most nursing homes are part of a large organisation comprising many smaller homes on different locations. These locations share highly specialised equipment, including modified walkers and medical beds. In practice, the location of such equipment is unclear, and when the item is needed by a carer, the search is on in order to retrieve the object. An RTLS solution that can indicate whether or not an object is present in a building could make this process more efficient.

6.3.2 Assets owned by residents. Van Hoof et al. (2016) described a large number of goods that go missing in Dutch nursing homes, and described the problems associated with searching for the items. Some of the objects that get lost are not only dentures, glasses and hearing aids, but also more personal and irreplaceable items, like jewellery, disappear. These personal belongings
may get lost during laundry by commercial laundry companies or are accidentally thrown away.
In the case of hoarding behaviour, things may be hidden or stored away in bins, garbage bags
and other containers that are disposed of without notice.

Again, search time for these items reduces the time staff can spend on care for the residents.
Also, relatives and residents have to spend time searching, which is a source of stress and
tensions. Older individuals can be particularly affected when items get lost, and one has to deal
with the financial consequences when expensive aids need to be replaced. Tracking personal
items could be done with different levels of accuracy, depending on the goal. When the items
need to be found back in a room, then the systems need to have a high level of accuracy, but
when the goal is to prevent expensive medical aids like dentures from being thrown away, it
suffices to get an alert when the object leaves the building. A related problem that can be
addressed is that one resident may take another resident’s dentures and wear them like it were
her/his own. These dentures do not fit well, and this can remain unnoticed for a prolonged period
of time. The same may occur with other personal items.

7. Future developments and conclusions

The design of RTLS for nursing homes requires a study into future systems and services. Santoso
and Redmond (2015) predicted unobtrusiveness, inexpensive and simple indoor positioning
systems that will no longer be based on tags and sensors that have to be worn by clients.
Instead, the building itself and its infrastructures will monitor the people inside. The use of
smartphone applications in relation to real-time monitoring of people and items is expected to
become more dominant (Li et al., 2016; Lopes et al., 2014). Such approaches could potentially
enhance the ease of use, as smartphones are familiar and frequently used devices. The size of
tags is currently still rather bulky. Madrid et al. (2012) conducted a study in which RFID tags were
successfully placed into artificial dentistry. Such technology takes away the need for carving
names into the dentures for identification. The design of body-worn RTLS requires the active
involvement of end-users in the actual design process in order to make the devices as acceptable
as possible (Oude Weernink et al., 2017). Instead of needing separate tags, all future medical
assets may have integrated tags. Nowadays, active and semi-active tags still need battery power
in order to be operational, and wireless charging possibilities may offer a solution to this problem.

This article provided an overview of potential RTLS applications for the nursing home context, of
which asset tracking of expensive goods owned by the nursing home, and asset tracking of
personal belongings are the most promising. The applicability of RTLS in nursing homes can also
be extrapolated to other settings, such as residential care homes, provided that the scale of such
homes facilitates the installation of infrastructures and devices.

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doi:10.1007/s11273-007-0011-1


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doi:10.1109/PICMET.2013.6687696


doi:10.3233/978-87-7681-125-0-567


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A neurological and philosophical perspective on the design of environments and technology for older people with dementia

Maarten J. Verkerk, Joost van Hoof, Sil Aarts, Sylvia J.M.M. de Koning and Johanna J. van der Plaats

Abstract

Purpose – Older people with dementia (OPD) have specific housing and technology-related needs, for which various design principles exist. A model for designing environments and its constituting items for people with dementia that has a firm foundation in neurology may help guide designers in making design choices. The paper aims to discuss these issues.

Design/methodology/approach – A general design model is presented consisting of three principles for OPD, namely designing for ageing people; designing for a favourable state and designing for beautiful moments. The neurosciences as a whole give shape to an eminent framework explaining the behaviour of OPD. One of the objectives of this paper is to translate the design principles into design specifications and to show that these specifications can be translated in a design.

Findings – Philosophical concepts are introduced which are required to understand design for OPD. Four case studies from Dutch nursing homes are presented that show how the theory of modal aspects of the philosopher Dooyeweerd can be used to map design specifications in a systematic way.

Research limitations/implications – These examples of design solutions illustrate the applicability of the model developed in this article. It emphasises the importance of the environment for supporting the daily life of OPD.

Originality/value – There is a need for a design model for OPD. The environment and technology should initiate positive behaviours and meaningful experiences. In this paper, a general model for the designing of environments for OPD was developed that has a firm foundation in neurology and behavioural sciences. This model consists of six distinct steps and each step can be investigated empirically. In other words, this model may lay the foundation for an evidence-based design.

Keywords Environment, Dementia, Technology, Philosophy, Design, Alzheimer

Paper type Research paper

1. Introduction

Worldwide, there is a sharp rise in the number of older people with dementia (OPD). In 2010, there were approximately 35 million OPD, and this number is expected to rise to 115 million in 2050 (Prince and Jackson, 2009). The increasing group of OPD poses challenges, including the development of technology and housing that fit their needs (Brawley, 1997; Day et al., 2000; Calkins, 2009; van Hoof et al., 2009; van Hoof, Kort, van Waarde and Blom, 2010; van Hoof and Verkerk, 2013; van Hoof et al., 2013; Marquardt et al., 2014; Charras et al., 2016; Kazak et al., 2017; Kenigsberg et al., 2017). OPD cope with the same age-related health problems as other older people. For example, the sense of hearing, eyesight, and mobility (Ebersole et al., 2004; van Hoof, Kort, Duijnstee, Rutten and Hensen, 2010; Kenigsberg et al., 2015), are abilities that may deteriorate when growing old. Hence, the principles for designing for dementia ideally include principles that are applicable for the ageing population in general.
The design principles for age-friendly technology and housing are described in various manuals (Fischer and Meuser, 2009; Feddersen and Ludtke, 2011).

OPD, however, are also confronted with specific physical, emotional, and cognitive limitations that are inherent to their condition. Various researchers proposed design principles specifically aimed at the declining abilities of OPD (Lawton and Nahemow, 1973; Pynoos et al., 1989; Marshall, 1998; Cohen and Weisman, 1991; Brawley, 1997; Marquardt et al., 2014; Hadjri et al., 2015). These researchers proposed the provision of clear and well-structured environments that can serve as a guide to behaviour, memory and reality orientation. Steeman et al. (2007) emphasised that we should support the remaining competences instead of focussing only on the skills that OPD are lost. The current design principles for technology and housing for OPD are based on their own experiences and those of their relatives and carers. These principles are not very specific and lack a firm foundation in neurology and behavioural sciences.

In the last decades, new insights were gained regarding the relationship between dementia, brain processes and human behaviour. OPD are decreasingly able to comprehend the environment around them and to plan their daily activities given their own cognitive abilities (Zuidema, 2008; van der Plaats, 2010). The contribution of the cognitive part of the brain to the execution of adequate behaviour diminishes gradually, and the emotional part takes over step by step (Woods, 2001). Behaviour merely becomes an emotional reaction to stimuli from the environment (Cools, 2012). It has been proposed that the purpose of a well-designed building, its interior and technologies for people with dementia should be aimed at evoking deliberate behaviour (de Koning, 2012).

The general objective of this paper is to support architects and designers to design a building, its interior and its technologies that match the needs and wishes of OPD based on knowledge of neurology and behavioural sciences. We have three specific aims:

1. to propose a general model for designing for OPD that has a firm foundation in neurology and behavioural sciences;
2. to identify principles for designing housing for OPD; and
3. to develop a methodology to translate design principles in design specifications.

This paper has the following structure. In section 2 the general model and the research methodology is presented. In Sections 3–8 the different steps of the model are described and discussed. The paper closes with conclusions.

2. General model and research methodology

Evidence-based design is the “holy grail” for designing products, technology and housing for OPD (Ulrich, 2006; van Hoof et al., 2015). In our view, the development of evidence-based designs requires models that explicitly relate neurological processes, behaviour, design principles and design. Each part of this model should be subjected to the cycle of hypothesis formulation and scientific testing.

Figure 1 presents an overview of a general six-step model that supports the development of evidence-based designs for OPD. This model contains three critical parts:

1. the model has to be based on insights in the neurological processes of OPD and the resulting behavioural consequences (step 1–3);
2. the model has to support the development of design principles and has to give a clue to translate these principles in design specifications (step 4 and 5); and
3. the model has to support creative processes in which design specifications are converted into concrete designs (step 6).

We would like to make three remarks about this model and its application. First, this model is quite ambitious. It tries to relate neurological processes and behaviour of OPD on the hand and design principles and design specifications for housing, interior and technologies on the other hand. To relate data from different disciplines requires an overall philosophy. There is no guarantee such a
philosophy is available. Second, this model has the status of a hypothesis. The line of reasoning seems to be very logical. However, the model and every separate step has to be tested scientifically, which is an essential requirement of evidence-based design. In addition, its practical value for architects and designers has to be demonstrated empirically. Third, for practical reasons, there is a focus on older people with Alzheimer’s disease, which is the most prevalent cause of dementia. It is believed that this model can also be applied to other types of dementia and to people with early onset dementia.

The research methodology for the steps 1, 2 and 3 is a literature review (Seale, 2004). The most important selection criterion was to what extent papers gave insight into the relationship between neurological processes of OPD on the one hand and the daily behaviour of OPD on the other hand. The research methodology for step 4 is a combination of a critical review of design literature (Seale, 2004) and an extensive evaluation of case studies (Yin, 1994). The currently available literature does not present any guidelines to execute this step. The quality of the proposed design principles strongly depends on the skills and creativity of the researchers. The research methodology of step 5 is to select a suitable philosophical theory that has the ability to relate human behaviour and specifications for technological design (Verkerk et al., 2016). An absolute precondition for such a philosophical theory is that it provides insight in the nature of human beings, the character of technological artefacts, and the relationship between these two. For this step there is one practical consideration: the proof of the pudding is in the eating. The research methodology of step 6 is an empirical evaluation of case studies (Yin, 1994).

3. Step 1: neurological processes and behaviour of older people

The domain of neurosciences provides an increasing amount of knowledge on information processing (Goldberg, 2002). This section is focussed on information processing related to “normal older people” or “successful ageing” (Rowe and Kahn, 1997).

3.1 Historical overview

The British neurologist Jackson (1835–1911) was one of the first researchers to characterize information processing in the brain as a step by step process in which increasingly complex parts of the brain are involved (Meares, 1999). In the 1960s, Luria proposed that the brain is hierarchically organised (Luria, 1973). In his view, there is a hierarchy in the brain that consists of an increasing complexity of neurons combined with a “higher” location in the anatomical and functional brain that ranges from the brainstem to the frontal lobe. Subsequently, Powers (1973) distinguished different
hierarchical levels of which the highest levels have the most sophisticated information-processing capacity. All these levels are actively part of the information processing within the brain (Cools, 1985). At present, over twenty hierarchical levels can be differentiated in the brain, which may be summarised into four groups (van der Plaats and Verbraeck, 2008) (Figure 2):

- **level 1**: maintaining homoeostasis, pain, hunger, primitive reflexes, reflex behaviour, waking, sleeping, sorting and arranging incoming stimuli, and so on (brainstem and formatio reticularis);
- **level 2**: concrete representation of context with a welling up of primary emotions (especially fear, fight or flight, pleasure and displeasure), automatic movement and language patterns and so on (amygdalae and hippocampus);
- **level 3**: consider own behaviour by consciously using key stimuli, memory, emotions, movement patterns, mental inhibition and so on (nucleus caudatus and nucleus accumbens); and
- **level 4**: planning tasks, start, keep up, adjust and stop, self-knowledge, awareness of others, awareness of time, choosing, generalisation and so on (dorsolateral and ventromedial prefrontal).

Levels 1 and 2 develop in the first years of our lives, and levels 3 and 4 develop until approximately 24 years of age. It is argued that, after the age of 24, the brain starts to (slowly) deteriorate again. The onset of dementia impacts these levels in due course (van Hooren et al., 2005).

Simple information can be processed by the lower brain (levels 1 and 2); complex information requires actions from the upper brain (levels 3 and 4). With the use of the higher levels functions, possibilities that are offered in life or by the environment are explored and choices are made based on these possibilities. These higher levels functions include for example, planning, reasoning and problem solving. At the lower levels, the options for behavioural action are more restricted. These include more basic, physiological functions such as breathing, which are important for surviving of the individual.

### 3.2 Neurological processes and behaviour

Cools (1985, 2014) provided a detailed description of the relation between information processing in the different levels of the brain and behaviour. According to his theory, behaviour is always the result of how a person perceives the environment (i.e. situation) around him. This process is called perception. Consequently, certain behaviour may emerge in case of misunderstanding a situation. This behaviour may be perceived as inadequate by others.

Our brain is hierarchically organised in lower and higher levels (). According to Cools (2013a, b), the various levels in the brain process different information. Dynamic stimuli (everything that moves or produces sound or light) may be processed by the lower levels and static stimuli (everything that does not move or does not produce sound or light) may be processed by the higher levels. Cools (2013a, b) also suggested that stimuli are sorted and ordered, and reflexes are being generated at the lowest level of the brain. At level 2, an image is created on the basis of dynamic stimuli (movement, sound), which is also processed in terms of safety. Spontaneous, unchecked emotions find their origins here. If these emotions are not managed by the higher levels they may

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**Figure 2** Simplified hierarchical model of the functioning of the brain

![Simplified hierarchical model of the functioning of the brain](image)

**Source:** van der Plaats and Verbraeck (2008)
result into fight or flight behaviour (Cools, 2013a, b). Another important function of these higher levels is mental inhibition. Impulses are constantly being slowed down and disruptive stimuli are being disposed of in order to obtain adequate behaviour-under-control (Goldberg, 2005).

The perception process occurs by means of so-called neural representations (Ratey, 2003). They are like vivid images (concrete or abstract) of the situation. In the lower levels relatively simple, concrete and less complex neural representations are formed. In the higher levels, the information send through by the lower levels can be processed into sophisticated, well-chosen and abstract plans of action with possible alternatives. The higher levels consciously supervise some of the lower levels, such as postponing needs and inhibition of impulses. In general, human interactions are so complex that higher levels are needed to process the input. According to this theory damage to these levels of the brain may lead to inadequate behaviour which may be labelled as “problem behaviour” or, more generically, behavioural symptoms.

4. Step 2: neurological processes of OPD

Altered behavioural and psychological symptoms are seen in many OPD (Perry et al., 2017; O’Callaghan et al., 2016). On average, six types of behavioural symptoms are observed (Zuidema, 2008, pp. 49-63). Behavioural symptoms that are quantified as most burdensome are calling out, aggression and obsessive walking (Kearns et al., 2009). Hence, the question that rises is:

RQ1. What goes on in the brain that drives OPD to these behavioural symptoms?

Information processing by OPD differs from that of older adults who do not have dementia. The most important difference is the decreasing capacity to process (complex) stimuli, which has a strong influence on behaviour. Van der Plaats (2010) has given an overview of characteristics that should to be considered in the design and evaluation of the environment:

1. The brain may only handle dynamic stimuli: for instance, stimuli that are moving or producing sound.
2. “Static” stimuli (without movement or sound) cannot be perceived correctly. In a static environment the person with dementia has to produce stimuli himself or herself by wandering, moving obsessively or making sounds.
3. In catching “dynamic” stimuli, there is a strict principle: only stimuli from one source of stimulation can be processed at a time. The brain has lost its capacity to select different sources of dynamic stimuli.
4. Dynamic stimuli within the direct sight-field of the OPD are processed. Stimuli coming from outside the direct sight-field, for instance, behind a person, may create chaos in the brain.
5. Voluntary and purposeful movements cannot be made by the cognitive part of the brain. OPD may not be able to initiate an efficient action on their own, or as the result of a single verbal instruction.
6. OPD need meaningful stimuli to initiate actions. Meaningful stimuli are stimuli in a specific context. These stimuli are processed by the lower brain.
7. These meaningful stimuli include a familiar environment based on their own technological generation, the right starting position of the body, an emotion or sense of humour, inviting music or songs, the option to imitate someone else (a real person or a person on a screen), or “persuasion” to act, especially by small animals or children.
8. Mirror neurons give people the possibility to imitate proper actions. Mirror neurons “fire” not only when a person performs a certain action, but also when a person is watching another person performs the same action. It has been argued that mirror neurons remain largely intact in OPD (Rizzolatti et al., 2009). However, a more recent study suggest otherwise (Moretti, 2016).

All these changes in the neurological processes may influence the behaviour of OPD. In designing environments we have to take into account that people with advanced stages of dementia may have difficulties in taking initiative, initiating actions and motion, and working their way through the environment.
5. Step 3: experience and behaviour of OPD

The neurological processes in the brains of OPD are impaired because of the underlying pathologies. Levels 3 and 4 of the brain’s functioning are impaired in such a way that visuospatial processing (Jacobs et al., 2015), voluntary switching in cognition or movement, adapting to circumstances (O’Callaghan et al., 2016), planning, and decision making may have pronounced deficits (Delazer et al., 2007; Zamarian et al., 2010). These kinds of deficits may have a severe impact on everyday functioning since real-life situations are complex and require various combinations of brain functions (Zamarian et al., 2010). Consequently, if these functions are damaged, the behaviour that OPD display may be ill-fitted.

5.1 Information processing in the impaired brain

Maintaining a high quality of life in older age requires advantageous decision making in domains such as finances, health care, use of technology and housing situations (Zamarian et al., 2010; Kazak et al., 2017). Hence, decision making is an important ability for independent living. OPD are confronted with extreme difficulties in decision making, especially when decision making is complicated by means of time-pressure or poorly structured situations.

Complex situations, in which decision making is required, are processed in the damaged upper brain, and may create a state of chaos in the minds of OPD (Cools, 2011, 2013a, b). The subsequent behaviours may be dictated by feelings of anxiety and anger. These behaviours affect the well-being of OPD, and are difficult to handle and are usually not well understood by carers. All the input to the brain should be fitting for the cognitive abilities of OPD in order for them to cope with the situation at hand. In conclusion, OPD slowly lose their capacity to organise their behaviour “voluntarily” and become increasingly dependent on the environment (Cools, 2012).

The amygdalae were originally “intended” to recognise danger by way of a quick screening of the environment. It determines behaviour programmed in level 2 (Jablonski et al., 2011). The activation of the amygdalae generates fight (aggression), flight (run) or freeze behaviour in stressful situations. Without the moderating qualities of the higher level systems this behaviour is non-reflective, impulsive and reactive (Phelps and Anderson, 1997). Neuroanatomical changes to the amygdala therefore also alter behaviour in OPD (Wachinger et al., 2016). It is, therefore, essential to present every situations as safe and pleasant. This means we need to create environments that feel secure and offer a protective atmosphere.

5.2 The environment as key determinant of behaviour

In normal brain-functioning there is a mutual interaction between a person and the environment (Perry, 2002). Research shows that the impaired brain becomes increasingly dependent on the environment at hand (Goldberg, 2010). In other words, the person-environment relationship is damaged and the environment becomes a key determinant for behaviour (Cools and Ellenbroek, 2002; Cools, 2012; Colombo et al., 2017). An important part of understanding the environment around oneself, are stimuli. Stimuli are defined as “something that incites to action or exertion or quickens action, feeling or thought”. Especially for OPD, the environment should incorporate a perfect balance in stimuli (Cohen-Mansfield et al., 2010). In order to prevent inadequate behaviour, a “balance” in stimuli has to be present.

Two types of imbalance in the amount of available stimuli might occur: an overload and an underload. In case of an underload of stimuli, the brain may switch to a state of dismay. The result is that the person with dementia may create his or her own stimuli by making obsessive sounds or movements like shouting, plucking, walking or obsessive sleeping (van der Plaats and Verbraeck, 2008). These behaviours may occur in situations without dynamic stimuli, such as in quiet private rooms, in a chronic bedfast situation, and at night alone in bed (van der Plaats and Verbraeck, 2008). These behaviours may act as stressors for professional caregivers and relatives. In order to avoid such behaviours, sources of dynamic stimuli, like moving coloured led-lights (in private sleeping rooms), appealing DVDs (in silent living rooms) and the so-called experience areas in corridors (in order to stop obsessive wandering) are created in practice (de Koning, 2012). In contrast, an overload of dynamic stimuli may arise, for example, when several carers are talking.
with each other while the television is on, and people are walking in and out. As a result, OPD may become restless and scared, which may result in shouting or behaving angrily or hostile

Consequently, a perfect balance regarding stimuli has to be found for people with dementia. We would like to coin the idea of designing for a balance of stimuli as “designing for a favourable state”. In order to acquire such an equilibrium, there are several considerations. First, one should consider all stimuli that are not in the person’s immediate field of vision. These stimuli may cause unwanted distractions (van der Plaats and Verbraeck, 2008). For example, when a OPD hears a noise, but may not know where the noise comes from and as a consequence, may get frightened. When designing housing and supporting technologies for OPD it is of utmost importance to prevent such unwanted stimuli. So, one should design rooms when nursing aides or paid carers cannot walk behind OPD or engage in conversations with them or other people when the OPD cannot see them. Furthermore, floor covering should be used in order to prevent the transfer of noise from hard soled shoes, and other sources of distracting noise from entrance-doors, kitchen equipment and the TV coming from behind should be limited. Seats should be backed to the walls and the OPD should be able to see all the emerging dynamic stimuli in the room.

Second, a great deal of the visual stimuli gets lost in the lower brain and is not processed. Therefore, the environment may be perceived only vaguely. OPD need higher light levels in terms of daylight and illumination, and bright and contrasting colours (Day et al., 2000; van Hoof, Kort, van Waarde and Blom, 2010). Examples of non-supporting design include furnishing in only one basic colour, bathrooms all in white, and walls in pastel (Brawley, 1997).

Third, the memory in dementia reverses to the neural representations of youth and early adulthood. Modern contexts, technologies, objects, words, noises and food are often unrecognised as the dementia progresses. This has an enormous impact on how things have to be designed. The environment has to be in tune with what interior designs and technology looked like when still young and when the brain was still developing. This has ever evolving consequences for the layout of buildings and the choice of furniture and technology, as styles and technological styles succeed each other with ever greater speeds.

These abovementioned considerations regarding OPD, stimuli and design, provide insights in the manner in which environments for OPD can best be designed. In conclusion, an institutional setting aimed at caring for OPD, can be improved by simply looking at how the brain of OPD handles stimuli in the near environment (Cohen-Mansfield et al., 2010).

5.3 Beautiful moments

In the foregoing section it was shown that both an underload and an overload of stimuli can result in aberrant behavioural responses. On the other hand, the right “dosing” of stimuli might create the perfect condition that OPD may function at the higher brain levels. We have coined the term “beautiful moments” to describe these.

Beautiful moments can be evoked spontaneously by (dynamic) stimuli from the environment that are adapted to level 2. The creation of an old-fashioned context can facilitate purposeful behaviour. For instance, in an old-fashioned church or chapel, people with dementia can sing psalms, make the sign of the cross, and talk about God. In a similarly old-fashioned cinema, people can sit down and enjoy a black and white movie.

5.4 The power of the environment

OPD may experience a reduced quality of life when the environment does not match their sensory needs. So-called “stimuli in context” are needed in a fitting environment, which “seduce” the person to conduct the expected action. These contextual stimuli include the characteristics of category vii of the overview of Van der Plaats (2010) described at Step 2. Various design guidelines can help designers and architects to create such environments (Brawley, 1997; Day et al., 2000; Calkins, 2009; van Hoof et al., 2009; van Hoof, Kort, van Waarde and Blom, 2010; Marquardt et al., 2014), for instance, the design of familiar taps in kitchens and bathroom that can be recognised and used as such (Boger et al., 2013) or the use of pictures for environmental orientation (Motzek et al., 2017).
6. Step 4: developing design principles for housing and interior for OPD

The challenge of this section is to translate these insights of the preceding sections into design principles. Such a translation requires a deep insight in the relationship between human behaviour on the one hand and design specifications on the other hand.

OPD are subject to “normal” ageing processes such as decrease in the sense of hearing, eyesight and mobility (van Hoof, Kort, Duijnstee, Rutten and Hensen, 2010). Consequently, the principles for designing for dementia ideally include principles that are applicable for the ageing population in general. The principles for designing for OPD are mentioned below.

6.1. Design for ageing people

OPD are ageing people themselves. In Section 3 we have investigated the neurological processes in brains of OPD. In Section 4 we have related these insights to the experience and the behaviour of OPD. It was argued that OPD have difficulties in taking initiatives, handling complexity, making up their mind, and interacting with the environment. Both an overload and an underload of dynamic stimuli might result in inadequate behaviour. A balance of stimuli prevents inadequate behaviour and supports meaningful behaviour. The idea of designing for a balance of stimuli as “designing for a favourable state” was coined (section 5.2). It has to be noted that all OPD have their personal characteristics and thresholds. Apart from these design aspects, designers should always consider the needs for safety and security when designing for OPD (van Hoof, Kort, van Waarde and Blom, 2010). The second principle for designing housing and technology for OPD is.

6.2. Design for a favourable state

OPD need an environment with a controlled level of stimuli. OPD can achieve a higher level of functioning including having social contact, enjoying beauty and experiencing spirituality. Such a state only can be realised when there is no excessive stress that induces a fight or flight response. Therefore, these higher functions only can be activated when the OPD are in a favourable state and when the environment offers the right stimuli at the right time and place in order to initiate and to support these higher functions: “designing for beautiful moments” (section 5.3). These stimuli depend strongly on personal characteristics and should be a research topic for future studies.

6.3. Design for beautiful moments

OPD may function on higher brain levels when the environment offers the right stimuli at the right place and the right time. Overall, this leads to a three-stage design model describing the general design principles for OPD (Figure 3).

7. Step 5: translating the design principles into design specifications

The design principles as formulated in the preceding section supports designers in asking questions related to the development of design solutions. For example, the first principle leads to the question: “What light levels are required to support the vision of older people?” The second one to “How to design a living room and technology to prevent an overload of stimuli?”, and the third one to “How to design a sacred space to initiate and to support spiritual experiences?” All these questions have the same structure. They ask how specific elements of a design have to

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Figure 3 General design principles with respect to OPD

- Design for ageing people
- Design for a favourable state
- Design for beautiful moments
be designed in order to support the different ways of functioning of OPD. The development of an integrated method “to translate” design principles into design specifications requires some philosophical building blocks.

7.1 Philosophical distinctions

The Dutch philosopher Dooyeweerd (1969) made a distinction between “aspects” and “wholes”. A whole is an entity with an own character and every whole functions in different aspects. Dooyeweerd (1969) describes in his theory of modal aspects that every whole or entity functions in different aspects or dimensions. For example, a human being needs food (biological aspect), thinks in a rational way (logical aspect), interacts with other people (social aspect), buys and sells products (economic aspect), and cares for others (moral aspects) (Verkerk et al., 2016, pp. 62-85). Dooyeweerd (1969) describes in his theory of individuality structures that every whole or entity has its own character or identity. For example, an enterprise is economically qualified, a court judicially, a piece of art aesthetically, and a church religiously.

7.2 Theory of modal aspects

The theory of modal aspects states that every whole functions in different aspects or dimensions (Verkerk et al., 2016, pp. 62-85). This theory is important to understand and to map the different modes of functioning of OPD and to define design requirements that have to support these different modes of functioning. Dooyeweerd (1969) distinguishes in total 15 different aspects of modes of being (Figure 4). By means of an in-depth analysis, Dooyeweerd argued that all these dimensions have their own character. For example, the nature of the biological aspect of a person with dementia is quite different from the nature of the psychic or sensory aspect. The dynamics of the social interaction for OPD are quite different from the subtleties of a spiritual experience. In other words, every dimension has its own dynamics, mechanisms, laws, and norms. Technological artefacts and long-term care facilities have to support the different modes of functioning of OPD. This means that specific specifications have to be developed to support the biological functioning, the psychological aspect, and the social and spiritual aspects. In conclusion, a multidimensional specification has to be developed in which all different aspects of the functioning of OPD have to be addressed.

Figure 4 The many aspects or dimensions of our reality

Different dimensions of reality

Religious/Spiritual/Creedal
Moral/Ethical
Juridical
Aesthetic
Economic
Social
Linguistic/Informatory
Shaping/Power/Historical
Logical
Sensory
Biological
Physical/Chemical
Kinematic/Movement
Spatial
Numerical

Source: Dooyeweerd (1969)
7.3 Theory of individuality structures

The theory of individuality structures supports us to understand the identity of wholes, for instance, the identity of a long-term care facility. Dooyeweerd (1969) emphasised that human beings cannot be characterised by one aspect or dimension. Humans are not only social beings but also rational beings, not only moral beings but also spiritual beings. Consequently, it is the challenge of health care to support all different aspects or dimensions in which humans function. The identity of a long-term care facility can only be understood from its function to care for OPD. The design of the technology, private rooms and kitchen areas all (have to) reflect this basic function. So, the identity of a long-term care facility is determined by “caring for”, i.e. the moral dimension. In the Dooyeweerdian terminology: the different functions of a long-term care facility have to be disclosed by the objective of caring for OPD. This formulation has firm implications for the design of the whole facility. For example, the social room is not a “simple” social room (qualified by the social aspect) but a social room that supports the social behaviour of OPD. In other words, it is disclosed or marked by the moral aspect of caring for. Another example is the design of the chapel. The chapel in a long-term care facility is not a standard design that supports religious activities but it is a design that supports religious experiences of OPD.

7.4 Developing a multidimensional specification

The philosophical concepts presented in the previous sections support the translation of design principles into design specifications. There are two methods to develop a multidimensional specification. The first method is to take the design principles as a starting point and to explore the different aspects systematically. The second one works the other way around. In our view, the first method is more appropriate. This section presents some examples to show the power of the methodology. The starting point lies in the functioning of OPD, particularly the biological up to religious aspects are relevant (Figure 4).

Principle 1: design for ageing people. As mentioned before, OPD are subject to normal biological ageing processes. That implies that designers first have to ask themselves how a certain aspect or dimension of the human being is influenced by the ageing process. Thereafter, one can translate that aspect or dimension in a design specification.

Biological aspect. Older people may have perceptual problems concerning the ambient temperature. This aspect can be translated in a set of design specifications, like control of the temperature of the indoor air, the design of thermostats and the use of radiant heating. Older people may be prone to falls, and emergency response systems in and outside the home may be necessary.

Sensory aspect. Older people may experience a decline in vision. This aspect can be translated in design specifications relating to the intensity of light and the level of contrast.

Logical aspect. Older people may have a decreased cognitive functioning. This aspect can be translated into designing for familiarity and adhering to logical structures.

Social aspect. Older people face more difficulties in making new social contacts and may experience loneliness. This requires solutions that stimulate social interaction and engagement.

Moral aspect. Being human is being a fellow being; being human implies giving care to others and receiving care in return. The environment should support older people taking care for others or of their pets.

Principle 2: design for a favourable state. The idea of designing for a favourable state is to guide behaviour by a controlled level of stimuli, preventing both an overload and an underload of dynamic stimuli. Dynamic stimuli are related to subtle changes and motions in the environment, such as people passing by, the sound of music and certain activities.

Sensory aspect. Too much motion around the OPD leads to an overload of stimuli and may result in restlessness. Therefore, the design of the living room should prevent nurses from “running around”. Furthermore, excessive noise from technology leads to an overload of stimuli and may result in agitation. The acoustics and music systems have to be designed in such a way that the
noise level can be controlled, without the risk of an underload. The sensory needs of all the OPD present in the shared space needs to be met. Of course, this is a tremendous challenge, since the threshold for under- or overload may differ per person.

Social aspect. The living room should be designed in such a way that it limits the number of people and provides places for withdrawal.

Economic aspect. The shop in the long-term facility has to be designed in such a way that OPD easily can find their way and can buy the articles they need.

**Principle 3: design for beautiful moments.** OPD can function on higher brain levels when the environment offers the right (amount of) stimuli at the right place and at the right time. The theory of modal aspects clearly shows the richness of human functioning. The design for beautiful moments can disclose all the different modes that belong to typical human activities: logical thinking (jigsaws, riddles), self-direction (shaping life, making decisions), language and symbols (talking, reading, understanding the meaning of symbols), social intercourse (drinking and talking together), economic transactions (shopping), experience of beauty (nature, art), treating older people fairly and justly (respect their interests and biography), love and care (for others), and spiritual experiences (chapel, singing together, praying). OPD indicate that they find these modes of functioning very important (Dröes et al., 2006). However, OPD cannot always initiate these modes of functioning by themselves but these modes have to be initiated and steered by the environment and its components including technology. When designing for a beautiful moment, a designer should focus on the qualifying aspect of an activity.

Social aspect. The qualifying aspect of a living room is the social aspect. An environment should offer options for meaningful interaction with others. It should not only prevent an underload or overload of stimuli (design principle 2), but it should also invite and support OPD to engage in social interactions with others.

Religious aspect. The qualifying aspect of the chapel is the religious aspects. It should offer OPD the possibility to give expression to their religious beliefs, even if their active participation in religious services and traditions is limited.

In conclusion, the Dooyeweerdian philosophy offers a means of linking the different aspects in which humans function and the different environments in which they live. This philosophy can be used to translate design principles to design specifications in a systematic way by mapping the different aspects.

8. Step 6: the creative process from design specifications to concrete designs

This section presents case studies to illustrate the model by describing the design of a living room, part of a corridor, baby room and chapel. The re-design of parts of corridors stemmed from the wish from the nursing home management to transform an unattractive corridor into a more appealing and interactive space for OPD to explore and enjoy.

8.1 Design of a living room

Most nursing homes have one or more living rooms. The identity or qualifying aspect of a living room is the social aspect: living together with co-residents, social contact with relatives, and interaction with staff (Rijnaard et al., 2016). Plate 1 presents a design of a living room. Windows are essential elements, but should not reach down to the floors, as OPD may not be able to tell the difference between inside and outside. People may actually try to step outside and hit the window pane, or experience cold sensations as they think a door has been left open. A solution to such design flaws could be the introduction of raised window sills or sticking foils to the windows to cover the lower part up. Windows that lead to the corridor should be covered by net curtains, so that people walking by do not form a source of distraction. If there are no curtains inside the room, people may think they are either moving out or having spring cleaning. In the evening, they may see their own mirror images in the window, faces they do not longer recognise and which leads to fear.
Ideally, the dining table is positioned next to a window, and residents can enjoy their breakfast there and sit around the table. Another solution that should be considered is having multiple smaller dining tables. It can be quite burdensome to be sitting around the table with multiple co-residents for a long time as one may be offended by someone else’s lack of decorum. Small square tables may do the trick, but one should be aware that in case of wheelchairs, the foot board should not touch the person sitting opposite. Based on intuition and character, people can choose their own table mates, and be together and interact. In a group with eight individuals, two tables are sufficient, and perhaps, a third small table should be considered for allowing additional guests or creating flexibility. In practice, however, there is no question of “one group of eight people” but “eight groups of one person” showing the complexity of the social interactions and its moral implications.

When designing the living room, it is important to stress and define the two functionalities of the room: dining on the one hand, and relaxation on the other hand. Large armchairs and a fire place should be designed in overdrive: the stereotypical design may contribute to recognition and familiarity. The seating area should have a different colour from the dining area. This contributes to a spatial distinction between the two functionalities (so-called zoning). The use of sofas in the living room should be avoided, as people will use sofas as beds. A sofa can be qualified as a waste of space, because no one will sit down next to someone sleeping on a sofa unless they are friends.

In order to create visual borders, one could mount horizontal wooden elements onto the wall, as a sort of mock wainscoting or panelling. It allows people see where the borders of a room are, and if there are corners inside. A window sill can also be a horizontal element that defines the borders of a space. The wall surface below the window sill or wooden slat can be painted in a different colour.

8.2 Re-design of a part of a corridor

Many corridors nursing homes are dull and designed to support the transfer people and goods. However, there are various design solutions to transform corridors in places where OPD can experience beautiful moments. In this case the aesthetic aspect of human functioning is activated by transforming a dull alcove in a corridor into an indoor garden experience corner (Plate 2). This corner should be appealing for the emotional part of the brain. If OPD wander around in the corridor, they are drawn in by a green light shining down on the floor, coming through green sticky foils that were put on the window pane. When residents come near, they walk through an infrared beam from floor-mounted sensor. When this sensor is activated, bird songs start to play. The same birds can be found sitting on the branches of the artificial trees, as well as an owl.
Some relatives stated that this corner provided topics for conversation, and they experienced this corner as a part of an adventurous route through the nursing home. Many variations on the theme can be made in practice.

8.3 Design of a baby room

Existing alcoves in corridors also can be used to enable OPD to enjoy beautiful moments by caring for others. In this case the moral aspect of human functioning is activated. A baby room was designed to

Plate 2

Pictures of before (a) and after (b, c) turning an alcove in the corridor into a garden experience corner. It should be noted that picture (c) shows the wall of the alcove that is not visible in picture (b)
offer an environment to initiate purposeful actions (Plate 3), which are related to doll therapy (Pezzati et al., 2014). At first glance this design appeared to be controversial. Regularly, family members asked critical questions suggesting that this room infantilises their beloved ones. After explaining the ideas behind this design, the criticism gradually ceased. However, this does not alter the fact that the question must be asked what a good design is to invite OPD to care for others.

In this baby room, the foil stuck onto the window pane is pink. Based on a sensor that is activated when walking by, a baby doll starts giggling and making baby sounds. These sounds are somewhat louder than normal, as older people should be able to hear well. The sounds only turn off when people leave the corner. Even though this corner is intended particularly for use by women, some men are attracted too. The intervention provides a number of stimuli that invites OPD to care. For example, the baby doll is placed on top of a chest of drawers, or inside a cradle. Baby clothes lie around. Some of the drawers of the chest of drawers are half-open, and clothes stick out. Some women start folding these clothes and put them back into the drawers neatly. Changing diapers is another activity that can be carried out in the experience corner.

8.4 Design of a chapel

The last example is related to the spiritual aspect of human functioning and concerns an alcove that was redesigned for worshipping. Many people have experienced support from religion throughout their lives and value religious rituals and festivities. It has to be noted that the choice of design elements is critical: for a Roman Catholic or Jewish chapel different symbols, images and architectural elements have to be applied. An alcove is a fitting space to redecorate as a religious space, as it resembles the type of space that people are used to from their previous church life. The existing window pane was turned into a stained glass window using paint. A slowly rotating light was placed behind, which makes a spectrum of colours shine onto the ceiling and the walls, just like a kaleidoscope. The colours of church are also applied on the walls of the corridor, as a means to draw in people or draw people towards the chapel. Two large candle sticks are placed in front of the alcove. The mock candles, which were battery-operated, burnt continuously. There is a sensor in the corridor which activated songs of worship or psalms. The room itself was large enough for three people, including the priest or religious worker. Inside the space was a large cross, and a small table that serves as the altar. There were two chairs for sitting.

9. Conclusions

The objective of this paper was to inform architects and designers in order to improve environments for OPD. Based on the constructions formulated in this paper, an environment can
be formed that matches the current needs and wishes of OPD. This paper needs to be viewed in the light of the past: there used to be an enormous focus on medical treatment for OPD. Nowadays, we know that excellent medical care is not enough. Neurology and behavioural sciences present insight in the brain processes, the behaviour, and the desires of OPD. These insights show the need of a paradigm shift. Instead of presuming that problematic behaviour in dementia arises directly from impairments to the brain and that requires medical interventions, there is a growing awareness that the environment plays a crucial role.

The first aim was to develop a general model for designing the building, its interior and technologies for OPD. We developed a general model that has a firm scientific foundation in neurology, behavioural sciences and philosophy. This model consists out of six distinct steps and for each step we presented some empirical evidence and/or theoretical arguments. However, the whole model, its distinct steps and its assumptions should be further tested and refined though empirical research. It is possible that parts of the model do not work and the concerning foundations have to be changed.

The second aim was to identify principles for designing the environment for OPD. The housing, interior and technologies should initiate positive behaviours and meaningful experiences. Based on neurology, behavioural sciences and design theories, three design principles were developed: design for ageing people, design for a favourable state and design for beautiful moments. These principles have to be applied in a logical and subsequent order. Also for these principles hold that they should be tested and refined though empirical research.

The third aim was to develop a methodology to translate design principles in design specifications. We developed such a methodology based on the theory of modal aspects and the theory of individuality structures as developed by the Dutch philosopher Dooyeweerd. We presented some examples that illustrated the used of this methodology. More research is required to validate this methodology and to test its practical applicability.

In conclusion, in this paper we have presented a methodology and three design principles that support architects and designers in designing an environment that matches the needs and wishes of OPD. The methodology and design principles are developed based on theoretical considerations and empirical data. Future research is required in order to build a proper foundation for this approach and to show its practical applicability.

References


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Technology implementation in delivery of healthcare to older people: how can the least voiced in society be heard?

Yvonne van Zaalen, Mary McDonnell, Barbara Mikołajczyk, Sandra Buttigieg, Maria del Carmen Requena and Fred Holtkamp

Abstract
Purpose – The purpose of this paper is to focus on ethical and judicial themes related to technology and the older adults.

Design/methodology/approach – Different consecutive phases in technology design and allocation will be discussed from a range of perspectives.

Findings – Longevity is one of the greatest achievements of contemporary science and a result of development of social relations. Currently, various non-communicable diseases affect older adults and impose the greatest burden on global health. There is a great emphasis across Europe on caring for the older person in their own homes. Technology has a mediating role in determining the possibilities for good quality of life (QOL). The concept of assisting the older adult through the use of technology so as to access healthcare services has enormous potential. Although the potential of technology in healthcare is widely recognised, technology use can have its downsides. Professionals need to be aware of the risks, namely, those related to the privacy of the older person, which may accompany technology use.

Research limitations/implications – By 2050, there will be more people aged over 65 than there are children. This phenomenon of global ageing constitutes a massive challenge in the area of health protection.

Practical implications – Professionals need to be aware of the risks, for example, related to the privacy of the older person, that may accompany technology use.

Social implications – There is a great emphasis across Europe on caring for the older person in their own homes. Technology has a mediating role in determining the possibilities for QOL.

Originality/value – The concept of assisting the older adult through the use of technology to avail of healthcare has enormous potential. Assistive technology, social media use and augmentative and alternative communication can have a positive effect on the QOL of older people, as long as they are supported enough in use of these technologies. However, ethical and juridical considerations are at stake as well.

Keywords Technology, Design, Older adults, Judicial, Social connectedness, Ethical considerations

1. Introduction
1.1 Older adults: the least voiced in society

In 2050, there will be more people aged over 65 than there are children, and more centennials than ever before in the world’s history, with nearly 80 per cent living in the less developed regions in 2050 (Department of Economic and Social Affairs, Population Division, United Nations, 2015, p. 9). This phenomenon of global ageing constitutes a massive challenge in the area of health protection. The fact that people live longer does not mean that they spend their later years in good health. Another phenomenon gaining emphasis across Europe is caring for the older person in their own homes. The idea behind it is that they have an increased autonomy and quality of life (QOL) as opposed to living in a residential home (Boulanger and Deroussant, 2008). Although aging adults wish to live in their own homes for as long as possible, it is costly due to a
dearth of medical and social infrastructures in place (Frossard, 1990). In the context of the well-being of older persons, promotion and protection of human rights becomes difficult due to social exclusion of senior citizens as persons with disabilities and/or the “poorest of the poor” (Gruskin and Dickens, 2006). Both phenomena are reasons why the human right to health of older persons, understood as the right to the highest attainable standard of health, has appeared on international agendas as one of the most current and complex issues of human rights law. Undoubtedly, there is a close link between international human rights law and ethics. They both operate at different levels, but their aims are convergent. Both aim to preserve human dignity, also in situations of illness, disability and at the last stages of human life. We will delve into the ethical and juridical issues related to allocation of technical solutions to cope with health burden in older people.

When discussing human rights, the issue of inalienable human dignity is usually considered. In general, at international forums, the notion of human dignity means the equal and inherent value of every human being, regardless of gender, race, nationality, origin, religion, political opinion, property status, sexual orientation and, certainly, age. This notion is usually recognised as a source of values and human rights, and as their axiological base. The concept of dignity generally enjoys common appreciation at the international level, but currently its contents are unclear and disputable. The question that rises is “to what extent can technology be helpful in maintaining human dignity in healthcare processes?” Before we will address this question, we will give an overview of possible technological solutions for older people to cope with health and social burden.

The remarkable and constantly progressive ageing of societies affects all the spheres of social life. They face a lot of challenges connected with the so-called silver economy, among others. However, the greatest expectations are aimed at the healthcare sector. The remarkable improvements in life expectancy over the past century have entailed a shift in the leading causes of disease and death. One hundred years ago, infants and children comprised the largest group of victims of infections and parasitic diseases. Currently, various non-communicable diseases affect older adults and impose the greatest burden on global health. For authorities and civil society, ageing poses an enormous challenge when treating/managing chronic and geriatric diseases, palliative and end of life care, effective assistance for carers, the promotion of health and well-being and ensuring the concept of positive ageing. Referring to these tasks is not just a moral duty of States, but relevant obligations in this field arise also from international law, and especially the law on international human rights (WHO, 2002, 2006). The latter guides the actions of governments and, to some extent, assumes an ethical role on an international forum where human rights and ethics are closely linked. The concept of ethics refers traditionally to relationships of individual health workers, researchers, organisations and institutions providing healthcare within a country. Instead, international human rights are addressed, obliging them to protect all human beings living within their jurisdiction (Gruskin et al., 2006), across contexts including in the area of health. The aim of this paper is to explore ethical and judicial themes related to healthcare technology and the older adults. In this opinion paper, we will focus on the possible benefits and risks of technology use in healthcare of older people about which we have personal thoughts and beliefs. Our goal is to persuade the reader that our position on this topic is a valid one. Therefore, we support our claims with facts, real-life examples or published research studies. Before we discuss ethical dilemmas related to different consecutive phases in technology allocation from a diversity of perspectives, three modes of technological solutions and their effects will be introduced.

1.2 Use of technology to cope with health and social burden in older persons has enormous potential

The older person is beginning to emerge as an important consumer in relation to technology and its use (Vroman et al., 2015). The concept of assisting the older adult through the use of technology to avail of healthcare has enormous potential. Boot et al. (2015) endorsed the social connectedness and importance of engaging with family and friends whereby information technology can be of huge assistance. The demographic shift caused by the worldwide growth of the older population coincides with the dramatically altering and redefining how people
communicate and relate to each other. Where the empowered, computer-literate young public is exerting tremendous influence on healthcare delivery, this is not seen in the older population. For the older population, this technological revolution can widen the generational gap and exacerbate feelings of loneliness, depression and anxiety and contribute to adjustment disorders. However, several studies indicate that bringing information and communication technologies (ICTs) to the older persons can have a significant positive influence on this population (Marek van de Watering, 2008; Tse et al., 2008). Some authors have even presented it as the only possibility for alleviating isolation, loneliness and alienation in certain older groups (Cody et al., 1999; Karavidas et al., 2005). Concurrently, it is known that a group of older people is unable to follow this development, because of mental challenges, communication or language problems or problems in self-use of computers or medical devices (Curran et al., 2007).

Dementia, cerebro vascular accident (CVA) and stroke in older adults are three examples of significant public health burden and are mostly characterised by problems in physical and mental decline (Schwamm et al., 2017). Various technology interventions may reduce the impact of the disease burden, in that solutions are emerging that render healthcare delivery, as well as assistance with activities of daily living (ADL), more accessible and affordable. Technologies mainly assist in memory support, treatment, safety and security, training, care delivery and social interaction (Lorenz et al., 2017). The usefulness of technology becomes even more salient for older adults with widespread inequalities in access to care, in particular due to living in rural/remote areas or to provider shortages.

While technologies are proving to be essential in modern times to ensure high-quality care and independent living in older people suffering from dementia, CVA and stroke, “solutions must be socio-technical (that is, technologies must be developed alongside the networked social relations that make them ‘work’) and pragmatically customised to meet people’s unique and changing medical, personal, social and cultural needs” (Greenhalgh et al., 2015, p. 91).

Technology can also play a mediating role in determining the possibilities for a life of quality (Walker, 2005). QOL technologies for healthy older adults may delay or prevent disability, encourage new activities and interests, assist in developing communication channels, improve knowledge, uplift mood, and ensure psychological and emotional health Schulz et al. (2014). However, to be successfully adopted these QOL technologies must be uncomplicated to use, trustworthy, effective and personalised. Inventors need to take into consideration older peoples’ attitudes towards these technologies while monitoring and evaluating their use for improvement recommendations to be made (Hawley-Hague et al., 2014).

Below we will discuss the potential and challenges of three different technological modes: assistive technology (AT), social media and augmentative and alternative communication (AAC).

1.2.1 Assistive technology. AT like video-monitoring, remote health monitoring, electronic sensors and equipment such as fall detectors, door monitors, pressure mats and smoke alarms can improve older people’s safety, security and ability to cope at home (Miskelly, 2001). AT, including wheeled mobility devices, has a significant impact on the ability to achieve functional independence and reduces the need for human assistance in older adults with disabilities. But if AT is being used as a reason to save money and (human) resources rather than looking at the needs of individuals for support and care, this is, in our opinion morally and ethically questionable. In addition the possibility of persuasion or even coercion of an individual with cognitive impairment to accept some form of assistive device may be rather questionable. Looking at this from a technical perspective is opposed to a person-centred approach. Unfortunately, in spite of being the largest group of consumers for utilisation of wheeled mobility devices, standard guidelines are lacking for prescription of these devices for older adults (Laferrier et al., 2010). Older people face different challenges in relation to medical device use. The challenges include the social consequences and effect on self-esteem, a certain amount of embarrassment, that are a result of these devices entering their lives. This change in situation from non-user to user can also have implications on the home in which they live and the people they share their life with (Thomson et al., 2013). Users are required to make adjustments to the way they live in their own homes (Thomson et al., 2013). The spouse and user are required to share the same physical environment and the resultant consequences of noise and aesthetics with the spouse not directly
benefiting from device use. The fact that some of these devices are used in the shared bedroom means that sleep can be disturbed or sleeping arrangements have to be altered (changing sides of the bed, sleeping in another room).

1.2.2 Social media. Freund and Baltes (2000) highlighted the importance of information technology providing stimulation and remediation for the older person and also enhancing their interpersonal and social environment (Fozard and Kearns, 2008). Caregivers also need support in this particular space and Blusi et al. (2015) showed that if internet supports were in place for caregivers in rural areas, it might assist in reducing their feelings of isolation when caring for their spouses (Torp et al., 2007). Social contact with other carers also provided support and less need for information about chronic illness and there was enormous value placed on sharing experiences (Torp et al., 2007). Integrated care needs to encompass the use of information technology and expand on the importance of social connectedness for the older person and their carer.

Social media may increase the older person’s empowerment and their sense of self-efficacy (Barak et al., 2008). Román-Garcia et al. (2016) clearly articulated the presence of ICTs that lead to the development of new forms of social, interactive and critical relationships. Those relationships for the older person diminish as the person ages and there is a direct connection between income brackets and the level of media skills (Román-Garcia et al., 2016). Bandura (1986) reported about personal self-efficiency and Compeau et al. (1999) highlighted the idea of computer self-efficacy. This can be achieved by the older person gaining confidence in their ability to use information technology in a trusted and protected way. As Bobillier-Chaumon et al. (2013) demonstrated learning situations should be created that would emphasise the older person’s skills and if they are not supported, encouraged and coached by their trainers, then they lose their confidence. All of the above are very interesting and make up for wonderful opportunities for the older person. However, the ethical dimensions need further exploration, e.g. who has access to these data and what actually happens to the information gleaned from the engagement of the older person using technology are important questions?

Different effects of social media use in older persons are discussed in the literature: increasing social connectedness and level of health information, increase of cognitive ability, as well as predictors of engagement in use, like internal motivation, social support, reduced loneliness and intergenerational communication. In the paragraphs below we will discuss these issues.

Vosner et al. reported that age, gender and education seemed to be important factors having a direct or indirect impact on the use of social online networks by active older participants. In their study on older adults and communication technology, Vroman et al. (2015) showed that the majority of participants used ICT to maintain family and social connections and to inform themselves about health and other routine matters. ICTs may play an instrumental role in social connectedness and assist the older person in engaging with both the residents and their families (Sorell and Draper, 2014; Bobillier-Chaumon et al., 2013).

Another positive effect mentioned by de Aguilar-Nascimento et al. (2010) in a group of older people an increase in cognitive ability was observed especially in the language and memory domains. This emphasises the importance of providing appropriate access for the older person to use the internet. It also echoes the work of Shapiro (2007); and Chu et al. (2009) also reported that when older people were taught how to use computers, they demonstrated a significant improvement in psychological aspects such as depression, loneliness and feelings of control. Social support through ICT can assist the older person when they encounter physical or engagement problems associated with ageing such as limited mobility (Owen et al., 2015; van Ingen et al., 2017). However, Culley et al. (2013) clearly showed in previous work that as age increases, activities with technology decreases, with the majority of participants using the internet to keep in touch with family and look up information pertaining to their health status. It is vital that as a society we use technology to assist in improving social connections and help to alleviate the level of loneliness the older person may experience. There are special needs of the older person, which need to be met with regard to the use of technology utilising an ethical framework to ensure that their connectedness with the outside world is maintained but not exploited in any way. In their
study of a Dutch experiment in using ICT to overcome loneliness amongst older adults, Fokkema and Knipscheer (2007), reiterating work by Vroman et al. (2015), concluded that the greatest reduction in loneliness was amongst those who were more highly educated with e-mail assisting in social contact and improving self-confidence. Heo et al. (2015) showed that higher levels of internet use was associated with higher levels of social support, reduced loneliness and a better QOL for the older person. Hill et al. (2015) also showed that the use of technology by older adults can assist in empowering themselves, thus contributing to a better QOL. With Almeida et al. (2012) showed that older men who use computers have a lower risk of dementia, in their study of 5,506 community dwelling men aged between 69 and 87 years.

Olpert and Damodaran (2013) reiterated that if older people are digitally included, this results in them having better QOL, maintain their independence, improving their social connectedness and sense of worth despite declining health or limited capabilities. It is not enough just to have someone online, they need to be assisted in overcoming their vulnerability on the internet. This is where the ethics of use comes in and safe guards must be in place to protect the older person. Olpert and Damodaran (2013) recognised that this divide has implications for social inclusion. Morrison (2015) highlighted the importance of educating the older person in searching behaviour and effective training so that they protect themselves from the dangers of the internet. Maintaining meaningful social relationships is one of the key elements of ageing well (Leist, 2013). It is important to remember that with the rise of social media, as echoed by Leist (2013), new threats emerge for older adults. As the internet is a very valuable tool in reducing loneliness and isolation it is vital that we embrace its full use, whilst protecting the older person (Nyman and Isaksson, 2015). Nef et al. (2013) demonstrated that the main benefit of using social media for older adults is to enter the intergenerational communication, but privacy concerns and the ethical dimension of protecting the older vulnerable adult are a challenge.

1.2.3 Augmentative and alternative communication (AAC). AAC is a technological solution to cope with communication problems in older people. People who have acquired speech or language problems after brain trauma, CVA or dementia can benefit from AAC. It is easy to imagine that dysfunctional interaction patterns place older adults at risk for an impoverished QOL, the nursing staff at risk for a variety of physical and psychiatric health effects and burnout and the spouses at risk of feeling left out or powerless. Using AAC aids increases the number of “self”-positive conversational statements with a reduction in negative, ambiguous and repetitive utterances. Without AAC, nursing aides are likely to misinterpret residents’ verbally disruptive and abusive behaviours, under the chronic strain of caring for frail elders with physical and mental impairments, and respond in ways that inadvertently reinforce residents’ dependent behaviours, or may even result in abuse or neglect (Bourgeois et al., 2001).

Communication between nursing home residents with dementia and staff has been a long-standing problem that can have devastating ramifications for residents and staff alike (Bourgeois et al., 2001). Nursing home residents, often presumed to be incompetent and dependent by their caregivers, may be spoken to in stereotyped ways that limit their “chances for a meaningful conversation and convey a sense of declining capability, loss of control, and helplessness” (Ryan et al., 1995, p. 23). AAC memory tools seem to help participants to focus their attention on relevant personal information, allowing them to centre the conversation on core positive identity contents, thus improving the quality of the conversations with fewer ambiguous utterances (Gómez Taibo et al., 2014).

Although technological modes like AT, social media and AAC can have positive effects on the QOL of older people, ethical and juridical considerations are at stake as well. This is especially true in using medical devices. In the next chapter, we will discuss ethical and juridical issues related to all four phases of medical device allocation.

2. Allocation process of technological medical devices

The process of medical device allocation and the perspective of the user describe the chain of activities in the area of medical devices: from the moment, a problem is reported by the client, to
the evaluation in using the medical device that has been supplied (Nictiz, 2009). In Figure 1, the activities have been grouped as client actions and care expert actions. The regulatory frameworks within which the actions are performed are indicated for each activity. In the process of device allocation and use, four main phases can be distinguished: demand for care; assessment; allocation and use and evaluation. In every phase, decisions are made and ethical and juridical issues are considered. We will discuss them phase by phase.

2.1 Phase 1: demand for care

When a person or the caregiver realises that a problem exists and that an aid can be used as a compensation for the experienced limitations, he/she will get in contact with a healthcare professional. Before contacting the professional, this person has gone through a process of realisation of the loss of skills/abilities and the need for support or possible solutions. During the assessment phase the professional will formulate the demand for care based on the experienced limitations and the barriers in social life.

Although people share the same limitations on the level of activity, the impact of these limitations on participation in society can be completely different. Insight in personal demands, needs and wishes is essential in this phase. Therefore, the input in this phase is mainly given by the user resulting in ethical considerations for the professional that are mainly focused on dignity, confidentiality and respect. To illustrate we give a real-life example, see Case 1.

2.1.1 Case 1. Robert is a 72-year-old retired policeman. After retirement, he remained active as a volunteer in a child protection home. Robert has diabetes Type 2. Due to the diabetes, the blood vessels of his left leg were affected to the level that a below knee amputation was executed. After the amputation, Robert’s need for rehabilitation was high. The resistance felt in Robert’s participation in the rehabilitation clinic was misinterpreted by the assigned care professional. The professional missed that Robert’s main concern was: not to be able to walk around. The professional decided to talk with Robert’s wife, without Robert knowing. He discussed the resistance to treatment with Robert’s wife and asked her to convince Robert to be happy with
the offered care. Contrary to the professional’s perspective, Robert wanted to remain an active member of society. In order to do that, he was not interested in exercises and acceptance of his limitations only. Robert needed mobility abilities within many different contexts as soon as possible. Temporary mobility solutions would have improved Robert’s QOL.

Undoubtedly, the human right to health, which has been introduced into international law along with other rights referring to the existence of every human being (e.g. the right to life and the freedom from torture and inhuman or degrading treatment), is closely connected with human dignity. Growing old does not mean that a human being slowly loses his/her rights and/or his/her dignity shrinks. Unfortunately, very often getting old means to face more and more threats to human dignity, whether it is lack of access to healthcare, essential drugs and appropriate treatment, lack of privacy in hospitals and care institutions, treatment without the patient’s consent, lack of personal data protection, or any number of other behaviours.

Confidentiality is one of the core duties of medical practice. It requires healthcare providers to keep a patient’s personal health information private unless consent to release the information is given by the patient (De Bord et al., 2013). In situations like Robert’s where a professional believes an ethical or legal exception to confidentiality exists, the question: will lack of this specific information put someone else at high risk of serious harm? should be asked. If the answer to this question is no, it is unlikely that an exception to confidentiality is ethically (or legally) warranted. The permissibility of breaching confidentiality depends on the details of each case. And if the person or someone else is at high risk of serious harm, breaching confidentiality may be required. But, with complex cases, health professionals are confronted with another dilemma regarding confidentiality, what do I need to share with another professional involved with, Robert? The fact that Robert is mostly interested in participating as a “healthy” citizen can be of great importance to the doctor who treats his diabetes as well. The only way to find out this answer is to ask Robert and follow his wishes, as long as this does not harm him.

In the interview with Robert the professional probably could have put more effort in trying to understand the reasoning of Robert with an open mind and at all times showing respect. But instead the professional decided, probably based on earlier experiences, that he knew without asking (i.e. tacit knowledge), and filled in the demand for care based on Robert’s limitations. We argue that implicit handling based on tacit knowledge (Millar, 2008) is not evidence based, because the actions are unclear to all involved (Herbig et al., 2001; Verkerk et al., 2017). The International Classification of Functioning Disability and Health states that it is not the lack of activities or the severity of a handicap which should be paramount in assessment planning, but the participation question (World Health Organisation, 2009). In other words, the professional should have respected and asked for Robert’s goals in life. Together with Robert he should have discussed the temporary and long-term demands and opportunities for Robert to get mobile again, before he even started his assessment.

2.2 Phase 2: assessment

The second phase of device allocation is mainly targeted on assessment and determination of the severity of limitations, possible compensations and design ideas. In this phase, ethical considerations are related to fiduciary trust; precise measurement; effective and confidential communication; age; personal preferences; and prejudice. Before a case study is introduced an elaboration on the topic of fiduciary trust will be made. Fiduciary derives from the Latin word for “confidence” or “trust”. In these relationships, ethics demands a higher than ordinary degree of care and responsibility from the dominant or trusted party. The bond of trust between the patient and the professional forms the basis for an effective and efficient physician–patient relationship, based on honesty and forthrightness.

2.2.1 Case 2. Priscilla is an 81-year-old high class lady from Upper Manhattan, New York City. After she experienced a stroke, she developed global aphasia. She can produce few recognisable words and understand little or no spoken language. She can neither read nor write. Priscilla has fully preserved intellectual and cognitive capabilities unrelated to language and speech. During the assessment, the AT advisor on AAC aids decides that an AAC device is not
applicable to this old lady. The advisor tells Priscilla that she should not worry anymore because he will take care of everything from now. Furthermore, he advises her children to draw pictures on a paper and invite Priscilla to do the same. As a result of this advice, Priscilla spends the last years of her life in total communicative silence.

During the assessment phase, careful measurements, based on biomedical and psychosocial principles, should be made by an experienced and qualified professional. The professional must protect the subjects’ privacy and confidentiality. Researchers must have mechanisms in place to prevent the disclosure of, or unauthorised access to, data that can be linked to a subject’s individual identity. Second, in order for the care professional to make accurate diagnoses and provide optimal treatment recommendations, the patient must be able to communicate all relevant information about an illness or injury (Ludwig, 1998; De Bord et al., 2013). Professionals are obliged to refrain from divulging confidential information. This duty is based on accepted codes of professional ethics, which recognise the special nature of care professional–patient relationships.

Priscilla’s severe communicative problems disturb the assessment phase dramatically. It takes a lot of time and skills by the assessor and advisor to detect the limitations and compensations of Priscilla. But in the above case the advisor is stressed in time and limited in effective communication, probably seriously affecting his decision making. Instead of searching for alternative communication modes and maybe influenced by prejudice about age he decides to advise on a communication mode that can contrast with her preferred life style.

Nursing staff extensively use elderspeak (infantilising communication) in conversations with older adults in long-term care settings, especially during care providing ADL (Williams et al., 2008). Piet Rijswijk (86), a retired teacher from Leusden, gave a clear example of this patronising behaviour when he told “the best example I can give you is when I was in the hospital and the nurse asked me if we were going to the loo together. I told her I preferred to do that on my own” (Wolthuis, 2013). In elderspeak, you underestimate other people. Research documents that elderspeak is perceived as patronising and can precipitate communication breakdown and problem behaviours for cognitively intact elders. In contrast, some social scientists promote the use of components of elderspeak to improve communication and cooperation in dementia care (Williams et al., 2008). The roles of stereotyping and stigmatisation need attention when a professional reflects on his/her behaviour. Older persons are microcosms of the general population and individuals in their own right. Thus, the application of broad generalities is both dehumanising, inappropriate and even discriminatory in its origin. From an ethical point of view stigmatisation means less respect and a reduction in dignity.

The fact that Priscilla is 81 years of age and experiencing severe communication problems, does not say anything about her personal need to communicate in a delicate way. Especially because Priscilla used to talk to almost everyone she encountered in her life, before she got sick. It is possible that she is no longer capable of learning to communicate in a different way, because of age. However, a professional should not base his decisions on prejudice on assumed duration of use due to age or financial consequences of the allocation, only. In his Thematic Study, Grover, the UN Rapporteur on the right of everyone to the enjoyment of the highest attainable standard of physical and mental health, identified discrimination against older persons on the basis of their age as the major barrier to accessing primary care and preventing chronic illness. Grover noted that discriminatory attitudes of medical professionals towards older persons could also undermine meaningful communication with their patients, and as a result this might affect the accuracy of diagnosis and the quality of treatment. He calls upon everyone to respect the right to health by refraining from various discriminatory practices (UN General Assembly, 2011, paras 38–39, 57).

Professionals can ask themselves three questions: can this device serve as an effective compensator for this person in the next three to six months? Or, will this device fit the personal characteristics of the person? And, will this compensation fit within the context and activities of this person? And if an answer is not available, an initial try-out period could well help. But a question like: is this investment well made for a person this age? is not considered to be ethically correct. Cost-effectiveness analysis comparing alternative health interventions in the
quality-adjusted life years produced from a given level of resources constitutes a quantitative method for prioritising different interventions to improve health. Ethical concerns regarding the applicability of cost-effectiveness and the quality-adjusted life years in regard to device allocation include: How is the value of a life defined? Should the young have a different access priority than the old? (3) How can we balance between the obligation to save a life and competing values? Six criteria have been proposed that should be met for QALYs to have ethical legitimacy in the clinical arena and within societal expectations. These include: QOL can be accurately measured and used; utilitarianism is acceptable; equity and efficiency are compatible; projections of community preferences can substitute for individual preferences; the old have less "capacity to benefit" than the young; and physicians will not use quality-adjusted life years as clinical maxims. Although these points are well-articulated and have some degree of rationality, they are not universally accepted. Ethical dilemmas ask for a thorough discussion, but straight forward or general answers are not easily apparent or provided.

Finally, the United Nations (2006b) also obliges States to take positive action in area of health protection. Its Article 25 requires taking all appropriate measures to ensure persons with disabilities to have access to health services that are gender sensitive, including health-related rehabilitation. "What is most important, older persons with disabilities are expressis verbis indicated as recipients of services designed to minimise and prevent further disabilities" (United Nations, 2006a).

When an advisor suggests a device, issues like personal preferences of the client on form, material and colour should be taken into account as far as reasonably possible. A fully effective device with an unwanted colour or fabric is less eligible for use, compared to an almost effective device with a preferred colour, design and or fabric. Use and satisfaction in particular are higher when the client is involved in the decision-making process on form, colour and fabric (Holtkamp et al., 2015). When a professional bases his ideas on his personal preferences or on commercial preferences that is considered to be unwanted and unethical behaviour. But when a professional works for a certain company which is not able to deliver a device but a competitive colleague is, we do understand that it can be difficult for that professional to advise on a device that he cannot sell. From an ethical point of view advisors about devices and allocators/producers of devices should make clear agreements to remain honest in their advice.

2.3 Phase 3: allocation and delivering

The third phase focuses on the manufacturing. The client expresses agreement to the choice of type of medical device or devices and investigates refund arrangements and procedures. The terms and conditions that apply to the provision of the medical devices are made clear to him. The professional determines which medical device(s) is (are) appropriate for the treatment goal and provides the desired level of function and informs the client of the pros and cons of this (these) medical device(s). He or she identifies contra-indications and consequences for the choice of medical device(s) and provides additional (written) information and gain client’s consent for the care plan. Details are recorded in the care plan and the care expert will find out whether the client is aware that there may be financial consequences for him/her personally and provide guidance if required (Nictiz, 2009). The ethical dilemmas in this phase are related to the decisions made by the professional: conflicts of interest, carefulness, respectful handling, personal involvement, integrity and transparency (Nierse and van Zaalen, 2017; Vrieland and Elias, 2017).

2.3.1 Case 3. Based on a thorough assessment an advisor in medical devices comes to the conclusion that Roberta needs a communicative aid with certain operational characteristics. However, his company does not supply this particular device. He decides that his boss will not be happy if he advises Roberta to consult a competitor. He decides to advice a second-best device that can be delivered by his company.

Careful and respectful assessment, as is the case in Case 3, is preferable from an ethical point of view. In Case 3, the advisor has a dilemma, because he knows that he advises another device than the one which is, or could be the best compensatory solution for Roberta’s problems.
Advisors should never experience these conflicts of interest: what is the best for Roberta is not the best for his company’s track record. After he realised that referring to a competitor was the best for Roberta and in the long run could result in recommendations to his firm, he realised that his future (and different) response will be different and beneficial for his company.

2.3.2 Case 4. Manuela has signed an agreement with her orthoptist that he would manufacture her foot orthosis with nylon, for reasons of flexibility of the material. But, when manufacturing Manuela’s foot orthosis the orthoptist chooses to use polycarbonate, because the polycarbonate is available in their production unit and nylon is not.

In Case 4, two ethical borders are crossed. The orthoptist used material that has not been agreed on in the literature to be the golden standard for foot orthosis (polycarbonate is used in ankle foot orthosis) and he delivers something else than what is paid for. Without consulting Manuela, he did not follow the agreed plan. Although the orthoptist may have felt involvement in manufacturing the best orthosis, his level of integrity and transparency can be questioned, because he did not discuss the change of materials with Manuela.

2.4 Phase 4: use and evaluation

In the fourth phase, the device is delivered to the client and checked on the pre-determined characteristics. In this phase of the device allocation process evaluation, tuning and control of the usability and appropriateness of an aid is critically addressed. Many different ethical issues need considerations, like: ownership, safety, human contact replaced by a tool and device tracking. Devices should meet the criteria of the user/consumer but that does not mean that the issues related to safety can be left unattended. To illustrate the importance of safety in the process of device manufacturing have a look at Case 5.

2.4.1 Case 5. Edwin went to a shoe specialist to get new orthopaedic shoes. After a thorough assessment the device demands were clear and a beautiful set of boots was delivered. At home Edwin had severe difficulties walking the stairs. In fact, he fell on some steps a couple of times before he had the courage to call the orthopaedic shoe specialist. When he explained his usability problems the specialist realised that although he had done a careful assessment he had missed one, in this case very important, question “Are you wearing the boots in the house and outdoors?” The boots were stiff and inflexible, something that was very convenient in walking around the house, but incompatible with him walking the stairs.

In Case 5, the feeling of safety is discussed. The orthopaedic shoe specialist did a thorough assessment but he also assumed that Edwin would walk bare-footed in the house. This assumption is probably based on his own habits related to not wearing shoes in the house. Although something is normal to us, it is possible that people within another context, culture or religion have different habits. So we should never think that we know it all, and remain open-minded. Handling information exclusively based on tacit knowledge is seen as a shortcoming in the design process (Holtkamp et al., 2015).

In the above sections, ethical dilemmas were discussed in relation to clients and personal device allocations. But in particular older and people with severe health conditions move to homes for older people or nursing homes. Forgetfulness, negligence or messiness can result in losing devices. Losing items is a time-consuming occurrence in nursing homes that is poorly described. An exploratory study conducted by van Hoof et al. (2016) with 12 residents who had early-stage dementia and 12 family caregivers investigated which items got lost by nursing home residents, and how this affected the residents and family caregivers. The participants stated that numerous personal items and assistive devices got lost in the nursing home environment, which had various emotional, practical and financial implications. Significant amounts of time were spent in trying to find items. Numerous potential solutions were identified by the interviewees, among them was device tracking. Although that seems to be a solid and timesaving solution, it too has some ethical dilemmas.

2.4.2 Case 6. Milleny a 44-year-old women who lives in a nursing home suffers from both Multiple Sclerosis and mid-stage dementia. Because of her mobility problems the institution
decided to provide Milleny with a walker-rollator so she would be able to walk around the nursing home when she wanted to. Due to her dementia on more and more occasions Milleny forgot where she had left her walking-rollator, resulting in frustration and despair. But Milleny was not the only resident of the nursing home who forgot where she left her medical devices. Walking-rollators, wheelchairs, beds and automated external defibrillator got lost in the nursing home. One of the professionals worried a lot about all the things that got lost and decided to observe people’s behaviour during working hours. He knew almost everyone working and living in the nursing home, so he could easily observe them during working hours. After a while he noticed that Mr X was walking around with Milleny’s walking-rollator. Mr X took the rollator into his living apartment in the nursing home. The professional kindly asked Mr X to return the rollator and he did so. Everyone was happy. A couple of weeks, and many observations later, the professional went to ask the board members of the nursing home if a device track and trace system could be implemented in the nursing home to retrieve lost materials. The board members were hesitant and ask the medical ethical committee for advice.

In Case 6, two other main issues are at stake: professionalism and data tracking. First of all, the professional chooses to observe the behaviour of people present in the nursing home. These observations are not done within the job responsibilities of the professional, but it is particularly disturbing that he did not ask peoples’ permission to be observed. By doing this he violates the principles of personal trust and safety of those people. Based on his observations he addresses Mr X and points him at the missing walking-rollator. Mr X was probably unaware of his wrong doing and by addressing Mr X by a non-regular professional, Mr X could feel worried, insecure and ashamed. The professional should have thought about this aspect of trust and safety before Mr X was addressed. The second dilemma in Case 6 concerns the data-tracking ideas. Although it sounds like a good solution the board members should realise that residents never opt into being tracked this way, as would be asked in mobile phone use, because they do not want it or do not directly benefit from it. If residents or consumers use products that belong to the institution, other ethical considerations should be made in tracking the devices compared to tracking products that are designed and/or owned by the person itself. When an older person uses products that belong to the institution, the institution often has the right to track this product, based on a signed user agreement. Tracking can also be defended if the person benefits from tracking the product himself. Conversely, so-called anonymous tracking is not very secure, because anonymity is fairly easily broken. Cracking open that anonymous shell/code and merging it with personally identifiable information from other sources is a fairly easy feat. In knowing where a product is at a certain moment and where it has been, a lot of information is gathered on the whereabouts of the user. The privacy of the residents in Case 6, or of consumers in general, needs to be protected. Before a data-tracking device is installed consensus is needed on the location of data storage, data access and data security. Although information leakage is mostly not done on purpose: “I did not mean harm […]”, leaked information can be harmful for those involved.

3. Conclusions

The concept of assisting the older adult through the use of technology to avail of healthcare has enormous potential. AT, social media use and AAC can have a positive effect on the QOL of older people, as long as they are supported enough in use of these technologies. Although technological modes like AT, social media and AAC can have positive effects on the QOL of older people, ethical and juridical considerations are at stake as well. This is especially true in using medical devices. Ethical and legal considerations need to be made in the entire process of device allocation and evaluation. Ask yourself: what is a good response? But also ask yourself: What is certainly not a good response? Although lots of solutions are possible, the question is which solution or possibility is advisable. Even from within the standpoint of a particular ethical theory or ethical view, these issues’ complexity means that different answers may be appropriate for a particular issue in the different contexts in which professionals work. Applying general statements implies substituting general terms for specific ones because a general descriptive statement applies to any arbitrary-specific case, instance or token. However, normative statements about actions are not applied in the same sense because individual cases of rational action are not arbitrary tokens.
For this reason, in normative contexts we may learn from a single example, which can be exemplary in a moral sense, without being an arbitrary sample. When applying normative good practice codes in care of older people, the derivation problem appears to occur in several ways and calls for careful meta-ethical reflection, prior to subsequent appropriate action.

References


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Future care: rethinking technology enhanced aged care environments

Jennifer Loy and Natalie Haskell

Abstract

Purpose – Cutting-edge hospital and residential care architecture and interior design aim to address the emotional and practical needs of patients, staff and visitors. Yet, whilst improving on past practice, current approaches to design still rarely recognise or respond to individuals. The purpose of this paper is to provide a review of design-led research into digital technology across disciplines for the personalisation of healthcare environments and is informed by the authors’ ongoing hospital-based research.

Design/methodology/approach – This review is based on a design anthropology framework providing insight into designing for changing the experience for older patients in current healthcare contexts and future focused strategies, integrating digital technologies and human-centred design across scale and disciplines. It is informed by ongoing hospital studies based on design-led research methodology, drawing on design anthropology and ethnographical methods.

Findings – Technology enhanced, human-centred, assistive devices and environments implemented into healthcare across scale are developing but integration is needed for meaningful experiences.

Research limitations/implications – This review is a positioning paper for design-led research into digital technology across scale and medium.

Practical implications – This paper provides the basis for practical research including the ongoing hospital-based research of the authors.

Originality/value – Future care scenarios are proposed, with technology and human experience as key drivers. Individualised and personalised solutions better cater for diversity. Within this context, it is strategic to question and test new ways of crafting the older persons care experience. This paper brings new direction to this discussion.

Keywords Design, Social, Health, Telemedicine, Spatial, User-centred

Paper type General review

Introduction

Healthcare scenarios rely on understanding complex systems of interaction in relation to a wide range of users and accommodating differing requirements within functionally diverse workplace environments. This challenge is growing as healthcare architecture in the twenty-first century becomes increasingly human-centred, as demonstrated in exemplar healthcare building projects such as the 330,000-square metre Karolinska University Hospital Solna, which won the Future Healthcare Design Prize and European Healthcare Design Award 2017. In this project, White Tengbom drew on evidence-based research to emphasise the importance of natural light, access to external views and a rethinking of the organisation of treatments based on a “patient first” strategy. The common spaces are a feature of this facility and furnished with natural materials, as well as site specific large- and small-scale art works. In addition to providing an environment that is visually interesting, the art pieces—one of the largest Swedish public art investments—work in conjunction with thematically designed signage and lighting, to assist wayfinding and a sense of connection within the building. The architects describe their intention as to create a facility that strengthens the “idea of a hospital as a civic building that people can take pride in” (White Arkitekter, 2017). Whilst this facility represents a shift in thinking in terms of patient care, it is still limited in its approach, with no apparent differentiation between
patient-experiences for individuals. With over 700 rooms for patients, the design focuses on improving engagement between healthcare providers and patients across the board, rather than on the basis of individual need. The individual’s experience is still dependent on the availability of staff and their cursory knowledge of the person’s history and personality. Vulnerable individuals, such as those with no immediate family, can be overlooked or isolated. This may be exacerbated by practical problems, such as an inability to navigate within the hospital independently, even with the help of established wayfinding strategies.

Many future focused research projects, such as the IBI Groups Salutogenic Home of Tomorrow, investigate scenarios where care occurs in the home. They suggest the home could include spaces for “diagnosis, treatment and healing and general wellbeing” (Mazuch, 2017, p. 43). Based on theories such as salutogenesis (focusing on supporting human health over the factors that determine a disease) and biophilia (suggesting that humans need to be closely associated with nature), the design of these spaces consider how environments can encourage wellbeing and health, rather than purely focusing on the treatment of disease. Even so, the likelihood of time spent within a hospital or residential care environment is still considerable. Extending the approach into these environments aligns with projects such as Maggie’s Centres (UK), which seek to create “comforting and uplifting environments”, as “refuges for care” for cancer patients (Jencks, 2017, p. 67; Wildevuur, 2017, p. 60). These projects demonstrate a more holistic approach to providing practical and emotional support, including opportunities for social contact and wellness activities.

Evolving technology-enabled healthcare

Over the last two decades, digital technologies have created opportunities for new layers of meaning, monitoring and communication. Technological disruptions in other fields inform the development of innovative solutions into the healthcare environment, from the introduction of continuous, real-time temperature monitoring (e.g. FeverSmart) to telemedicine for remote regions, slowed by the complexities involved in the healthcare context (Grol et al., 2013). Innovations in thinking create new connections between people, objects and their built environment. Tom Dixon, Creative Director at the Finnish furniture company Artek, demonstrated this by embedding stories into the company’s iconic stools, accessed through a smart phone. Technology-enhanced hospital environments can now incorporate data collection points via, for example, smart wristbands or door monitors, to provide real-time patient data (Majumder et al., 2017), and integrated technologies to enhance aesthetics and patient communication, such as demonstrated in the digital wall displays in the Peter MacCallum Cancer Centre. This design of the visual environment within healthcare, based on factors such as lighting, colour, artwork and views of nature (Salonen et al., 2013, p. 3; Andrade et al., 2016, p. 301) demonstrates that digitally facilitated, responsive placemaking can be employed as a counter to static design solutions, for example, through parametric design based on optical design systems controlling moving images, colour and light frequencies, etc. (Ziegler, 2015, p. 55) to create personalised spatial cues (Morag et al., 2016, p. 247). Building on this, it should be increasingly possible to create bespoke engagements between people, products and place not driven by utility only, but rather by an individual’s character and emotional needs. The practical research informing this paper is founded on a design anthropology framework, considering how people, “perceive, create, and transform their environments through their everyday activities” (Gunn et al., 2013, p. xiii). This perspective includes embracing design ethnography in the design process, to consider the role design has in defining the human experience both through designed artefacts, the design process and in this case, the patient experience.

The value of this approach has been highlighted by researchers, such as Pullin (2009), as the next step in healthcare design. This builds on the work of architects such as White Tengbom, taking the “patient first” approach to the next level with technology in order to be “people-first”:

A recent conference on assistive technology described its vision as “utility, usability and accessibility.” If these necessities are the extent of our vision, then traditional clinical testing could probably suffice. But more subjective and sensitive aspirations seem overdue: the engagement, experience, and emotion that a design elicits should be just as important. (Pullin, 2009, p. 138)
Advanced digital technologies now provide multiple opportunities for monitoring and interaction in real time via multimodal sensor data allowing the design of personalised responsive environments. The MIT DoppelLab demonstrates real-time motion detection, audio levels, temperature and humidity monitoring. Whilst the application of this data for building management and maintenance is clear, the MIT Tidmarsh Living Observatory study suggests directions for a next level approach that could be integrated into new design thinking for healthcare environments. This is where sensors pick up data that enhance the experience of the environment. Sensor networks “document ecological processes and allow people to experience the data at different spatial and temporal scales. Small, distributed, low-power sensor devices capture climate, soil, water, and other environmental data, while others stream audio from high in the trees and underwater” (MIT, 2017a, b), This aligns with Carlo Ratti’s Internet of Things based Office 3.0 personalised office experience, coined the Internet of Spaces. Although in different contexts, these projects demonstrate the technological facilitation of a personalised experience, relevant to healthcare environments.

Rather than as a passive recipient of ubiquitous computing outcomes, wearable technologies are starting to provide individuals with greater control over their environment. Designer Monisha Chippada designed a battery powered hood that blocked out electronic signals and shielded the user from view as a “safe space in this chaotic kind of world” (Yu, 2017). Taking control further, hearing aids now connect to smart phones, and provide users with the ability to change how they experience sound, as demonstrated by the LiNX 3Ds (Alter, 2017). Enhanced healthcare environments combining personal and spatially responsive technologies that contribute to the “holistic treatment of patients” (Huisman et al., 2012) will need to be crafted across scales to be truly human-centred. Digital technologies evolve at a rapid pace, across multiple platforms and through disparate disciplines making it difficult to maximise the opportunities an integration across mediums and scale could bring. Research is needed that targets different contexts (driven by user identification and analysis) to understand their potential across applications. Strategies are needed that respond not only to the functional needs of patients but also their emotional needs, based on digitally enabled experience tailoring and management. Such enhanced tailoring has the potential to address the “people-first” challenge for healthcare environments. The Australian National Digital Health Strategy highlights the changing consumer expectations for empowerment in the healthcare experience along with expectations that “digital technologies will facilitate improved access to healthcare services, delivering services in ways that are convenient for them” with 65 per cent of respondents suggesting the healthcare system is difficult to navigate (Australian Government, 2016).

Older adults patient experience

A key demographic in this context is older adults because of the potential benefits for the emotional wellbeing of this group and also the impact of an ageing population on healthcare costs and priorities. The developed world is entering the “Third Era of Health” with longer lifespans and an increasing focus on patient wellbeing (Mazuch, 2017, p. 43), resulting in a shift to embrace the human aspect of healthcare environments: “the complex and personal, not only within academic and clinical medicine, but also within health and social care” (Miles, 2017, p. 3). The growing emphasis for a “people-first” approach aims to recognise and respond to the uniqueness of an individual’s lived experience. As discussed by Miles (2017), patients are complex—not only defined by disease or organs requiring medical intervention, but as human beings “with narratives, values, preferences, psychology and emotionality, cultural situation, spiritual concerns […] worries, anxieties, fears, hopes and ambitions – and more” (2017, p. 4). Within current healthcare environments, including aged care facilities, it is difficult to respond to the narratives of individuals, yet with the potential of digital technology to facilitate responsive, engaged environments, this could change.

Older adults frequently present with deteriorating cognitive or sensory abilities (sight, hearing, touch sensitivity), reduced motor function, the possible onset of early stage dementia and a heightened response to the impact of medical treatments. It is not possible to generalise capabilities—and would be the opposite of the intent driving this research—unfamiliar environments are likely to be confusing and difficult to navigate when experiencing any number of these impairments. As suggested by Burton, Mitchell and Stride (2011), the “consideration of the built environment is particularly pertinent for older people; as they age […] declining health and functional status can make them more susceptible to barriers”. In addition, the dual-task performance required to navigate a space;
memory – cognitive navigational skills and sensorimotor skills (Zijlstra et al., 2016, p. 62) – is more difficult with ageing. Multi-sensory environmental cues matter, for example, through changes in sound and lighting, first to orientate and map pathways, then to provide journey progression indicators to counter issues such as memory loss and confusion. Morag, Heylighen and Pintelon state that “people need to be provided with a consistent set of indications […] good wayfinding design promotes healing because it provides people with a sense of control and empowerment, key factors in reducing stress, anxiety and fear” (2016, p. 243), irrespective of—and in direct response to—the impairments they may be experiencing. More, the facilitators for a sense of control need to be tailored to the individual. This results in a complex set of requirements based on considerations of engagement and time, including extended periods in communal areas. As highlighted by Daily (2017), “much of the patients’ time investments remain invisible to clinicians”. Montgomery highlights these “places in between key areas of the hospital”, such as the hallways and waiting areas:

These are the spaces we find ourselves as we search for entries and exits, walk from department to department, and wait, vulnerably with our loved ones […] It is the quality, character and configuration of these spaces that can make or break our healthcare experience. (2017, p. 114)

Counters to the “toxicity of time” should include personalised interventions enabled by digital interactions. Spatial and technology strategies are needed to redefine the older patients healthcare scenario.

Adams suggests a re-coding of modern hospitals is needed. He argues that people’s expectations of hospital environments have changed, to seeking designs beyond impersonal clinical institutions to ones that inspire wellness. Emotionally, Andrade discusses the “spatial and physical conditions of hospital settings on patients’ subjective well-being” (2016, p. 301) and the impact of a lack of connection. The hospital environment can be designed with the intent to create an appealing image, but Andrade et al. suggest that “correlational studies cannot disentangle the unique effect of the physical and social forces” and the complexity of the hospital care relationship—invoking “trust, intimacy and empathy” (2016, p. 300). The social aspect is supported by Annear et al. (2014), who found “access to networks of support and social participation” was a positive influence on older adults health (p. 602). This expands with concepts such as “sense of coherence (SOC)”, taking an individual’s responses to external factors into account, for example in determining the impact of stress. Antonovsky (1996, p. 15) discussed the relationship between the built environment the sense of coherence (Boscherini, 2017, p. 108) with the intent of making experiences more meaningful, comprehensible and manageable for individuals accessing services. Technology enables a layer of customisation to individual needs, particularly for an individual’s sense of coherence, to encompass “cognitive, behavioural and motivational” drivers that are unique—difficult to support in a one-size-fits-all solution.

Ongoing design-led research explores the confluence of environment and technology across scale and disciplines to provide an integrated approach to spatial and physical interaction in public hospitals and aged care facilities. As part of ethnographic research, site surveys including systems and usage patterns enable a broad understanding of the hospital environment. Building on this, ethnographic methods are also being used within the current investigations to uncover individual perspectives, through interviews, surveys and focus groups (to include design methods integrated into workshops to engage participants and participatory processes). In gaining data and insights from field study, ethnography has had a growing inclusion in design process since the early 1990s, largely driven by HCI and firms such as Xeros PARC (Plowman, 2003, p. 35), to organisations such as IDEO today. As suggested by Gunn, Otto and Smith there is a “genuine affinity between design and ethnography as processes of inquiry and discovery that includes the iterative way process and product are interconnected and the reflexive involvement by researchers and designers” (2013, p. 6) relevant for study involving patients in an empathic and reflective experience intended to uncover lived experiences, individual needs and behaviours. As technology, and in turn real-time data, is increasingly part of the patient experience, wider considerations of phenomenon such as the “Quantified Self” and “Qualified Self” and the subjective qualitative experiences of patients becomes possible.

“Healthy Aging” as defined by the World Health Organisation, is facilitated by age-friendly environments (both physical and social) and older-person-centred approaches that create “healthy environments” enabling quality of life and wellbeing, involve designing “supportive environments enabling people to do what is important to them, despite losses in capacity” (WHO, 2015).
Digital developments create opportunities to consider how trust and empathy can be facilitated to increase patient agency and positively augment the patient experience, how patient time can be reduced in the hospital environment (with aspects of care extended into the home through improved communication and telemedicine) and how time spent within the hospital environment can be supported. Salonen cites Ulrich and Horsburgh in suggesting healthcare environments are “often considered starkly institutional, unacceptably stressful, and unsuited to the emotional needs of patients, their families and healthcare personnel”, that there is “a need to create a healing […] environment that supports wellbeing and helps patients cope with the stress that accompanies illness” (2013, pp. 3–4).

Adding value

Older individuals have challenges and concerns additional to those of other demographics, but there is little more than basic universal design evident in healthcare facilities. There is a need to understand the lived experience of older-persons when designing assistive devices and experiences: “design innovation and anthropology […] should adhere to clear principles of respectful engagement with people’s values, the translation of them through processes of inclusive co-design, and the evaluation of their effects on people’s experiences from the perspective of the vulnerable” (Gunn et al., 2013, p. 245). As supported by Kolko (2014) “the first part of the design strategy is the emotional value proposition” (p. 117).

When designing for this demographic, a people-first approach calls for that emotional, social and cultural context to be explored. Hoffman highlights the “societal embedding of products and needs” (2012, p. 28) and the importance of latent and future needs in innovative product development (Hoffman, 2012, p. 10). Future needs are relevant to the changing use of technology, digital literacy, digital equity and future uptake implications, as well as sociocultural sustainability. Customisation, facilitated by technological innovation, allows culturally, socially and contextually relevant solutions that respect diversity and create interactions that are familiar, that people want to engage with, form attachments too and make part of their lives. Rowland et al. (2015) suggest “four different ways to look at context: operational, behavioural, ecological, and sociocultural” (p. 162), and Greenfield (2006) emphasises the humanisation of digital integration:

Some of the most beautiful everydayware I’ve seen was designed by former PARC researcher Ranjit Makkuni, whose New Delhi-based Sacred World Foundations works to bridge the gap between technological and traditional cultures. This is information processing interwoven with the familiar daily forms not of the developed world, but if the global South, cycle rickshaws, clay pots, and amulets among them. It’s a lovely reminder that the world contains a great many different “everydays”, beyond the ones we happen to be used to.

Whether clay pot or beer mat, though, these projects all capitalize on the idea that the distinctly local application of intelligence, and not the generic, one-size-fits-all vision embodied in computers, will turn out to be amongst the most important and useful legacies of our technological moment. (Greenfield, 2006, p. 22)

Kuniavsky advocates emotional design in digital innovation, with greater relationships between experiences and devices because the “use of devices is rarely the most important activity in someone’s life, but the devices form part of a larger flow of needs, desires, and activities […] having an experience may be impossible without the use of a specific device, but the device does not form the whole experience” (2011, p. 15). Norman states, “any object is part of its environment”, that there is a need to consider context more, the environments things are used in and usage patterns (2011, p. 123). These perspectives highlight the opportunities designers have to look across scale and discipline, to consider solutions and objects that are familiar when incorporating digitally assisted devices and system wide solutions:

Norman argues, in The Invisible Computer and elsewhere, that the difficulty and frustration we experience in using the computer are primarily artefacts of its general-purpose nature. He proposes that a truly human-centred design would explode the computers many functions into a “quiet, invisible, unobtrusive” array of networked objects scattered throughout the home: simple, single-purpose “information appliances” in the form of shoes, bookshelves, even teddy bears. (Greenfield, 2006, p. 22)
The key driver in designing for the older adult demographic is the respect for, and understanding of, diversity and character. Research is needed in this area when looking at value-adding in the healthcare context. The ideology of global design consultancy, IDEO, encapsulates this approach, arguing that the users themselves “are the ones who hold the key to their answer”. To create “innovative new solutions rooted in people’s actual needs” (IDEO, 2015, p. 9), according to Rowland et al. (2015, p.176) “the first step is to move beyond the comfort of your own workplace into the places where potential users work, play, eat and sleep”, hear their stories and gain knowledge of lived experiences. In the context of this paper, to design with empathy should result in interactions patients trust. The intent is that this will lead to their use in vulnerable moments to access care that has the potential to value add to their lives and experience (rather than detract).

Challenging design

If design has done less to engage with some disabilities than others – less with sensory impairment than mobility impairment, for example – then an area it has made little contribution to all is cognitive impairment. Perhaps one reason cognitive impairment is difficult for any design team is that it is so difficult to imagine what it must be like. (Pullin, 2009, p. 285)

The loss of cognitive functions, such as impaired memory and attention span is a key issue to consider. In current healthcare environments, digital interfaces support navigation facilities and service provision (such as automated patient check-in kiosks). Recent advances in individualised digital wayfinding, including the Mayo Clinic’s Patient app and the MediaNav application, guide patients from home and navigating the hospital. These provide a consistent system of cues that can adjusted for the individual patient. The strategy reduces missed appointments, automates reminders and the preparation needed for hospital visits. These systems also enable data analytics on the patient’s movements that can further help a healthcare provider understand the patient journey as a starting point. Conceptual approaches look at providing more personalised and customised solutions, such as the FeelSpace, which provides tactile cues in an unobtrusive wearable to guide users to destinations.

There are growing numbers of assistive devices, wearables and systems providing digitally assisted care. Solutions providing a holistic, integrated approach are based on the whole patient journey, key interactions and care relationships (Mould et al., 2010, p. 2). The supplemental e-Health approach is being incorporated in test groups utilising consumer wearable health-tracking products, e.g. Fitbits, to track health data (Nelson et al., 2015; Wired, 2017) through telecare, such as Bristol Careline, to more speculative robotic companions for the older people, for example, ElliQ. These interventions can potentially reduce time in hospital, streamline consultations and therefore reduce waiting time. However, these systems require a level of digital literacy that needs to be considered alongside the acceptance and use of digital aids by this demographic. As suggested by Mostaghel and Oghazi (2017), a number of factors will impact on uptake, including “gerontechnology self-efficacy, gerontechnology anxiety, cognitive abilities, self-reported health conditions and physical function” (p. 1970). The impact of digital devices on the older patient’s experience can vary, it can be a support (such as an aid in memory cues for navigation), or, for example, increase anxiety, with the perceived added complication of the device to comprehend. Technology integrated solutions can aid or detract from an older patients’ sense of independence and control. Perceived usefulness (how it will improve the experience and quality of life) and ease of use (correlating to usefulness and the level of effortlessness to use) are key uptake drivers, linked strongly to the individual’s level of confidence in using technology (Mostaghel and Oghazi, 2017, p. 1973). As digital tools are implemented in older persons healthcare solutions, the patient experience and importantly the patient uptake and engagement with these assistive technologies will impact the future care experience.

Nordgren (2014) emphasises preference differences, with some preferring only human contact and face to face socialising, whilst others embrace the independence of digital tools, or it may be context or situation dependant. It is therefore strategic in research to customise and offer digital tools as a choice when testing disruptive innovations for this sector. This is supported by Kolko (2014), “[...] you must perceive technology as a means towards a larger end, and that larger end is to help people achieve their goals and realise their hopes and dreams” (p. 21).
Immersive technology

Stories are my contextual framework for thinking. And story-telling is my way to connect buildings with people. (Morris-Nunn, 2006)

Architect Robert Morris-Nunn (2006) describes story-telling as an architectural form, with the aim of engaging with the “culture and traditions of people and place”. His three-dimensional settings are staged with the aim of adding to the richness of people’s lives, including for aged care facilities. In the Tasmanian Corumbene Aged Care facility:

Corridors outside people’s private rooms were transformed to become “theatrical” streetscapes, rich with meaning for the residents themselves, many of whom suffer from dementia and live in a world of memories from long ago. (Morris-Nunn, 2006)

Digital technology allows designers to build on responding to the shared history of patients and to embracing personal histories as an overt part of constructed experiences via technology-enabled wearables, responsive environments and — going forward — mixed reality. Technology is only now making this a realistic possibility. The different environments experienced concurrently by different characters through tailored digital immersion portrayed in the market scenes in the 2017 science fiction film, Valerian, are still some way off, but the ability to utilise integrated digital technology to create a richer, more personal, informed experience is not:

In the area of interactive media, the distinction between a product, the content it delivers, and a service that it may be just a small part of is blurring. The role of design is broadening, and even a user-centred approach to design is no longer focused on issues of usability alone, but on the overall experience being created. (Pullin, 2009, p. 137)

Redesigned healthcare spaces, such as the exemplars discussed, incorporate strategies to create supportive environments. The use of integrated devices can add another layer, to craft the experience with the patient, rather than with the care facility, to enhance their subjective experience. Wearables can mediate the care experience no matter where the patient is. This has the potential to provide a sense of empowerment and control for the patient, with the ability to track and record health issues as they occur, access personal medical data and receive targeted prompts for medication, care information or healthy living activities. Added to that, the ability to place sensors on the body to record variances and provide real-time feedback to individuals, healthcare personal, carers or family members, allows a level of self and community monitoring that could see a rise in telemedicine and home-based care. The implications of this digital shift, and the perception of care transitioning from largely institution focused to personalised and constant in a person’s life, can change how and where older people live, and the nature of home and residential care. As governments support the uptake of digital health services, such as in Australia with the National Digital Health Strategy (2016), the impact of these digital interventions and innovative solutions need to be considered.

Conceptual designs are exploring the personalised assistive care market for older people, while also redefining what that market is. The Design Museum (2017) recently explored future ageing and the “potential for design and designers to enhance the experience of our later lives”. The Aura Powered Suit, for example, supplements muscular ability rather than accommodating a lack of mobility (Fuseproject, 2016). It presents a shift in thinking towards augmenting in promoting healthy ageing and engagement with the world physically, socially and emotionally, despite loses in capacity:

“Ubiquitous” meant not merely “in every place,” but also “in everything.” Ordinary objects, from coffee cups to raincoats to the paint on the walls, would be reconsidered as sites for the sensing and processing of information, and would wind up endowed with surprising new properties. Best of all, people would interact with these systems fluently and naturally, barely noticing the powerful informatics they were engaging. The innumerable hassles presented by personal computing would fade into history. (Greenfield, 2006, p. 11)

In spite of Greenfield’s argument, responding to the opportunities provided by ubiquitous computing does not mean merely creating invisibility, but rather engaging with the technology to enhance the experience of the individual in ways that may be seamless but not neutral. For the first time, it is now possible to tailor individual experience to a person, to recognise who they are and respond to their character and behaviours. For example, smart orthotics can monitor the gait of the wearer, giving real-time information on stability, pace and direction. This information can provide
clinical evidence, but also be translated into wayfinding to rest spots for example, or the way back to the individual’s room. Beyond that, it can provide information in a way that is tailored to the physical needs and emotional preferences of the individual through subtle or direct cues. In future healthcare, it should be possible to tune the environmental response to the individual much as avatars in online games are adjusted to favour different characteristics.

Conclusion

Design is about humanizing technology or finding ways for technology to integrate into the fabric of our culture. (Kolko, 2014, p. 21)

At the core of the design process are the people accessing care. On a recent site visit during this research, an older man had spent two hours finding the hospital building and was unable to find the waiting area for his appointment. He was tired and in the midst of treatment. The space had been designed for aesthetics and included automated enhancements, but it was not comprehensible for him. It is impossible to summarise a particular patient demographics experiences without stereotyping, but talking to staff and patients, a person-centred approach is a common theme.

As designers, more time is needed to understand the particular challenges older people face physically and emotionally, and their individual needs and experiences, to design truly supportive environments and experiences that respect and empower to best meet their care needs. The future care scenario is being redefined with technology and human experience as key drivers. It is time to question and test new ways of crafting care experiences through a range of innovative design and health solutions as the research and technical possibilities evolve. The older demographic presents with a diverse set of needs, and, beyond that, the myriad of history, character and behaviours that individuals bring to a group. This paper aims to highlight the need for cross-disciplinary research to investigate not only the specific practical requirements of this group, but highlight the value in learning from, and responding to their experiences, attitudes and preferences in tailoring design facilitated by ubiquitous digital technology solutions integrated across scale and medium.

The ongoing hospital-based study informing this paper is based on a design-led research methodology. The research questions the constraints of disciplinary thinking on the application of digital technologies a holistic approach to design for health and wellbeing. This research engages with:

1. advances in digital technologies allowing for new interactions in healthcare scenarios;
2. sensitive handling of digital technologies for older patients;
3. a change in thinking utilising digital technologies working across scale and time for integrated, immersive experiences;
4. the ability to recognise and respond to individuals beyond the functional to add meaning, connection, respect and tailored interaction styles to the scenario; and
5. design-led research to explore the potential change in thinking and development of specific tools.

The architects and designers of the twenty-first century healthcare facilities have the opportunity to create new experiences through the recent advances made in digital technologies. Designing for older patients provides a good starting point to developing a universal design approach that challenges the idea that one-size fits all, and instead works to acknowledge, support and celebrate the individual.

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Further reading


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