Testbed Requirements for Technology Enhanced Stroke Rehabilitation to Support Independent Living

Awais Ahmad, Peter Mozelius and Karin Ahlin
Department of Computer and System Science, Mid Sweden University, Östersund, Sweden

Keywords: E-Health, Stroke Rehabilitation, Independent Living, Ageing Well, Testbed Requirements.

Abstract: An identified global phenomenon is that, as the percentage of older adults increases, new challenges arise for medical care and rehabilitation. Several research studies have presented e-health as a promising concept to support the idea of independent living among patients with chronic diseases. The Mid Sweden region has a relatively old population and is a region where people live with long distances to the nearest hospital or health care centres. This study had a focus on defining testbed requirements for a technology enhanced stroke rehabilitation adapted to the specific region. The focal research question to answer in this study was: What are the requirements and their associated benefits and barriers of using technology-enhanced systems instead of traditional techniques for stroke rehabilitation in the Mid Sweden region? With Design Science as the overall research strategy, data was collected by semi-structured interviews with key stakeholders in the field of stroke rehabilitation. A deductive thematic analysis was conducted where important themes were grouped into the four main requirement categories of: Technical, Human-computer-interaction, Clinic and Sustainability. Beside the more specific requirements, an interesting finding was the division of stroke rehabilitation into the categories motoric, cognitive and speech rehabilitation; also, how technology enhanced solutions might be used in these categories. Each category has a potential for a successful use of technology enhanced services, but as the standard procedure in traditional stroke rehabilitation each patient needs a personalised treatment.

1 INTRODUCTION

Because the population of older adults is increasing significantly all over the world, leading to current and future demographic changes, the world is facing substantial challenges (Chaaraoui and Florez-Revuelta, 2016). According to United Nations' global ageing indicators, number of people aged more than 60 years was 801 million in 2015 which will become 1.4 billion in 2030 and mover over in 2050, it will increase to 2.1 billion which means that 20% of the total papulation will be 60 years or older. Consequently, the number of people requiring long-term medical care will also be increased and more medical and social services will be needed that are designed to support chronic diseases (Ehn et al., 2015, Chaaraoui and Florez-Revuelta, 2016). Traditional rehabilitation systems require a large number of clinical staff and they are difficult to deploy because of high running costs (Zhang et al., 2016).

In the last two decades, Technology Enhanced Systems (TES) has emerged as potential tools for many treatments in therapy and rehabilitation. Those technologies are not only cost effective, they are helpful to develop more usable, useful, and accessible e-health services that can be helpful for physical, cognitive and psychological rehabilitation (Zhang et al., 2016, Rizzo and Kim, 2005, Broeren et al., 2008). Some other theoretical findings show that there are some critical requirements, which need to be addressed in order to adopt those e-health technologies such as trust, personal integrity, technology acceptance, e-health literacy and accessibility of ICT (Fischer et al., 2014, Ahmad and Mozelius, in press). These findings therefore need to be meet with requirements from the user perspective. Thusly, this study had a focus to understand the requirements of technology enhanced systems (TES) for independent living and to determine the challenges for deployment of TES.

Stroke is one of the biggest causes of death around the world and a main reason of chronic disabilities in adults (Yamato et al., 2016). It is considered a primary cause of permanent physical damage in the

Ahmad, A., Mozelius, P. and Ahlin, K.
Testbed Requirements for Technology Enhanced Stroke Rehabilitation to Support Independent Living.
DOI: 10.5220/0007658101740182
In *Proceedings of the 5th International Conference on Information and Communication Technologies for Ageing Well and e-Health (ICT4AWE 2019)*, pages 174-182
ISBN: 978-989-758-368-1

adult population and, due to those physical disabilities, the affected people fail to continue a healthy social life and they must compromise the pure joy of life; the older adults are the most affected age group (Broeren et al., 2008).

Although the challenges for stroke rehabilitations are common all over the world, our main focus was the Mid Sweden region. According to "Statistics Sweden", the population of the Mid Sweden Region is scattered in the whole region and a large number of people are living outside the cities (SCB, 2016). Consequently, providing rehabilitation services in the remote areas is even more challenging and a large amount of resources are needed to meet these challenges. Technology enhanced systems can play a vital role there.

1.1 Aim

The aim of the study was to define the testbed requirements for a technology enhanced stroke rehabilitation to support independent and active living. The main research question was: What are the requirements, benefits and barriers of using technology enhanced systems instead of traditional techniques for stroke rehabilitation in the Mid Sweden region?

2 EXTENDED BACKGROUND

2.1 Stroke Rehabilitation

After stroke, rehabilitation has been challenging for both patients and healthcare providers, as it requires high motivation and hard work from patients and extensive resources from health care providers (Yamato et al., 2016, Broeren et al., 2008). Most commonly, a stroke patient may suffer from some serious motor, cognitive and speech impairments (Langhorne et al., 2011). Various treatments are available for stroke rehabilitation that involves physical therapy, cognitive recovery and speech restoration with language therapy (Seniów et al., 2009, Langhorne et al., 2011, Veerbeek et al., 2014, Pollock et al., 2014).

Stroke patients experience motor impairments in the left or right side of the body that can limit their physical activity and consequently the patient's ability to perform their daily routine tasks decreases immensely (Langhorne et al., 2009, Palmcrantz et al., 2017). In order to overcome the aftereffects of stroke, and to increase the quality of patient's life, intense and long-term physical training is needed and should be started as early as possible (Ehn et al., 2015). Many of the currently used treatments for motor injuries involve physiotherapy and guided physical exercises; the perceived benefits of using physical therapy in stroke rehabilitation are continually increasing (Veerbeek et al., 2014). In the last two decades, several technology-enhanced rehabilitation systems for stroke have been suggested in different studies with their own benefits, drawbacks and limitations (Rizzo and Kim, 2005, Broeren et al., 2008, Palmcrantz et al., 2017). A number of novel therapies has been developed and tested and, in few of them, virtual reality and robotics are also involved. Although the perceived benefits of these interventions are not well known yet, there are strong possibilities of progress in these types of therapies (Langhorne et al., 2009).

2.2 Independent Living and Ageing Well

Considering the rapid increase of older population, several research studies have highlighted the importance of designing new e-health services to support the ideas of independent living and ageing well (Bowes and McColgan, 2013, Christophorou et al., 2016). Recent research studies have found that most older adults prefer to age in place, and that this concept is favored by policy makers (Peek et al., 2016), but also that contextual and psychosocial factors must be carefully explored if e-health services should result in a beneficial impact (Bowes and McColgan, 2013, Axelsson and Wikman, 2016).

The concepts of ageing well and older adults' possibilities for independent living are related and intertwined (Billis et al., 2015). Ageing well, or healthy ageing, has been described as a lifelong process to optimise the opportunities for improving and preserving health and physical, social and mental wellness to obtain independence and quality of life (Peel et al., 2004). Stroke is one of several acute health conditions that often results in lost independence, and a main objective in the rehabilitation must be to reestablish and facilitate patients' independent living to obtain their quality of life (Gwozdz and Sousa-Poza, 2010).

3 METHOD

The overall research strategy for the study was a Design Science approach inspired by the fivefold

process outlined by Johannesson and Perjons (2014). In the general definition, Design Science should involve a rigorous process where the design of artefacts should try to solve observed problems and make research contributions (Hevner et al., 2004, Peffers et al., 2007; Johannesson and Perjons, 2014). This study was carried out for the first two phases of the process that is illustrated below in Figure 1. Firstly, a problem was identified and formulated, and in the second phase the testbed design requirements were defined.

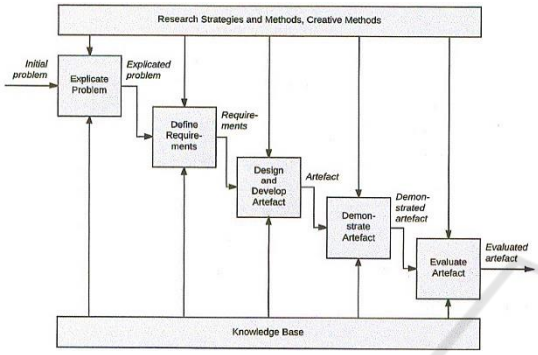

Figure 1: Phases in the Design science process.

Many design science studies do not carry out all the five phases of the method framework depicted in Figure 1. This study was conducted as a Requirement-Focused Design Science project, with a focus on defining requirements. This type of study starts with an existing problem and defines requirements in a combination of a literature study and interaction with relevant key stakeholders. In Requirement-Focused Design Science Research, the artefact design is only outlined and involves neither artefact demonstration, nor artefact evaluation. (Johannesson and Perjons, 2014).

Defined requirements will be the foundation for future work, where the remaining phases in Figure 1. will be carried out. Defined testbed requirements were divided into the categories of 1) Technical requirements, 2) HCI requirements, 3) Clinic requirements, and 4) Sustainability requirements, as the four fundamental pillars for a successful implementation of a testbed for stroke rehabilitation to support independent living.

3.1 Data Collection

Some type of interviews may be the most common data collection method for defining requirements. A direct approach to requirement specification is to interview different stakeholders about which explicit requirements they would suggest. Interviews can be highly efficient, but they also risk stifling creativity if they are too structured. Best practice is often to use semi-structured or unstructured interviews to encourage informant initiatives. It is also of importance to select informants with a competency and engagement that add value to the requirement specification process (Johannesson and Perjons, 2014).

Data for defining the requirements in this study were gathered in a combination of semi-structured interviews and by a literature study. All interviews were carried out following a common instrument, with a basic question schedule that allowed adaptation to the various interviewees. The basic question schedule included themes such as work relation to stroke rehabilitation, current knowledge, use, and understanding of use of ICT and its usefulness in relation to stroke rehabilitation, future wishes for use of ICT in relation to stroke rehabilitation, and budget for using ICT in relation to stroke rehabilitation. Keywords for searching literature were: e-health, stroke rehabilitation, independent living, and ageing well. Interviews were also combined with taking handwritten notes, to provide a backup to the audio recording, but also to facilitate the analysis process. The analysis process has been reflexive for the researchers, looking at the novelty of the requirement area, stroke rehabilitation (Thomsson, 2002). The impact has been further knowledge building and reflection following each interview session and further reading to understand the area.

Table 1: Informants' professional roles and years of experience of Stroke rehabilitation.

Informant	Professional role	Years of experience
Informant 1	Speech therapist	25
Informant 2	The region's medically responsible doctor	25
Informant 3	Therapist #1	5
Informant 4	Physiotherapist #1	18
Informant 5	Physiotherapist #2	3

Data were collected from five informants with different roles in contemporary stroke rehabilitation. This was a purposive sampling where all informants have special expertise and deep knowledge in the investigated area. Purposive sampling is a sampling technique where researchers rely on their own judgment when choosing informants to participate in ta study. Chosen informants' roles and their years of experience are described below in Table 1.

Informants 3 - 5 work as part of a mobile team for stroke rehabilitation located at the region's hospital. The mobile team includes one manager and four co-workers, adding one more therapist. The mobile team is responsible for rehabilitation after clinical care as the patients have been relocated to their homes. The mobile team offers care for patients living 70 km from the hospital, which covers parts of the region. Patients living further away are not provided with any support from the mobile team.

3.2 Data Analysis

A deductive thematic analysis was conducted with Technology, HCI, Clinics and Sustainability as the four predefined themes. The analysis was conducted as content analysis based on audio recordings and the transcribed recordings. Each researcher conducted an individual analysis, followed by discussions on the various findings to conclude the material. The individual analysis was formed by the steps in meaning units, condensation, code, category, and themes (Elo and Kyngäs, 2008, Bengtsson, 2016, Erlingsson and Brysiewicz, 2017).

As pointed out by Gibbs (2018) there are both pros and cons with the use of Computer Assisted Qualitative Data AnalysiS (CAQDAS) tools to assist the analysis process. CAQDAS, is a term, introduced in 1991, that refers to the wide range of software now available that supports data analysis in qualitative work. At the same time as the software provides a structured and powerful way to manage the analysis, CAQDAS has also been criticised for inflexibility, and for creating distance between the researcher and the data (Gibbs, 2018). However, the latest versions of CAQDAS tools have improved the flexibility, and, when several researchers collaborate, a common computer assisted structure can be of value. A CAQDAS tool facilitates the process of storing, organising, categorising and visualising the gathered data. The common CAQDAS used in this study was the NVivo tool (Alfasoft, 2018).

3.3 Ethical Considerations

The ethical considerations relate to the informants taking part in this study and the consequences of the actual research (Helgesson, 2015). The informants were all briefed on and responded to informed consent, including details such as the right to withdraw from the interview or interview questions and personal integrity. Further, the purpose of collecting the informant material is solely for research purposes.

This study does not consider the individual third person, such as patients performing stroke rehabilitation, but does discuss stroke rehabilitation in general. Therefore, interview questions related to individual patients were omitted, as well as specific training programs or patient names for further interviews. To protect the informants, their names are omitted in the transcriptions, while the transcriptions are stored at the local university's appointed and password saved information system for empirical material.

The consequences of the actual research is determined by clinical and social aspects, since the focus is on the usability for stroke rehabilitation and the patient. The technology requirements are subordinated, since technology is supposed to support the patient.

4 FINDINGS

The process of defining testbed requirements for technology enhanced stroke rehabilitation was conducted holistically, but with requirements divided into the categories of Technical, HCI, Clinical and Sustainability requirements. The categories have several interrelations, but findings are presented separately.

4.1 Technical Requirements

Physical damage has large variations between different persons and stroke recovery is heterogeneous in its nature (Langhorne et al., 2011). As highlighted by Informant 1, the rehabilitation has to be individually adapted with more advanced technology enhanced solutions for patients that have the cognitive ability to use a text based and complex interface. For this target group, the use of virtual reality and interactive video gaming may be beneficial for the motoric recovery (Laver et al., 2015), and that the language relearning can be facilitated by various standard applications for

language training. Preferably, these applications should involve features for recording and replaying the patients' pronunciation exercises. (Informant 1)

Considering more severely damaged patients, language skills can be lacking and the recommendation is to use image based applications, which can be used to diagnose the damage level (Dobkin, 2004). An example of an image based tool are the so-called 'Talking photographs', applications that can be run from a tablet or a smart-phone (Informant 1). Some patients have a damage level where the initial training has to be carried out by oral exercises with repetition and mimicking only, and many patients have a visual impairment caused by the stroke. (Informant 1)

For patients with mild-to-moderate upper extremity motor impairment, low-cost, off-the-shelf exergames connected to sensors seem an interesting add-on alternative (Laver et al., 2015, Tsekleves et al., 2016). Considering patients with more severe motor impairment, a solution might be to use technology based on eye-tracking navigation (Informant 2). Finally, a crucial factor for technology enhanced services is the quality, or existance, of internet connections in the patients' homes. There are still several blank spots without internet access in some the region's remote areas (Informant 3-5).

4.2 HCI Requirements

Human-computer interaction (HCI) is an established field in computer science where designing, evaluating and implementing interactive computing systems is considered from the user's perspective (Gulliksen, 2017). The requirements should be considered from the HCI prospective and some important HCI factors need to be addressed. Several theoretical findings showed those critical HCI factors are trust in different forms, personal integrity, technology acceptance and e-health literacy (Fischer et al., 2014, Veer et al., 2015, Ahmad and Mozelius, in press).

The approach of older adults towards e-health applications is different from younger people and they feel difficulty in adopting those applications (Fischer et al., 2014). As reported by Informant 1, not all people accept Technology Enhanced Systems and few of them are actually set against them. Older adults especially have difficulty using e-health applications (Informant 1).

Despite the fact that a large amount of resources are invested on Technology Enhanced Systems, they are not easy to adopt for patients and there are some issues regarding usability and perception of usefulness which need to be addressed (Haslwanter, 2018). During the interviews, both Informants 1 and 2 emphasized heavily the importance to consider the aspects and requirements of usability and usefulness of technology enhanced services (Informant 1; Informant 2). Informant 1 described that there are many different kinds of mobile phone or iPad based applications available for stroke rehabilitation and they recommend them for the patients' use. The usability of those applications depends heavily how much a patient is affected by stroke and how much their brain has been damaged (Informant 1).

While designing e-health services, personal integrity and patient's privacy should be considered as a critical issue and Healthcare providers need to consider it while deploying technology-enhanced systems such as monitoring cameras (Courtney et al., 2008, Ahmad and Mozelius, in press). Three informants mentioned that patients are very much concerned about their privacy and personal integrity (Informant 3 - Informant 5).

Several studies highlighted the importance of e-health literacy to increase the usability of e-health services for older adults (Ahmad and Mozelius, in press, Vines et al., 2015). The use of web applications in stroke rehabilitation depends on the understanding of these applications and there should be clear guidelines and instructions to use these applications (Informant 1, Informant 5). Older adults especially have more difficulties using mobile applications because of their lesser understanding of how to use them (Informant 1).

4.3 Clinic Requirements

This striking disease is caused by interruption of the blood supply to the brain because an artery to the brain is either blocked (ischaemic stroke) or bursts (hemorrhagic stroke) and it damages the brain tissues (Yamato et al., 2016).

The rehabilitation must be carefully adapted to each individual, and how stroke has affected a patient's abilities show large variations (Informant 1). Depending on where in the patient's brain the damage is located, there can be a wide variety of disabilities that need rehabilitation (Informant 2). An important principle is to start the rehabilitation as soon as possible (Informant 1; Informant 2), and preferably in two or three days after the stroke has occurred (Informant 2). How the rehabilitation should be carried out in detail depends on the patient's cognitive and motoric condition, and a technology enhanced rehabilitation has the best probability to be successful for patients with milder cognitive and motoric disabilities (Informant 1; Informant 2).

Stroke rehabilitation could be divided into three main categories: cognitive, motoric and speech rehabilitation (Informant 3-5). According to the informants, there is a potential for technology enhancement in all the categories, but probably not for stroke patients with more severe disabilities (Informant1; Informant 3). In a rough estimation at least 25% of the patients could benefit from various types of technology enhanced support (Informant 1).

Specific to the investigated region is that the population is evenly spread out with the city of Östersund as the central hub (Informant 2). The mobile stroke team visits patients in their homes if they live inside the 70 kilometre radius that defines their working range. Patients living outside the radius are excluded from the services that are carried out by the mobile stroke team.

4.4 Sustainability Requirements

Sustainability is created by finding the balance between its three pillars: environmental, social and economic (Brundtland, 1987), aiming for a wished end-goal, here the stroke rehabilitation. Sustainability is usually discussed as a direction for fulfilling today's need by not sacrificing the coming generations' possibilities to fulfilling their needs. Detailing the pillars shows that environmental sustainability, often viewed as the fundamental part, deals with maintaining long-term human and material resources. Here the human resources, looked upon as social sustainability, includes every possible patient in need of stroke rehabilitation and their specific needs (Informant 1 - Informant 5).

The economic sustainability derives from the ability for everyone to afford to take part in stroke rehabilitation and the efficient use of co-workers' time (Informant 1 - Informant 5). One primary reason for economic sustainability equalising efficiency might be the lack of financial resources in the region. Equalisation between technological development and economic growth, and further between economic growth and sustainable development, is far from unproblematic. One problem is to understand the equalisation in itself, and another is defining development as sustainable.

Social sustainability includes meeting the patient at their level, supporting them in feeling secure, performing everyday courses, and performing exercises related to their physical level (Informant 3 - Informant 5). There is, therefore, a need for flexibility related to social sustainability, e.g. while using TES in a health care context or at home. One such could be the variation for cognitive rehabilitation, where some of the patients need everyday instruction and evaluation. Another social perception is that of joyful and inspirational rehabilitation. Their view is that younger patients might view using TES as more inspiring than physical rehabilitation and thereby be more likely to use it.

The economic sustainability was discussed concerning both the patients and the co-workers. For rehabilitation in the patient's home, the software needs to be affordable, both in consideration to the investment, implementation, and maintenance. The latter is discussed as the Mid Sweden region does not offer any maintenance technicians for home support (Informant 3 - Informant 5). Related to that is the cost for power supply and other surrounding costs. Therefore, the informants view the health care context as more economically sustainable, regarding implementation and maintenance. The other view on economic sustainability is that of the co-workers. Using TES, regardless of context, can make them more efficient timewise. They view driving far to meet the patient for half an hour as a waste of time in comparison to talking to them, e.g., using Skype or cell phone. The saved time could be used for quality improvements, not further specified. They did discuss the office situation, and finding needs for reconstruction related to privacy concerns.

The environmental sustainability was not highlighted by the respondents, and was more viewed as a foundation. Environmental sustainability refers to the long distances, where the co-workers need to drive for several hours per workday to meet the patients in person (Informant 2 - Informant 5). However, one idea to make the implementation more environmental in a friendly way was to use geographically closed health care centres that include space for self-care situations, such as measuring blood pressure (Informant 3).

5 DISCUSSION

What is specific for the investigated region is the heterogenous demographic spread around Östersund as the central hub for healthcare. The relatively long distances inside the 70 km work radius for the stroke team raised thoughts about telecommunication and technology enhanced services. An ordinary 20 minutes home visit for the mobile stroke team could involve a 2 hour car drive in both directions (Informant 3-5). However, all informants agree on the importance of human-to-human interaction and that technology should be tested as a complement and not as a replacement.

There seems to be a potential for using e-services in all three stroke rehabilitation categories with obvious benefits in the motoric rehabilitation. Exergames and other game-based solutions would be interesting adjunctive alternatives (Karasu and Batur, 2018) but always with the principle of a careful individual adaptation. As pointed out by Pollock et al. (2014), the effectiveness of a treatment depends upon the patient's physical and mental condition. Therefore physiotherapists should choose the treatment according the patient's medical requirements (Pollock et al., 2014).

Considering the speech rehabilitation there are also a wide range of software for articulation exercises and language relearning (Informant 1). A speech therapist can prescribe the combination of hardware and software that has been selected for a patient. However, not all patients have the computer skills or the visual ability to use all existing applications. A custom built, tablet-based stroke rehabilitation platform with software applications for speech rehabilitation has been tested with promising results in Canada (Pugliese et al., 2017).

The cognitive rehabilitation might use both games and software for telecommunication (Informant 3). Patients often suffer from memory impairment and a digital game based approach could be an appreciated complement to traditional rehabilitation (Withiel et al., 2018). Finally, the concept of telecommunication was brought up by the mobile stroke team, and also the idea of testing a mobile robot based communication tool in patients' home environments (Informant 3-5).

Stroke is one of the most common causes of physical, cognitive and speech disabilities. Right after stroke, effective and urgent rehabilitation is needed in order to overcome or decrease the disabilities. Technology Enhanced Systems can play a vital role here (Zhang et al., 2016). However, there are some critical factors that need to be addressed while constructing these systems. Things should be seen from the user perspective and human requirements should be fulfilled.

Technical requirements have to be carefully outlined. The willingness to use Technology Enhanced Systems heavily depends upon the perceived benefits of using these technologies, quality of information and training to use them, degree of joyfulness in these technologies, the medical condition of the patient after stroke and the age group of the patient. All the informants agreed that technology-supported solutions should be interactive, interesting and joyful to increase the ease of use and to meet the above mentioned requirements (Informant 1 - Informant 5). As suggested by many studies, attitude towards contemporary technologies depends upon usefulness, usability, education and training, previous experiences and trust on these technologies (Broeren et al., 2008, Fischer et al., 2014, Lee and Coughlin, 2015, Zhang et al., 2016).

An important part of the HCI requirements is to consider trust and privacy. Patients are in general concerned about privacy and integrity, and even more when it comes to the use of monitoring devices (Informant 3 - Informant 5). Finally, the economic sustainability needs further investigation, and with the perspective that efficiency always should be related to patients' personal integrity and social sustainability. Technology must be a complement and support social interaction and not only a cost-effective substitute.

6 CONCLUSION

With the help of surprisingly collaborative and open-minded informants, the study has generated useful general requirements for further future testing and for the planned implementation of a testbed. However, in all of the three found rehabilitation categories, motoric, cognitive and speech rehabilitation, there is a need for more specific requirements.

Some important benefits and barriers have also been discovered in the field of technology enhanced stroke rehabilitation. Technology enhanced solutions seem to have a potential to support independent living, but only if HCI requirements such as trust, privacy and user-friendliness are met. Stroke patients often suffer from memory impairment and visual impairment and therefore the requirements for user-friendliness need to be stricter than for just any ordinary technology enhanced solution. Finally, findings have also contributed to a better understanding of the specific health care conditions in the Mid Sweden region.

7 FUTURE WORK

This study defined the more general requirements for a future testbed implementation for technology enhanced stroke rehabilitation. The natural next step would be to define more specific testbed technical and HCI requirements for each of the three found rehabilitation categories. From a longer perspective, the presented requirements should be used as part of the design and implementation of a future testbed.

REFERENCES

Ahmad, A.,Mozelius, P. Critical Factors for Human Computer Interaction of eHealth for Older Adults. In proceedings of The 5th International Conference on e-Society, e-Learning and e-Technologies (ICSLT 2019), in press.

Alfasoft. 2018. What is NVivo? [Online]. from: http://www.alfasoft.com/en/products/statistics-and-analysis/nvivo.html. [Accessed 11/11/2018].

Axelsson, S. W.,Wikman, A. M. 2016. Ready for eHealth. Older Swedes' Perceptions of eHealth Services: Using the PIADS Scale as a Predictor for Readiness. Technologies, 4(3).

Bengtsson, M. 2016. How to plan and perform a qualitative study using content analysis. NursingPlus Open, 2,8-14.

Billis, A. S., Papageorgiou, E. I., Frantzidis, C. A., Tsatali, M. S., Tsolaki, A. C.,Bamidis, P. D. 2015. A decision-support framework for promoting independent living and ageing well. IEEE journal of biomedical and health informatics, 19(1), 199 - 209.

Bowes, A.,McColgan, G. 2013. Telecare for older people: promoting independence, participation, and identity. Research on Aging, 35(1).

Broeren, J., Bjorkdahl, A., Claesson, L., Goude, D., Lundgren-Nilsson, A., Samuelsson, H., Blomstrand, C., Sunnerhagen, K. S.,Rydmark, M. 2008. Virtual rehabilitation after stroke. Studies in health technology and informatics, 136, 77.

Brundtland, G. H. 1987. Brundtland Report. Our Common Future. In: MUNDIAL, C. (ed.).

Chaaraoui, A.,Florez-Revuelta, F. 2016. Technologies and Applications for Active and Assisted Living. Current situation.

Christophorou, C., Kleanthous, S., Georgiadis, D., Cereghetti, D. M., Andreou, P., Wings, C., Christodoulou, E.,Samaras, G. 2016. ICT

services for active ageing and independent living: identification and assessment. Healthcare technology letters, 3(3), 159 - 164.

Courtney, K. L., Demeris, G., Rantz, M.,Skubic, M. 2008. Needing smart home technologies: the perspectives of older adults in continuing care retirement communities. Informatics in Primary Care, 16, 195 - 201.

Chaaraoui, A., Florez-Revuelta, F., 2016. Technologies and Applications for Active and Assisted Living. Current situation.

Dobkin, B. H. 2004. Strategies for stroke rehabilitation. The Lancet Neurology, 3(9), 528-536. The Lancet Neurology, 3(9), 528 - 536.

Ehn, M., Hansson, P., Sjölinder, M., I.L. Boman, Folke, M., Sommerfeld, D., Borg, J.,Palmcrantz, S. 2015. Users perspectives on interactive distance technology enabling home-based motor training for stroke patients. In pHealth, 145 - 152.

Elo, S.,Kyngäs, H. 2008. The qualitative content analysis process. Journal of advanced nursing, 62, 107-115.

Erlingsson, C.,Brysiewicz, P. 2017. A hands-on guide to doing content analysis. African Journal of Emergency Medicine, 7, 93-99.

Fischer, S. H., David, D., Crotty, B. H., Dierks, M.,Safran, C. 2014. Acceptance and use of health information technology by community-dwelling elders. International journal of medical informatics, 83(9), 624 - 635.

Gibbs, G. R. 2018. Analyzing qualitative data, SAGE.

Gulliksen, J. 2017. Institutionalizing human-computer interaction for global health. Global health action, 10(sup3), 1344003.

Gwozdz, W.,Sousa-Poza, A. 2010. Ageing, health and life satisfaction of the oldest old: An analysis for Germany. Social Indicators Research, 97(3), 397 - 417.

Haslwanter, J. D. H. Review of Telecare Technologies for Older People. In International Conference on Computers Helping People with Special Needs, 2018. Springer, Cham, 407 - 415.

Helgesson, G. 2015. Forskningsetik, Lund, Studentlitteratur.

Hevner, A. R., March, S. T., Park, J.,Ram, S. 2004. Design Science in Information Systems Research MIS Quarterly, 28, 75-105.

Johannesson, P.,Perjons, E. 2014. An introduction to design science. , Springer.

Karasu, A. U., Batur, E. B. 2018. Effectiveness of Wii-Based Rehabilitation in Stroke: A Randomized Controlled Study. Journal of rehabilitation medicine, 50(5), 406-412.

Langhorne, P., Bernhardt, J.,Kwakkel, G. 2011. Stroke rehabilitation. The Lancet, 377(9778), 1693-1702.

Langhorne, P., Coupar, F.,Pollock, A. 2009. Motor recovery after stroke: a systematic review. The Lancet Neurology, 8(8), 741-754.

Laver, K. E., George, S., Thomas, S., Deutsch, J. E.,Crotty, M. 2015. Virtual reality for stroke rehabilitation. Cochrane database of systematic reviews, (2).

Lee, C.,Coughlin, J. F. 2015. PERSPECTIVE: Older adults' adoption of technology: an integrated approach to identifying determinants and barriers. Journal of Product Innovation Management, 32(5), 747 - 759.

Palmcrantz, S., Borg, J., Sommerfeld, D., Plantin, J., Wall, A., Ehn, M., Sjölinder, M.,Boman, I. L. 2017. An interactive distance solution for stroke rehabilitation in the home setting–A feasibility study. Informatics for Health and Social Care, 42(3), 303 - 320.

Peek, S., Luijkx, K. G., Rijnaard, M. D., Nieboer, M. E., Voort, C. S. v. d., Aarts, S., Hoof, J. B. v., Vrijhoef, H. J. M. c.,Wouters, E. J. 2016. Older adults' reasons for using technology while aging in place. Gerontology, 62(2), 226 - 237.

Peel, N., Bartlett, H.,McClure, R. 2004. Healthy ageing: how is it defined and measured? Australasian Journal on Ageing, 23(3), 115 - 119.

Peffers, K., Tuunanen, T., Rothenberger, M. A.,Chatterjee, S. 2007. A design science research methodology for information systems research. Journal of management information systems, 24(3), 45-77. Journal of management information systems, 24(3), 45 - 77.

Pollock, A., Baer, G., Campbell, P., Choo, P. L., Forster, A., Morris, J., Pomeroy, V. M.,Langhorne, P. 2014. Physical rehabilitation approaches for the recovery of

function and mobility following stroke. Cochrane Database of Systematic Reviews, (4).

Pugliese, M. W., Wilson, K., Guerinet, J., Atkinson, K. M., Mallet, K. H., Shamloul, R., ... & Dowlatshahi, D. 2017. Mobile Tablet-Based Stroke Rehabilitation: Using mHealth Technology to Improve Access to Early Stroke Rehabilitation. International Journal of Interactive Mobile Technologies (iJIM), 11(1), 148-157.

Rizzo, A. S.,Kim, G. J. 2005. A SWOT analysis of the field of virtual reality rehabilitation and therapy. Presence: Teleoperators & Virtual Environments, 14(2), 119 - 146.

SCB 2016. Sweden - Population in the provinces on 31 December 2014.

Seniów, J., Litwin, M., Litwin, T., Leśniak, M.,Członkowska, A. 2009. New approach to the rehabilitation of post-stroke focal cognitive syndrome: Effect of levodopa combined with speech and language therapy on functional recovery from aphasia. Journal of the neurological sciences, 283(1-2), 214-218.

Thomsson, H. 2002. Reflexiva intervjuer. Studentlitteratur, Lund, Studentlitteratur.

Tsekleves, E., Paraskevopoulos, I. T., Warland, A.,Kilbride, C. 2016. Development and preliminary evaluation of a novel low cost VR-based upper limb stroke rehabilitation platform using Wii technology. Disability and Rehabilitation: Assistive Technology, 11(5), 413-422.

UN 2015. Department of Economic and Social Affairs, population division. Trends in contraceptive use worldwide [Internet].

Veer, A. J. d., Peeters, J. M., Brabers, A. E., Schellevis, F. G., Rademakers, J. J. J.,Francke, A. L. 2015. Determinants of the intention to use e-Health by community dwelling older people. BMC health services research, 15(1), 103.

Veerbeek, J. M., Wegen, E. v., Peppen, R. v., Wees, P. J. v. d., Hendriks, E., Rietberg, M.,Kwakkel, G. 2014. What is the evidence for physical therapy poststroke? A systematic review and meta-analysis. PloS one, 9(2), e87987.

Vines, J., Pritchard, G., Wright, P., Olivier, P.,Brittain, K. 2015. An age-old problem: Examining the discourses of ageing in HCI and strategies for future research. ACM Transactions on Computer-Human Interaction (TOCHI), 22(1), 2.

Withiel, T. D., Sharp, V. L., Wong, D., Ponsford, J. L., Warren, N., Stolwyk, R. J. 2018. Understanding the experience of compensatory and restorative memory rehabilitation: A qualitative study of stroke survivors. Neuropsychological rehabilitation, 1-20.

Yamato, T. P., Pompeu, J. E., Pompeu, S. M.,Hassett, L. 2016. Virtual reality for stroke rehabilitation. Physical therapy, 96(10), 1508 - 1513.

Zhang, H., Shen, Z., Lin, J., Chen, Y.,Miao, Y. 2016. Familiarity design in exercise games for elderly. Int J Inf Technol, 22, 1 - 19.