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Information and Communications Technology in Health Care

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Preface

This thesis has been written on assignment for a project called “Value Creation in Smart Living Environments for Senior Citizens” funded by the Academy of Finland. This Oulu-based project aims to develop and evaluate the effects of smart technologies in the home care of the elderly with memory disorders, which is the main focus in the last chapter of this thesis after having thoroughly gone through the theoretical background. For offering the assignment and guidance from VESC side I want to thank Professor Olli Martikainen, and from the Aalto University School of Economics side Professor Matti Pohjola. I would also like to thank the whole project VESC and several helpful people working within the project, especially: MD, PhD Ilkka Winblad, Prof. Petri Pulli, researchers Kaisu Juntunen and Eeva Leinonen. Furthermore, I would like to express my gratitude to Service Chief of Oulu home care Rita Oinas, Project Manager Jaana Kokko and nurse Kaisu Jyrkäs for providing the data that was needed. For funding I am thankful to Oulu Deaconess Institute and the Chief Physician of Geriatrics Petteri Viramo.

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ABSTRACT
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INFORMATION AND COMMUNICATIONS TECHNOLOGY IN HEALTH CARE

Information and communications technology has increased productivity in many sectors of the economy, and economic growth rests more and more on the contributions of ICT. However, even though the investments in ICT have been growing, the adoption information and communication technology has been relatively slow in health care industry. Health care systems are under constant discussion and there is pressure to improve productivity, as the already struggling industry will face serious challenges due to the ageing population. As the population is ageing, the demand for health services will increase and the labor force decrease. Thus, to be able to provide good quality health services to the citizens, the productivity needs to increase and it is widely believed that ICT will be playing a major role.

This thesis discusses the role of ICT in improving productivity in the health care sector as well as the related problems and the reasons behind the slow adoption. The discussion is based on existing literature and research on the subject. Health ICT applications are constantly developing and new research comes up frequently, and one of the objectives is to get a picture of the current situation in Finland as well as in Europe and the US.

Moreover, memory disorders will be posing a major challenge for future health care. Due to population ageing the prevalence of dementia is going to increase and there is discussion about the use of ICT to enhance productivity in home care. Especially smart living environment technology has received a lot of attention in this context, and also the last chapter of this thesis deals with a particular Oulu-based smart living environment project called “Value Creation in Smart Living Environments for Senior Citizens”. I try to assess the cost-effects of possible technology solutions, but since there is no concrete technology yet, I have been able to get only very rough and suggestive results of the cost reductions. The calculations are based on information attained by interviewing two home care nurses and the Service Chief of home care in the city of Oulu.

The main conclusions are that despite its limits, it seems that eventually ICT will be effecting the productivity in health care greatly, and possibly change the process considerably. Furthermore, with the help of ICT, the focus is moving from acute type of care towards more prevention and self-care, which – in the long run – is obviously good for the economy as well as our health.

Keywords: Information and communications technology, eHealth, health care, dementia, smart living environments, population ageing

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1. Introduction

Population ageing will pose a serious challenge to health care systems in becoming decades in most of the world. The amount of people needing care is increasing parallel with the decrease of the labor force supply. Finland is facing this problem among the first ones in Europe as the population is older than in other countries – having the median age of 42 compared to the European average of 40.2 years. It has been estimated that by 2040, to keep the health and social services as they are, Finland would need 200 000 employees more in health and social services sector if the productivity stays on the same level (Parkkinen 2007). However, due to the ageing population, the number of workers is only going to decrease. Thus, to keep health services available to all, health care process has to be improved. This has been noticed and the health care process is being under constant discussion in Finland, as well as in many other developed countries. The role of health information and communications technology in improving productivity and overcoming the awaiting challenges has been widely acknowledged and sometimes considered as the only way forward (European Commission).

One very common form of health ICT is patient self-care and education, including for example interactive web sites and medical devices for self-monitoring. Along with adapting health ICT the patients are being involved more and more in their own health care process. This also seems to be a welcomed trend from the patient side, as more and more people are interested in their own health and proactively looking for health information in internet. Obviously, with modern ICT also the communication between health professionals and patients and other actors can now be done faster than ever, even real-time. Furthermore, one of the most commonly referred use of health IT is the electronic data storage and data sharing across providers. This has also received attention in the European Union, and the European Commission envisions a common health database for the European Union. In addition to the increasing importance of self-care, modern forms of communication and electronic data processing, there can also be very complex technologies that combine all these. These technologies make it possible to do certain monitoring tests at home and send the data to health care professionals to be analyzed, resulting in an intervention when needed. (Christensen et al. 2007)

Many commentators herald the potential of information and communications technology in health care in improving the productivity and quality of the services. This is not surprising, since ICT has indeed helped to improve productivity in many fields of the economy. For instance the banking sector has benefited from the automation that was made possible by the new technology. Moving towards internet banking has reduced the need for labor that was tied up in the routines, and thus enhanced labor productivity. All in all, in Finland, ICT has been estimated to contribute to the overall productivity growth by one percentage unit, implying that half of the whole labor productivity growth comes from ICT (Pohjola 2008). However, in health care industry, the adaption has been relatively slow. Health care is clearly an information intensive sector which could benefit from information and communications technology, and the potential has also been noted. Why is it taking so long to move towards the adaption of more comprehensive health ICT?

There are many reasons why the adaption of health ICT has been happening carefully. First of all, there is a lack of demonstrated cost-effectiveness. There is no comprehensive, existing evidence that investments in health ICT unquestionably improve efficiency. Furthermore, as an industry, ICT markets have some shortcomings that can act as barriers of adaption. Low product differentiation, high switching costs and the lack of technical compatibility are typical problems for ICT products and systems and can complicate health ICT adaption. Health clients are very heterogeneous in their needs and backgrounds, and the low product differentiation can become a problem. The switching costs can also be substantial, especially in big health organisations where huge amounts of information have to be transmitted into new formats etc. Also the interoperability plays a crucial role in health care process and calls for common standards to cope with the lack of technical compatibility. In addition to this, also the issues of privacy have to be taken into account. All in all, in health industry it is important to consider thoroughly before making any decisions, as mistakes and medical errors can have serious consequences that are not well tolerated by the society (e.g. premature death). (Christensen et al. 2007)

Despite all the barriers, ICT is seen as a possibility to cope with the rising health care demands. There are already very promising experiences from the use of ICT in the treatment of chronically ill, and a lot of discussion of applying it to the home care for the elderly. The increasing need for the home care of the elderly is a serious economic and societal question, and will be assessed in this thesis as well.

Chapters 5 and 6 discuss the role of ICT in the home care of the elderly with memory disorders. The prevalence of dementia will increase sharply along with the ageing population and it is predicted that in 2030 the dementia patients alone will occupy the same number of beds in institutions as exists in Finland today (Pulli 2008). Thus, there is an order for ICT solutions that improve the efficiency of home care. Smart living environments are receiving more and more attention and there are various ongoing projects trying to develop this technology. Smart living environments aim to empower the elderly to manage with their daily activities and thus reduce the need for help, possibly allowing them to live at home longer. If successful, this would reduce the need for additional employees and still keep the adequate level of quality. It has been calculated that if the functionality of the elderly would be improved (with the technology or otherwise) by 5 years - so that the functionality of a 65 year-old in 2040 corresponds to the one of a 60-year old today – we would need 70 000 employees more in health and social sector (Parkkinen 2007). This is considerably less than the estimation of 200 000 extra workers above. In addition, the smart living environments activate the person and can give the feeling of independency. This can have many positive effects on the quality of life and delay the weakening of the memory, and consequently delay the institutionalization.

All in all, despite the limitations of technology and the special character of health care industry, ICT might be the key in reorganising health care and solving future challenges. The adoption has been slower than in other industries, but eventually it is likely to play a major role. When it comes to integrating ICT solutions in any organisation, it is important to adapt whole new ways of working and thinking. To get the best results, you cannot just add the new technology applications on top of the old habits. Large organisational changes are required and the whole personnel need to accept the role of the new technology – and this can take time. (Pohjola 2008, Brynjolfsson 2003)

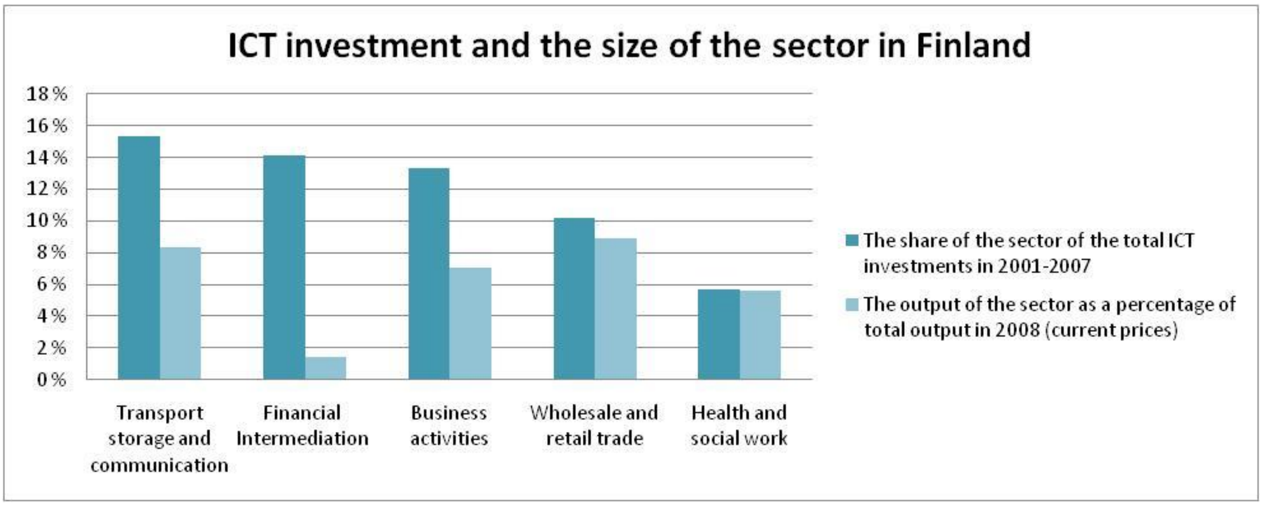
I will start Chapter 2 by discussing the productivity effects of ICT in general and in the health care sector. Then I will discuss different forms of health ICT and present some examples of successful ICT applications in the European Union. Chapter 3 deals with the Finnish health care and eHealth status compared to other countries. The reasons behind the slow adaption are also considered in this chapter. In Chapter 4, I will discuss one very potential field for health ICT: home care. Chapter 5 is dedicated to ICT in the home care of dementia patients, and in the last chapter I will present a particular technology project and some very simplified, suggestive calculations of cost effects of smart living environments in the home care of dementia patients in the city of Oulu.

2. ICT and health care

Two decades ago the productivity enhancing effect of ICT was not clear. In 1987 Robert Solow made a well-known remark that computer-age could be seen everywhere except in the productivity statistics. Since then a lot has happened and the general opinion has changed. Today it is clear that information and communications technology has improved efficiency in many industries.

Health care industry is an information intensive sector, and could be expected to benefit from advanced information and communication technologies. However, we have seen the adaption of ICT happen slower than in many other industries.

Figure 1 ICT investment and the size of the sector



Source: ICT investment: EU KLEMS Database, April 2010

Output: Official Statistics of Finland, National Accounts, April 2010

This is the case also for Finland. As can be seen from chart 2.1., the investment in ICT in health industry makes up slightly less than 6 per cent of the total ICT investment in the economy. This is far less than in business activities and financial intermediation industries, for example. When we take the size of the industry into account, this effect is even more emphasized. Industries that contribute to the total output much less than health care industry have seen considerable investments in ICT. However, most commentators believe that health ICT would lead to enhanced productivity.

2.1. ICT driving productivity growth

Health care IT has received a lot of attention during past two decades. Its potential has been stated as a foregone conclusion with reduced costs, improved quality and enhanced productivity (PwC 2007). Indeed, in many industries and on aggregate level ICT has improved productivity considerably.

In general, the contribution of ICT investment to aggregate growth and labour productivity has been undeniable in OECD countries, especially in the United States. The productivity growth gap between the United States and Europe has been largely explained by faster and better adaption of ICT in the US. Although Europe was already catching up in the mid 1990's, the difference has risen again close to the 10 per cent that it used to be. In the end of the decade the United States made considerable ICT investments that were sometimes twice the size of the investments in Germany or Italy - along with the accelerating productivity growth. However, the countries in Europe differ from each other, as Finland for example has had almost the same ICT investment rate as the US. Also the labour productivity growth has been rapid in Finland. It is estimated that information and communications technology contributes to the overall productivity growth with approximately one percentage unit between years 1990 and 2005, implying that half of whole labour productivity growth comes from ICT. (Pohjola 2008)

There is also evidence from a few countries, where sectors that have seen much investment in ICT, have also experienced more rapid productivity growth. Examples of this can be found notably in the United States and Australia from sectors such as wholesale and retail trade (OECD 2003). Also Brynjolfsson and Hitt (2006) have found very powerful effects of IT investment in cost-effectiveness (over longer time horizons of 3 to 7 years). According to their findings, the productivity advantage in of an IT investment was two to five times the IT investment itself. (PwC 2007)

In most economic analyses, there are three distinguished effects that ICT can have on business performance and growth. The first impact comes from the contribution to capital deepening:

investment in ICT is considered as a capital good and therefore raises labour productivity. Second, technological progress in the production of ICT goods and services is rapid, and it may contribute to more rapid multifactor productivity growth in the ICT producing sector. Third, as firms use more ICT, they might be able to increase their overall efficiency and thus their multifactor productivity. In addition, the impacts of ICT may also be seen in network effects as transaction costs may be reduced and innovation might be more rapid. As mentioned above, in Finland the contribution of ICT in labour productivity growth has been around one percentage unit. Two thirds of this are due to the productivity growth in ICT production, and one third is due to the use of ICT as capital goods in other sectors (Pohjola 2008). (OECD 2003)

Moreover, it can be stated that the economic growth rests more and more on information and communications technology. The population is aging and labour input inevitably decreasing. Thus the growth can only come from productivity growth. To prevent the slowing down of productivity growth, the role of ICT becomes crucial. According to Pohjola (2008), the challenge of assuring the continuous productivity growth may be overcome with the help of ICT, but this requires comprehensive changes in the ways we and the organizations work. He proposes that in the long run the benefits of ICT may even be comparable to the benefits that were brought by the latest general purpose technology - the electricity. It took over 50 years to fully accomplish the benefits from the electricity, and it showed us that the production of the new technology and the use of the technology as capital goods are only a part of the productivity effects. In the long run the behavioural changes contributed the most, as the work could be organised in a completely new, more efficient way (using assembly lines, for example). As the ICT sector is still young, we might see the real benefits of the new information and communications technology only after there has been enough time to change the ways of working.

All in all, as ICT has contributed to the overall growth of the economy, many commentators herald also the potential of ICT in health care industry. For example electronic health record systems, better health knowledge infrastructure, health promoting websites, remote monitoring of chronically ill and other forms of information and communications technologies are likely to result in improved efficiency. Also in the EU the general opinion is that investing in health ICT is the only way forward. The European Research and Development "Framework Programmes" have emphasized the role of innovative information and communication technologies in facilitating and delivering health services for more than 20 years (good eHealth report). There have been over 450 projects worth more than one billion euros concentrating on this area, of which some have been very beneficial. I will present some of the most advanced uses of ICT later in this chapter.

Also Kassier (2000) proposes that the use of telecommunications could considerably help physicians, who are dissatisfied with the conditions. The problems of large patient loads, burdening administrative tasks, frustrating reporting requirements, and the loss of control of patient care decisions could be at least partly overcome with the help of ICT. According to Kassier, the patients are also frustrated because their doctors are rushed and not adequately listening to them, and they have independently started to take more interest in their own care. ICT offers opportunities to overcome the workloads by for example increasing patient independency. In fact, health care consumers seem to also want to be more involved and informed of their own treatment. A growing number of people are proactively looking for information online about their own medical conditions (Detmer et al. 2003).

It is true that in some industries - retail trade, wholesale and banking for instance - the efficiency gains have been substantial. However, despite the heralded potential, the ICT adoption has been relatively slow in health care industry and I will discuss the reasons and limits of ICT in chapter 3.

2.1.1. US and the rest of the OECD

In 2003, the United States had less physicians, practising nurses and acute care bed days per capita than the median OECD country. At the same time, US health spending per capita was almost two and half times the one in the median OECD country. Andersen et al. have explained the relatively poor productivity and high spending of the US health care with service use, administrative complexity, population age, threat of malpractice litigation, defensive medicine, the lack of waiting lists and with the "most compelling explanation": high prices. In a more recent article (2006) they propose that one reason behind the high and in-efficient health spending is the slow adaption of health information technology (HIT). The US is lagging a dozen years behind other industrialized countries in HIT adaption, and this could explain at least part of the difference. This is interesting, since in other fields the United States has been a forerunner in adapting ICT and also enjoying the consequent productivity benefits as we saw in the previous section. (Andersen 2006)

As for 2005, most of the medical records were still stored on paper and it is widely believed that if an electronic medical record (EMR) system was broadly adopted in the US, it would lead to significant health care savings, reduce medical errors and improve health. Hillestad et al. (2005) estimate that if an EMR system was adopted on the national level, over fifteen years the cumulative savings from hospital systems could be almost $371 billion and from physician practises $142 billion. Many commentators have questioned these estimates because of adequate savings demonstrations. Walker (2005) stresses the contribution and importance of EMR in the health care transformation, but is sceptical about the financial estimations and calls for real-world demonstrations of cost-effective improvements in care. (Hillestad et al. 2005)

2.2. IT investment and hospital performance

There has been increasing interest on health care information and communications technology benefits during the past decade. Plenty of separate examples of successful ICT can be found, but despite the considerable research on the subject, the overall results are not exactly compelling. Not even the most notable studies have been able to find a strong relationship between investments in information technology and operational performance. (PwC 2007)

To explore the unclear relationship between IT adoption and organizational performance in hospitals, consulting company PricewaterhouseCoopers (2007) has studied almost 2000 US hospitals by econometric techniques. They claim that their analysis (at the time the report was published) of IT's impact can be considered as close a measure of the real world impact as has yet been published. Their results point to the direction that investments in IT in fact tend to eventually reduce costs, although the answer to the question remains complicated and the effects quite modest. They measure the cost-effectiveness by calculating the changes in costs per bed, and the quality of care by mortality. The extent of IT investment is measured by IT Capital Index, in which the score attributed to each application is weighted according to its price.

One of the findings in the report is that the investment in IT may initially appear to have a cost-increasing effect. When a hospital reaches a certain level of investment – referred to as the tipping point – the costs per bed start decreasing. Moreover, the effects tend to strengthen over time. This is consistent with the findings in other industries. The benefits of ICT may intensify over time, presumably because the organization gains skills in leveraging the technology implemented and has time to adapt to new ways of doing business brought along by the information systems. The authors also found that the initial cost increases of adapting IT are especially large for those few hospitals that are uncharacteristically low on the IT Capital Index.

The report also investigates the time lags on the relationship between IT Capital Index and hospital costs. As they introduce a time lag of two years, the cost-reducing impact of IT was intensified and the estimates found for operating cost per bed at every level of IT were lower. This implies that the effect of IT increases over time.

PwC report also explores the effects separately in not-for-profit and for-profit hospitals. The cost reducing effect is consistently slightly stronger in the case of for-profit organizations. Also the tipping point is reached at earlier stage of ICT investment.

As for the quality of care, the data is difficult to obtain. The authors decided to use mortality as the measure for efficiency. They acknowledge that mortality is not a comprehensive measure and therefore adjust it for risk, case mix and state average to investigate if at least a directional impact of IT investment can be detected. The results show a tendency towards reduced mortality rates with higher IT Capital score. Thus, including the quality measure intensifies the relationship between IT investment and cost. This implies that hospitals investing in IT can reduce mortality without increasing costs, implying better quality at constant costs per bed.

While not so many of large-scale studies have been done, there are plenty of separate small-scale studies and pilots. I will present concrete examples of ICT applications throughout this text.

2.3. ICT in health care

The applications of information and communications technologies in medicine are commonly referred to as telemedicine and medical informatics. Although these terms are often used together and confused with each other, they are separate and have their own definitions. The Institute of Medicine (1996) defines telemedicine as *the use of electronic information and communications technology to provide health care when distance separates the participants*. It includes all forms of electronic communication between patients and providers and among providers, starting from telephone to interactive video and web-based communication. Medical informatics is defined by The National Library of Medicine (2001) as *the field of information science concerned with the* *analysis and dissemination of medical data through the application of computers to various aspects of health care and medicine.* Medical informatics can also be referred to as the intersection of information science, computer science and health care. For example, medical informatics includes health care delivery processes that are supported by computers that help in analysing electronic data. (Christensen et al. 2007)

Christensen and Remler (2006) have roughly categorized the different possible applications of ICT in chronic disease care in four groups: technologies that support 1) patient self-care and education, 2) communication between patients and providers or between providers, 3) electronic data storage and data sharing across providers, and 4) the technologies that combine all these three applications. Although the authors have mainly discussed the case for chronic diseases, the results can in many respects be applied in other fields of health care as well. Notably the applications of the second and third group - communication technologies and data storage - can be useful in also in other aspects of health care. Next, I will discuss shortly the four groups.

2.3.1. Self-care and education

Successful management of chronic disease care is facilitated considerably by active involvement of the patient in his or her own treatment procedure. There is also increasing willingness from the patient side to be integrated in their own health care process, and health consumers are actively searching information independently (Detmer et al. 2003). The involvement is usually realized by patient education and information about his or her disease (Asmar 2000) and information and communications technology can provide effective methods for patient participation.

This first category includes medical devices for self-monitoring as well as interactive websites for education on the diseases. One example of self-monitoring equipment is software that accepts and analyzes data from blood glucose meters of people living with diabetes. As for interactive web sites, especially in the United States there are many firms - mostly insurers - that maintain web sites to help people with chronic diseases. Moving towards more self-care and patient and health consumer inclusion is largely associated with new ICT technologies and has been noted by other commentators as well (Haux 2006). (Christensen et al. 2007)

2.3.2. Communication

All the communication technologies fall into the second group. It includes traditional telephone conversations, e-mails and videoconferencing. Modern communication technologies enable real-time communication and make more frequent monitoring possible. Efficient communication plays a major role in adjusting care and preventing serious problems as interventions can be done faster. Medical data can be transferred electronically in seconds and thus enables faster reacting to changes in patients' conditions. (Christensen et al. 2007)

2.3.3. Electronic data storage and sharing

The ICT applications in the third category - electronic data storage and data sharing across providers - have probably received the most attention. It has been stated that shifting from paper-based storing to electronic health records (EHR, or electronic medical records, EMR) is associated with remarkable cost-savings (Hillestad et al. 2005) and faster access to information, which results in improved efficiency. Also unnecessary tests can be avoided, when information can be easily found from the data base by different users (good eHealth report). Electronic process also enables storing bigger quantities of medical data (Haux 2005). This is essential as the amount and complexity of health-related information and knowledge constantly increases and has already made information processing a major component of any health organization.

Health ICT facilitates moving from decentralized and institution-based towards more global data storing (Haux 2005, Good eHealth report). Having national health records can improve health care processes as different providers can access the same information fast and for example the duplication of tests could be prevented. In the European Union the long term goal is to have a system where all the clinicians in Europe can access health records from all countries (Andersen 2006). This would improve conditions for treatment as the patient as well as the health care professional mobility is expected to increase (European Commission 2004). Without electronic records and communication technologies having wide databases would practically be impossible.

2.3.4. Combining technologies

For instance, software that integrates and analyzes provider and self-monitored patient data combined with communication technology belongs to the fourth group. These technologies make it possible to do certain monitoring tests at home and send the data to health care professionals to be analyzed. When there is need for intervention, it can be done inexpensively and without delay. These kind of technical solutions have already been used in continuous remote clinical monitoring and have brought significant benefits to both patients and payers. For instance in care of hypertension patients, remote monitoring has helped to drop the blood pressure of the test groups (Artinian 2001) and reduce the costs of the care (good eHealth report). (Christensen et al. 2007)

There is also a steady increase of new technologies such as ubiquitous computing environments and sensor-based technology for health monitoring from distance (Haux 2005). These technologies, coupled with modern communication technology to connect the patient and health professional belong to this group as well. These represent an area with a lot of potential for example in the home care of the elderly. In the sixth chapter I will focus on this form of ICT in the home care of dementia patients.

2.4. eHealth in European Union

In the European Union it has become a commonly accepted policy premise that only with the help of wider adoption of eHealth solutions, health systems will be able to cope with the steadily rising demands for better and cost-efficient health services (The Good eHealth report). There have been revolutionising ICT applications in Europe during recent years, but they have been very fragmented across the continent. It is believed that with cross-boarder coordination we could reach bigger benefits for the patients. In 2004 the Commission adapted a common eHealth Action Plan with targets concerning issues from electronic prescriptions and health cards to new information systems that reduce waiting times and medical errors (European Commission website). In January 2009 European Commission published a Good eHealth report on the best practices seen so far and their benefits. Next, I will present some of the examples.

One of the many successful examples was found in a Bulgarian cardiology hospital, The National Heart Hospital that implemented and integrated a comprehensive hospital information system (HIS) including medical and administrative applications. Today, ICT applications support various processes like patient admission, registration, primary care, hospitalisation and discharge, purchase and distribution of drugs, costs calculation, accounting and reporting, laboratories investigation, as well as general management and administration. There are 250 computers and ten servers connected to the intranet that constitute the infrastructure. Moreover, there is a common standard for medical data exchange assuring the interoperability. This comprehensive system has resulted in significant benefits. First, due to rapid access to the patient record with full medical information, many unnecessary tests and procedures can be avoided. Second, the system has allowed for treating more patients in a given period of time. Consequently, the costs for patient stays in the hospital were also reduced by 10 - 15 per cent. Third, the quality of health service improved considerably as the physicians receive the information needed in seconds, which allows them to treat the patient without delay.

In Germany, one successful example of the use of ICT in health care is the Medical Online Portal in Ingolstadt Hospital. It is a communication platform that connects all the health care professionals in the hospital. It interconnects the hospital's databases, including radiology, patient records and patient administration via web services. The doctors enter data into different forms using a tablet PC. As this information can be retrieved any time and by all the professionals, the duplication of data gathering can be avoided. The physician can also schedule x-rays, laboratory tests and ultrasound examinations at the same time without needing to re-enter the patient information. Before the portal was implemented, all the patient information was collected on paper forms and manually inserted into the electronic information systems for further processing, which is obviously very time-consuming. It is estimated that 2 000 hours of work time is saved annually due to improved administration procedures resulting in more time for actual health care activities. Furthermore, due to the enhanced search for medical information, approximately 35 000 euro per year is saved. In addition, the risk of entering and receiving wrong information is reduced.

Remote treatment of alcohol abusers in Denmark has also had positive effects. The Alcohol Rehabilitation Centre (ABC) in Funen County and two hospitals located on remote islands are providing teletherapy with video equipment. As a remarkably low proportion of people from the remote islands of Funen County were seeking treatment for alcohol abuse, the application was introduced to make the alcohol abuse therapy more accessible. The accessibility is improved in two ways. First, by providing easier access to treatment for patients living in remote places and second, by preventing them from being stigmatised when entering a rehabilitation centre. As a result of this pilot the number of alcohol abusers receiving therapy and the duration of therapy has increased significantly. The access to alcohol abuse therapy is now also easier for patients in remote locations. During the pilot the users encountered some minor technical problems because the equipment was not fully adapted to the therapeutic context - regarding the quality and user-friendliness - but these difficulties were quickly remedied.

In Luxembourg, there is a portal that enables citizens with food allergies to identify which packaged food products contain allergens from which they might have a serious reaction. Wikifood.lu is a simple portal that contains details of some 13 000 products. The site was set up in 2006, and since then the usage has grown steadily. Over the six preceding months of the eHealth report, there were over 90 000 visitors. Also the number of food products registered doubled within the preceding 18 months. With the help of the web site, allergic persons can avoid buying food containing allergens more easily.

Another compelling example of ICT in health care can be found in Netherlands and Germany, where an electronic health record system which enables home-monitoring for thrombosis patients. The Thrombosis Digital Logbook allows patients to perform their blood analysis at home and have their data monitored by the Thrombosis Services. Without this system, they would have to go to hospital for blood tests 18 times a year. Now, however, they can log on to their Digital Logbook and submit their data every ten days from home. If the results diverge from the established parameters, there will be an intervention by the health care professional who holds the ultimate medical responsibility. Moreover, Logbook also enables communication between the patient and the health care professional through free text messages along with the traditional phone conversations. There are currently approximately 10 000 users of the Logbook system, and the solution is also available for diabetes, stroke and COPD treatment. The benefits of Logbook are significant time and cost savings with respect to the paperwork supervision of patients. The empowerment of the patient through self-management results in patient compliance, high satisfaction and a feeling of independence.

3. Health markets and the slow adoption of ICT

In this chapter I will discuss health care industry more deeply and consider the reasons why adapting information and communications technology is more complicated in health care than many other industries. First, I will present features of the Finnish health care system to be able to understand the context where we live in.

3.1. 1. Health care provision in Finland

The Finnish constitution states that public authorities shall provide adequate social, health and medical services and the promotion of the health of the population. Health care services cover all the residents in Finland. Finnish health care is performing well in international comparison and has been cost-efficient, as the health spending is lower than in OECD countries on average. In 2006, for example, health spending was only 8.2 per cent of GDP. (Hämäläinen et al. 2009)

Finnish health care is much decentralized. By law, arranging health care is primarily on the responsibility of municipalities. In the beginning of 2010 there are 342 municipalities (www.kunnat.net), of which the number of inhabitants varies from 1000 to more than 500 000. As the population is often dispersed, the local decision making has been considered important and the decentralization has received little opposition. In the municipalities primary health care services are provided by health centres, and hospital-district hospitals provide the specialised medical care. Some municipalities purchase most of their health centre services from private providers. As for the specialised medical care, there are 20 hospital districts, each serving a population from 70 000 to 800 000 citizens. Each municipality must be a member of one of these districts. A municipality may run its own health care, or do it in cooperation with other municipalities. (Järvelin 2002, Hus 2010)

The Ministry of Social Affairs and Health directs and guides health care provision on national level. They deal with major reforms, policies and legislation, but it is the municipalities that have the main decision-making power on planning and organization of health care services. The decisions are made inside the municipalities by the health committee, the municipal council and the municipal executive board. There are variations, but often the leading personnel of the municipal health centres are also included in the planning and decision making. Thus, also the decisions on investments on health ICT are made on the municipal level. (Järvelin 2002)

Public health care is financed mainly by taxes, the municipalities having the primary responsibility and the right to levy taxes on residents. The state subsidies municipalities, and in 2008 the subsidy was 33 per cent of the health care costs (Hämäläinen et al. 2009). The subsidy is not earmarked and the size depends along others on the municipality's age structure, unemployment rate and the number of pensions for disabled. In addition, the National Health Insurance and patient fees make up a considerable part of the financing, patient fees covering around 9 per cent of the public costs. The voluntary or private insurance on the other hand is insignificant in Finland, since it accounts only for 2 per cent of the funding. In the United States for example, the system works very differently and the private insurance makes up 35 per cent of the health spending, which is by far the largest share in OECD countries (OECD Health Data 2009). (Järvelin 2002)

Alongside with the public health care provision there is also some private supply. In 2002, the costs of private health care provision were approximately 14 per cent of total health care expenditure and 20 per cent of the 153 000 people working in health service sector were in private sector. Private hospitals provide only 5 per cent of bed days in Finland (Hämäläinen et al. 2009). When thinking of all health care – including both private and public care – also most of the finance comes from public sources (mainly taxes) as 76 per cent of health care was financed publicly in 2006. The remaining 24 per cent was financed privately, including out-of-pocket payments by households and employer payments. All in all, most of Finnish health care is public and this is one of the biggest differences when comparing with the United States for instance. (Ministry of Social Affairs and Health 2004, Järvelin 2002)

3.1.2. eHealth policies in Finland

The first Finnish national strategy concerning information technology in health care was brought up by the Ministry of Social Affairs and Health in 1996. Since then Finland has had a chain of four governments and they have all included the promotion of health ICT in their programmes. The policy visions of the beginning have step by step evolved to operational systems and deployment projects, and the work is continuously under development. During the most recent years, the main issues have been building the national eArchive and ePrescribing system, as well as starting pilots on eServices to the citizens. (Hämäläinen et al. 2009)

The first strategy in 1996 focused on developing and implementing ideas that promote efficient, accessible, affordable and high quality health care. One of the main targets was the horizontal integration of social services together with primary and secondary care. The patients were envisioned as informed and participative actors in the health care delivery process. In 1998 the strategy was updated with the new target of adopting digital patient records in all levels of care, combined with nationwide interoperability between distributed legacy systems, with emphasized high level of privacy and security protection. In April 2002, the Council of State released a document called Decision-in-Principle stating that introducing a nationwide electronic patient record should happen by the end of 2007. The National Health Project Programme was launched and the Ministry of Social and Health affairs formed a working group to produce a definition of national electronic patient records and their implementation strategy. (Hämäläinen et al. 2009)

In July 2007, the parliament approved the legislation on regulating the use of electronic social and health care client and patient information (Act 159/2007). It covers archive services, encryption and certification services, and patient's access to data. It was expected that the creation of a nationwide archiving system would promote patient and client care, confidentiality, and increase the efficiency of health care services. The law obliges all public health care units to incorporate into the electronic archiving system, as well as the private providers that do not use paper-based data storage. (Hämäläinen et al. 2009)

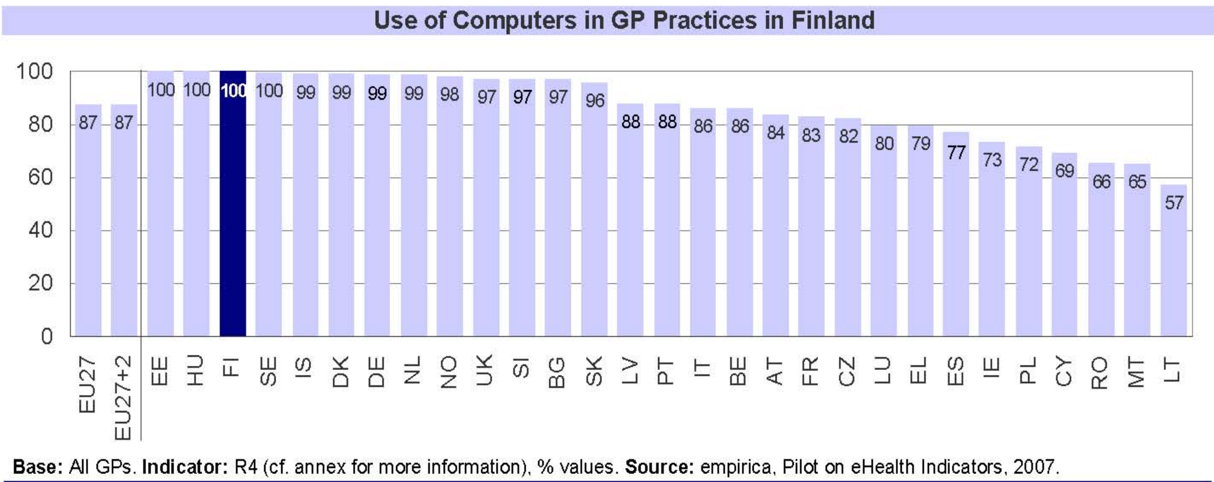
In the vision for 2015, the Ministry of Social Affairs and Health envision that information and communications technology can enable more efficient information and process management using real-time data. Also the position of the citizen may be improved with the access to reliable information on health, welfare and service system, and the possibility to manage their own information and interact with health providers flexibly. The ministry emphasizes the importance of up-to-date legislation, national guidelines and information systems services on the national level when adopting information technology applications. According to the Ministry, the best results and support from IT for productive health care process is attained when compatible joint standards and applications are used nationwide. (Hämäläinen et al. 2009)

The Finnish Government has stated that the development of information systems is to be continued. The National Archive of Health Information is constantly being built and tested. The archive refers to a range of national health care information systems including e-prescriptions, a national pharmaceutical database, an electronic health records archive and a portal where citizens can access their own health information online (www.kanta.fi). The objective was to take the archive into use and make local patient records compatible with the national archive (maintained by the Social Insurance Institution, KELA) by April 2011. However, the schedule of this huge project has proved to be too tight and the implementation will be delayed by at least one year, compatibility posing the biggest problems. For example the commencement of e-prescribing pilots has been postponed already five times due to compatibility problems. (www.tietoviikko.fi , www.apteekkari.fi)

3.1.3. Finnish eHealth in European context

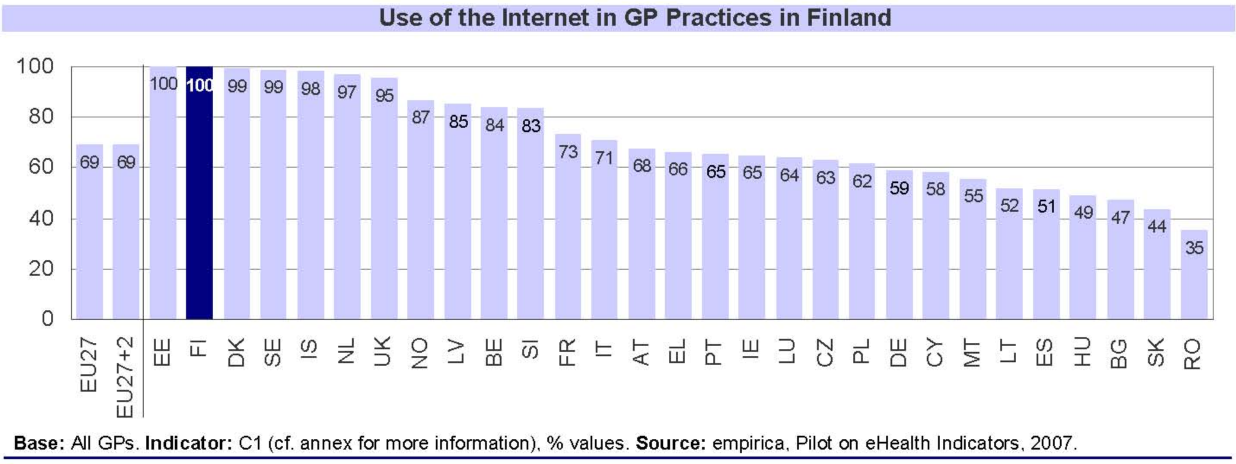
In 2007, European Commission released a report on eHealth practises in member countries. According to this report Finland is one of the frontrunners in ICT use among General Practitioners, ranking third in overall comparison. Only Denmark and the Netherlands have more advanced use of eHealth in Europe. Finland does well both in the field of infrastructure (the availability of computers and Internet) and the use of ICT in health care purposes. 100 per cent of the GPs in Finland have computers and internet access, compared to the European averages of 87 and 69 per cent, respectively. As for the electronic data storage, 100 per cent of Finnish GPs store electronically at least one type of patient data. Finland is above the EU-27 average in all but one of the observed data types, including among others the electronic storing of medication, lab results, symptoms and radiological images. ICT is also used for communication purposes more actively than on average, 90 per cent of the GPs using networks to receive laboratory results and 55 per cent exchanging data with other health care providers.

Figure 2 Use of Computers in European GP Practises



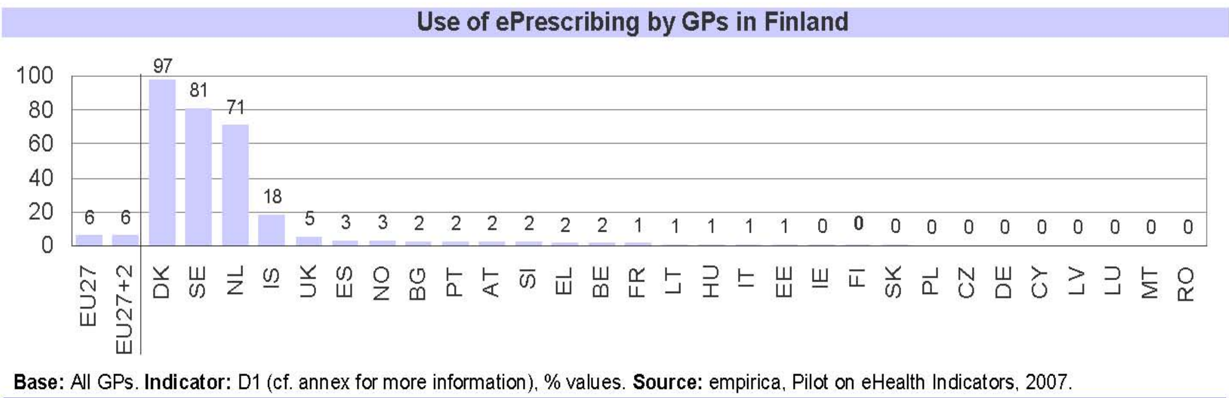
Source: European Commission 2007

Figure 3 Use of the internet in European GP Practises



Source: European Commission 2007

Figure 4 Use of ePrescribing by GPs in Finland



Source: European Commission 2007

As can be seen from the table, in 2007 ePrescribing applications of ICT had not been taken into use almost anywhere, and Finland is no exception. However, there are three countries where ePrescribing can be considered as a reality - Denmark, Sweden and the Netherlands. In Denmark already 97 per cent of the GPs were using ePrescribing, while in Finland the percentage was 0. Apart from these three countries, the adoption rates are never more than 5 per cent. However, as noted above, even though ePrescribing is not yet a reality in Finland, it is on its way. There is existing legislation on the use of electronic prescriptions that was approved by the parliament in 2007 (Act 61/2007). The central ePrescription database is already under construction and all organisations in Finland will be connected to the system – although in a delayed schedule. After this, customers can get their medication in any pharmacy at any time without the paper prescription. The system also gives the people working in the pharmacy the access to the information of all the medication of the client, and thus enables them to give better advice (Finlex 2007).

Electronic exchange of different kinds of patient data has not fully arrived in Europe yet. On average 40 per cent of European GPs receive analytic results from labs electronically, and only 10 per cent transfer medical data with other health care providers or professionals. Moreover, telemonitoring and data transfers across boarders are nearly non-existent. Although in Finland networks are widely used to get laboratory results and more than half of the Finnish GPs exchange medical data with other care providers, telemonitoring and data exchange with other countries are as modest as in other countries. Electronic data exchange has been adapted to a lesser degree in health care than in many other industries, where a huge amount of information is exchanged electronically every day. As for Finland, one could imagine that as a sparsely populated country (outside the biggest cities), it could benefit from more active use of communications technology, notably telemonitoring. (European Commission 2007)

3.2. Slow adoption

Although different forms of information technology have been used in hospitals and by GPs for decades, the adoption of ICT has been relatively slow in the health care industry compared to many other industries. In the banking industry for example, the ICT has made the automation of many routines possible and thus reducing the need for work force that was tied up in these routines. Consequently, the productivity of labour has increased permanently. However, health care industry is lagging behind despite all the heralded benefits of ICT adoption. (Shortliffe 2005)

There are many reasons why this is the case and I will consider them next.

3.2.1. Lack of demonstrated cost-effectiveness

One obvious barrier for new ICT adoption is the lack of demonstrated cost effectiveness of ICT investments in health care. As noted before, there are many separate small-scale studies, but comprehensive studies have not been conducted yet. The decisions to adopt new technology are often irreversible, which means that it is extremely hard or impossible to go back to the old methods if the new technology proves to be poor. It is rational from the health care providers to be careful with their investing decisions as there is no considerable evidence of the benefits.

For example Whitten et al. (2002) have reviewed the research on the effects of telemedicine. They went through 612 reported telemedicine studies and concluded that one cannot draw any conclusions of the cost effectiveness of telemedicine from the existing literature. Only four per cent of the studies met their quality criteria, and most of them were small scale, short term and pragmatic evaluations. From these studies, of which many have reported positive results, we cannot draw generalisable conclusions.

However, it has to be kept in mind that there is constant research on this area. The review by Whitten et al. was made in 2002, and new results come up continuously. But it is true that the results from existing, separate studies are not generalisable and there have not been very large scale studies with unambiguous evidence of performance improvement.

3.2.2. The problems of interacting ICT and health markets

Christensen and Remler have gone through some features of ICT industry and health industry that complicate the interaction between them. Health care industry differs in many aspects from other industries like banking, and these aspects can partly explain the slow adoption of ICT.

3.2.3. ICT markets

ICT markets have some typical, significant shortcomings that can act as barriers of adoption in all markets. Christensen and Remler mention the low product differentiation, high switching costs and the lack of technical compatibility.

When it comes to adopting new ICT, the lack of compatibility of all the different components of an ICT system can pose a major problem. New information and communications technology has to be interoperable with other electronic means of data storage and communication. One way of overcoming this problem can be common technical standards. (Christensen et al. 2007)

In the case of information and communications technology, it is also important to consider how well new technology interacts with the systems of other actors on the same field. The so-called *net work effect* means that the software or other forms of ICT must be interoperable with the systems of the other relevant providers or actors in the process. In our context, networks include both physical and virtual networks. Christensen and Remler give telephone and airline networks as examples of physical networks, and networks of compatible fax machines or networks of compatible software programs for personal computers as examples of virtual networks. The value of a network depends on the number of existing users. For instance, as more and more people started using a fax machine, it became a more valuable way of communication. If there is only one person using the fax machine, it obviously has no value (Katz et al. 1994). (Christensen et al. 2007)

It is also quite typical for the information and communications technology industry that product differentiation is low. The reason behind this, according to Christensen and Remler, lies in the "positive feedback" mechanism related to the network effect. As the value of the network increases with the number of users it is likely that the bigger manufacturers with larger market share get even bigger and the smaller ones disappear altogether. As a result it might happen that a single firm dominates the market with little diversity in the technologies available. Katz and Shapiro (1994) have discussed the competition in the market with network effects, concentrating on the communication systems and hardware/software markets. They have come to the conclusion that positive feedback creates "tipping", which means that there is a tendency of one system to pull away from its rivals in its popularity as it has gained an initial edge. It follows that there is a tendency towards standardization as everyone starts using the same product. There are fewer suppliers in the market, and thus less product differentiation. (Christensen et al. 2007)

Another typical feature for information and communications technology compared to other forms of technology is that the costs of adoption tend to be high. The reason for this is that in addition to the pure acquisition costs there will be plenty of other costs as well. First, the personnel must be trained frequently to use the new technology, which implies short-term costs as the time spent on learning takes time away from other tasks, which in turn decreases productivity. Moreover, switching from old paper records to new electronic records implies costs as all the existing information has to be transferred to the new system. (Christensen et al. 2007)

The switching costs of ICT are particularly large. When switching from one information system to another, the choice is hemmed in by the choices made in the past. For instance, if you have invested in a Macintosh computer in the past, and now you want to switch to a PC, you face more costs than just the price of the computer. You have probably purchased some Mac software, you are familiar with using it, you might have a Mac printer with many good years ahead, and you may trade files with other Mac users. You have to consider these issues before buying a computer of a different brand. When the consumer has made significant *durable investments in complementary assets* that are specific for a certain system or machine and have different economic lifetimes, there is no easy time to start using new incompatible system. Therefore, he or she might be locked-in to a specific form of ICT. Furthermore, switching to a new technology can be very risky, and, especially in the case of unproven technology, the risk of encountering huge costs due to a possible system disruption or break-down can act as a barrier of adoption. Moreover, as the decisions to adopt new technology are not easily reversible, the damage cost by a break-down or other problems may be irreversible. Having this in mind, it is easy to see why many users might be locked-in to sub-optimal forms of technology. (Christensen et al. 2007, Shapiro 1999: 103-104)

To reach the highest possible benefits from adapting new information and communications technology, it is important to make complementary organizational changes to assure that the organizational conditions are optimal. The investments in ICT do not enhance productivity as much as they could if the line employees are stuck with the old work practices and have many inherited patterns, many of these often sub-consciously. Sometimes the best results have been reached when the new equipment is introduced in a "green field" site, meaning young employees with no knowledge of the old practices. Thus, just adding the new technology on top of the old processes is not the right way. Organizational complements such as new business processes, new skills and new organizational and industry structures are needed to fully enjoy the contribution of information technology. This is true for organizations in all industries, including health care. (Brynjolfsson et al. 2000)

3.2.4. Interaction between health and ICT markets

In this section I will analyze the above mentioned barriers of adoption together with the features that are unique to the health care industry. Christen and Remler remark that health care industry possesses some features that clearly intensify the general above mentioned problems of ICT adoption.

It is good to bear in mind that the paper by Christensen and Remler deals with the health care structure of the United States, which limits the possibilities of applying all that is said to other countries, including Finland.

First, there is a large amount of actors affected by ICT decisions in health markets. The market structure is complicated with heterogeneous patients, public and private providers, doctors, insurers that can also be private or public, and out-of-pocket payers. Often, as new communication technology is adopted, it will affect people in all stages of the service as each actor directly or indirectly depends on other actors. Replacing one component of the communication or data sharing infrastructure causes switching costs to all interlinked agents, in the form on technological change or change in user requirements. To adopt new ICT, the network effect has to be so great, that it overcomes all the collective switching costs. In the US this problem is intensified compared to Finland, since there are more agents involved in the process, particularly because of the bigger role of insurance markets. In some situations also the patient is the user of the technology. Often they tend to be older and not used to ICT, which increases the requirements for user-friendliness. One form of ICT will not fit all the patients' needs due to the heterogeneity. Platforms have to be adjusted for disease-specific cases, which implies more switching costs. (Christensen et al. 2007)

There are in general three sources of switching costs. First, there are the costs of new hardware, such as mainframe computers and operating systems to store information. These costs also include the complementary products such as system management software to manage the information database. New technology may also dictate the future hardware investments, as the consumer must purchase products that are compatible with the old systems. The second source is the cost of information storage in databases and the cost of transferring information from the old database to the new one. This can be very time-consuming and costly, especially in big hospitals that have existed for a long period of time as there are huge amounts of information in the old formats that have to be moved to the new systems. There is also the above mentioned risk of being locked-in to a specific system, if the information is in a specific non-transferrable format when even newer advanced information systems come up. Third, there are the training costs that arise from teaching the personnel to operate with the new systems. These costs are the direct financial training costs as well as the costs that come from the lost time that could have been spent on other productive tasks. (Christensen et al. 2007)

Switching to new ICT is costly and often risky. The risk of technical problems or break-down exists in all the industries and the financial damage can be substantial. However, in health industry also the societal costs of errors have to be taken into account. Medical errors can have serious and irreversible consequences, at worst premature death. These kinds of outcomes are not tolerated, and the decisions have to be done carefully. (Christensen et al. 2007)

As for the compatibility, the requirements for adopting ICT in the health care industry are particularly complicated. As already mentioned, there are many interlinked actors who all depend on each other (again, more in the US than in Finland). To operate most efficiently, the information and communication systems need to enable the communication and data exchange between providers and payers, providers and other providers and so on. Each of these consumers of ICT has special needs and the interoperability requires common technical standards to accommodate all the different needs. Problems with compatibility have also been standing on the way of adapting the National Archive of Health Information in Finland as we saw in the previous chapter. (Christensen et al. 2007)

As it has already come up, the consumers in health markets tend to be very heterogeneous. They differ in their needs and services required. Compared to banking industry, the situation is very different. Many banking services can be automatic and similar to all the clients, such as paying the bills electronically. Health care is a very information intensive industry, and the services required cannot be as standardized as in the banking example. When it comes to the actual care process, the provider needs to have all kinds of information of the patient that is not necessary for paying bills or other e-banking services. Even inside the same disease groups the needs differ based on the severity of the disease, age or socio-economic status. The characteristic of low product differentiation obviously limits the use of ICT. (Christensen et al. 2007)

The issues of privacy, confidentiality and security also come to mind in the context of ICT use in health care, especially in the case of databases. Our medical records contain a lot of information about us such as height, weight and blood pressure to mention some. Sometimes they contain very sensitive information about us that we do not want to be available to outsiders. Access to information about topics like fertility and abortions, sexual behaviours and psychiatric care must be controlled because disclosure can harm us. This kind of information can cause prejudice and embarrassment, complicate getting and holding a job and affect our insurability. When putting information online, do we expose to risks like network computer break-ins? The issues of privacy, confidentiality and security have to be considered when adopting new ICT technology to store and exchange information. (Rindfleisch 1997)

In addition, the legal framework can complicate the ICT adoption. Varying by the country there are laws related to the above mentioned privacy issues, licensure, liability, malpractice, compliance and so on. (Christensen et al. 2007)

3.2.5 Is Finnish constitution hindering the adoption of ICT in public sector?

As for Finland, Helena Tarkka (2010) from Ministry of Finance suggests that the recent changes in Finnish constitution may hinder the adoption of information and communications technology in public sector (thus, including health care as well). Finland used to be considered as a progressive information society in the very beginning of the 21st century, but since then international ratings suggest that we have been falling further and further behind from the leaders. At the same time, in 2000 there were some constitutional changes towards parliamentarism, and Tarkka proposes that these two phenomena might be connected.

As noted above, interoperability is important if we want to get the maximum productivity gains from modern information and communications technology. Since the mid 1990's personal computers have been linked with each other forming large networks. Common, sometimes huge databases are taken into use and interoperability plays a key role. Thus, there is an increasing need for common standards and centralised decision-making, while the latest trend was in the opposite direction. In many companies and organisations this means that some decision-making power has to be taken back from individual departments. This is often a problematic process, as departments are protesting and fighting for their independency. It has been anticipated that the public sector may experience similar difficulties. Different levels of public administration or individual municipalities may turn against each other and protest against the lost independency due to the reorganisation caused by the new demands of modern networking society (Castells 2009: 40–41). Public sector is very information-intensive, and thus especially dependent on the information and communications technology and related issues. (Tarkka 2010)

Nevertheless, it seems that common standards are needed to get the best use of ICT. Helena Tarkka points out that there is inconsistency between the latest changes in the Finnish constitution and the demands of transformation into a networking society. We clearly need common compatibility standards and nationally centralized guidance, but the changes made in constitution in 2000 favor more decentralized behavior and increased parliamentarism. The executive power was given to the parliament, the municipal autonomy was enforced and independency of government offices was emphasized. Thus, the direct decision-making power was taken away from the Council of State. Around that time Finland started to fall behind in the transformation towards networking society. Could there be a connection? (Tarkka 2010)

Helena Tarkka stresses the importance of the adjustment of strategy and the organization model when technological environment is changing. When the first computers came, organizations had information centers with central computers that handled the information processing in the company. All working hours, salaries, purchase and sales quantities were processed in one and the same place. Strict, centralized controlling was justified, and all units needed to provide the information in the same form and in a common schedule. Together the new technology and common rules improved efficiency considerably.

Afterwards, in 1980's, the appearance of personal computers made it possible to process information with smaller computers that could be placed on employees' desks. The information could be processed closer to its source and it was beneficial to move towards more decentralized and flexible organization model. Again, with the organizational change, new technology improved efficiency. As for the current tendency towards more networking, we need to adjust the organizational thinking towards common rules and standards. However, Tarkka has noticed that the changes that were made in the constitution in 2000 seem to be standing on the way. These changes may partly explain Finland's fall in networking society ratings. The development pace has slowed down when comparing with the peer group. Could our public sector perform better without the constitutional changes of 2000? Would public health care have been able to benefit from ICT better if the Council of State had had the power to set common, national standards? This is a relevant question, since the compatibility issues are currently the major barriers in our national health ICT projects.

3.3. Is slow better?

All in all, the adoption of ICT has been relatively slow in health care and some valuable improvement opportunities might be missed. However, it is not necessarily a bad thing to wait before making investments. As the costs of adopting wrong kind of technology can be tremendous, the value of waiting is likely to be higher than in many other industries (Christensen et al. 2007).

The reason behind this lies in the fact that the value of future ICT is very uncertain. This is due to the rapid technological change, as better technologies might come up and the risk of being locked-in to sub-optimal technologies exists. Also the uncertainty of network effect complicates the situation, as the decisions of other relevant actors in the interlinked markets have to be taken into account. Together with the irreversibility of decisions the uncertainty generally reduces the value of ICT investments in health care. (Christensen et al. 2007)

When there is uncertainty and the investments are irreversible, the recent investment theory suggests that the value of waiting is higher (Dixit and Pindyck 1994). This is also referred to as the real option value theory. As these are exactly the conditions in health care, Christensen and Remler apply this theory in this sector as well. When a health care provider is considering an ICT investment that has uncertain future outcomes, it might be better to wait. After uncertainty has been resolved, it is possible to actually make the socially optimal decision of whether to invest or not. When other relevant actors have chosen their ICT, it is easier to make the right decision. Here the theory of real option value and network effect and positive feedback conjoin. (Christensen et al. 2007)

Christensen and Remler conclude that going slowly seems to be both the optimal and the realistic way forward. The uncertainties in the value of new technology, irreversibility of the investments, lack of standards, and the many interlinked markets all emphasize the value of careful contemplating before making investing decisions.

3.4.1. Imperfect competition

When it comes to the slow adoption of ICT in health care and the reasons behind it, it is also interesting to investigate the market structure and its implications. According to the economic theory competition improves efficiency. As inefficient companies are priced out of the market, there are incentives to innovate and improve cost-effectiveness in order to survive. Health markets are often very imperfect with both private and public providers and finance. Inefficient hospitals are not automatically forced to exit the market, which would result in an outcome where only the most cost-effective providers continue operating. Under these conditions, the incentives to innovate and exploit new technology are likely to be smaller. It is also typical that in health markets the consumer is not actually the one who is paying the price for the service. As the GP visits are mostly covered by insurance (public or private) instead of out-of-pocket payments the consumer is insulated from the real costs of their health care and have little reason to evaluate whether the benefits actually are greater than the costs of the service. In addition, the consumers seldom have enough price and quality information to make informed decisions (Baicker 2006). Obviously the health markets are far from perfect; could the lack of the dynamics of perfect competition explain part of the slowness of ICT adoption in health care markets?

The market structure of health care varies from country to country. There tend to be imperfections everywhere but the ways the markets are organized differ. The system is a combination of private and public providers with private and public payers of which some are employers and insurers and so on.

According to the World Health Organization report on health expenditure (2009), the share of government spending in health care varied from 76 per cent in Europe to 34 per cent in South-East Asia. In low-income countries government expenditure is typically low, and the rest comes from private spending, of which 85 per cent is out-of-pocket payments. The payment is made at the point of accessing health services. The prices are likely to become catastrophically huge, as the system does not allow for pooling of risks. As a result, the household can get into serious financial problems following from illness. (WHO 2009)

In majority of the OECD countries the most of health care is provided and financed publicly. In Finland, the general government expenditure on health was 76 per cent of the total health expenditure in 2006. The remaining 24 per cent was financed privately. The United States is again an exception where private payers play a bigger role, as the share of private expenditure on health was more than half, 54.2 per cent. Private insurance accounts for 35 per cent of the total health spending. The only two other OECD countries where private insurance represents more than 10 per cent are France and Canada (OECD 2009). All in all, it is very characteristic for a European country to have mainly publicly financed health care. (WHO 2009)

3.4.2. Most advanced health ICT - private or public market structure?

A bigger share of private expenditure and provision generally implies more competition in the industry (if it does not lead to a natural monopoly). Based on economic theory, one could think that the countries with lower government involvement become more cost-effective and have adopted more advanced technology as a result of better incentives. Does competition really improve efficiency in health markets? And does it imply more advanced technology?

The effects of competition seem to be different across private and public sector in the first place. According to Simpson (2006) the empirical evidence on the relationship between the amount of competition and productivity is different across private and public sectors. In her working paper she presents some empirical studies (Nickel 1996, Disney et al. 2003, Aghion and Griffith 2005) from the private sector that indeed show evidence of improved efficiency where the competition is more intensive. Market entry and exit tend to be associated with higher productivity growth and Simpson concludes that restructuring and reallocation of resources towards more efficient providers have a significant role in driving productivity improvements in private sector.

Public sector usually exists where the competitive markets would fail to produce the socially optimal outcome. In the case of common examples of public services such as national defence, education and health care, government intervention is widely accepted to correct market failures. The exit of inefficient firms in private sector may raise the average level productivity in the industry, but in the case of public sector organisations this is more complicated. For example in the health care industry, accessibility is an important aspect of the output and greatly valued by society. To get reliable results, accessibility and other elements valued by society should be captured in the productivity measure. If they are not, it might be incorrectly interpreted that the productivity has risen in the industry, even if it in fact has declined. (Simpson 2006)

Burgess et al. (2006) have investigated the empirical evidence of competition and hospital performance in the United States. Their conclusion is that increased competition seems to be associated with decreased costs, but at the same time the effects on quality remain unclear. The relationship between competition and the efficiency has not been studied as extensively and the results are controversial. The evidence from the US suggests that more intensive competition implies higher quality, while in the English internal market this was not the case. When the impact on the quality - often measured by death rates - is unclear, we cannot draw any definite overall conclusion of the effects of competition on the health care outcomes.

The discussion above suggests that the operative performance enhancing effect of competition might not be true for health industry. However, examples of cases where more competitive conditions have promoted more advanced use of ICT can be found. Christensen and Remler (2007) give examples of services that are usually paid out-of-pocket from which it follows that the consumers have to compare the value and the costs of the service before making the purchasing decision. This creates incentives for providers to reduce costs and find the most efficient way of production. For example, psychotherapy in the US is often paid by consumers themselves, as approximately 40 per cent of the services are paid out-of-pocket (Zuvekas 2001). At the same time this field has seen a rapid growth in the use of therapy via e-mail or other internet media. Also the long-term care is often not covered through conventional private insurance but paid out-of-pocket instead. In this field there is an emerging use of "smart technologies", for example for monitoring and communicating with the elderly living alone (Wallace 2003). These examples seem to emphasize the effect of competition in improving productivity by adopting new technologies in the US. (Christensen et al. 2007)

In the research conducted by PricewaterhouseCoopers that was presented in the previous chapter, the hospitals where divided into two groups, not-for-profit and for-profit hospitals. In this study the for-profit hospitals where constantly slightly more cost-efficient with lower average costs per bed. After the IT investment the costs started to increase in both hospital groups but after some time the trend turned downwards and costs started to decline. In the case of for-profit hospitals this tipping-point was reached earlier and the costs where reduced more rapidly. In this study there was a constant difference between more competition-oriented hospitals and not-for-profit ones. This might signal of incentives to adapt more innovative forms of IT.

Nevertheless, the case does not seem to be straightforward. In Europe the government generally plays a big role in health care markets. Yet there are countries that have the most efficient health care and that are using the most advanced information and communications technology. As noted before, comparing other industrialized countries - where national governments have played major role - to the United States, the US seems to be lagging 12 years behind in health information technology adaption. At the same time American health industry is less cost-effective. In 2003, the US had fewer physicians, practising nurses and acute care bed days per capita than the median country in OECD. Yet, health spending per capita in the United States was almost two and half times the one of the median OECD country. It seems that the competition reducing public intervention in the health markets does not necessarily lead to less effective outcome when comparing cross-country data. (Anderson et al. 2006)

In conclusion, there is mixed evidence of the effects of competition on health care productivity. Some empirical studies seem to promote the effects of competition and conventional market forces. In the studies inside the US that were presented, it seems that the more intense competition and thus, the incentives to innovate have led to adapting more advanced ICT. However, when comparing cross-country data, the most advanced and efficient processes are often associated with high government involvement.

4. ICT and homecare

In the rest of my thesis I will be focusing on the use of ICT in home care. Telehomecare can be the solution for treating the people who suffer from chronic diseases, as well as the elderly who form a major target group. This is a very timely matter, as the population is ageing and a bigger part of the population will need home care. The population is ageing will be a global problem, first landing in more developed countries but eventually the middle and low income countries will have the most rapidly ageing population. In developed countries, the population aged 60 or older is growing faster than ever, around two percent annually and is expected to more than double over the next four decades - rising from 264 million in 2009 to 416 million in 2050. Globally, the median age is 29 in 2009 and is projected to increase to 38 years in 2050. The population in Europe is the oldest, having a median age of almost 40 years which is expected to rise to 47 years in 2050. In Finland the population is one of Europe’s oldest, at the moment having a median age of 41.8, expected to rise up to 44,8 years in 2050. Thus, half of the population will be more than 45 years old. Another study calculates that the amount of people over 80 years old will rise to almost 11 per cent from current 4.2 per cent (Parkkinen 2007). (United Nations 2009)

Consequently, the amount of nurses relative to people who need health care is reduced and the costs are increasing. Finnish surveys suggest that the need for help at old age in rural areas seems to be increasing parallel with the increase of the aged population (Winblad et al. 2001). We are facing a challenge of how to assure high quality care with reasonable prices to all. Different forms of telehomecare have been suggested to help to overcome the future challenges. The debate over the value of telehomecare has been ongoing for over a decade and many home care providers are just waiting for definitive large-scale studies that will confirm that the cost-effectiveness will be improved in agencies that implement these systems (Atteberry 2009).

As is the case for the health care industry in general, also in the home health care the ICT diffusion has been slow. The reasons behind this lie in the limited availability of monitoring devices that are reliable, rugged, of acceptable cost and easy to use. The patients must be willing and able to cope with the measurement and reporting requirements. Also the providers must be willing to accept the self-measurements and reports and integrate them in their decision-making process. Furthermore, the implementing costs of the systems and the limited potential for reimbursement have been slowing down the technology diffusion in home health care. (Atteberry 2008)

4.1. Telehomecare

Telehomecare can be defined as the provision of care, construction, and education to patients in their residence using telecommunication technologies (Britton et al. 2000: 27). This includes traditional communication via telephones, as well as video-based interaction between the patient and the health care professional. It can also include complex technology that measures weights, vital signs, glucose, oxygenation, or runs electrocardiogram strips, and then transmits all this information to health care personnel via some form of communication technology (Bowles et al. 2001).

There are three primary goals in home care telehealth programs. These are to identify early exacerbation or decompensation of the patient's condition, to reduce unscheduled nurse visits and to decrease emergency room visits and acute hospitalizations. In addition, with successful use of telehomecare the patient or the caregiver satisfaction can be increased. Overall, the goal is to transition from the need of an acute type of care to self-care with the assistance of home care agencies. With the help of telehomecare, the agencies can continuously evaluate patient's condition and needs and then provide interventions and education (Atteberry 2009). (Franz 2004)

Continuous monitoring of the symptoms of chronically ill can be very advantageous, and has been noticed decades ago. When needed, the intervention or care adjustment can be done more rapidly, thus preventing more serious complications. Roglieri et al. (1997) studied the effects of a weekly phone call from a nurse to congestive heart failure (CHF) patients. The nurse asked standardized questions and if needed, alerted the physicians. The results were promising: during a period of one year, they found a decrease of 63 per cent in the hospital admissions of pure CHF patients. Furthermore, the average length of stay and the use of the emergency room also declined. With the help of modern communication technologies we could improve the outcomes of home care and monitoring considerably. The early applications of self-monitoring were in the form of paper diaries that were mailed to a clinical centre to be evaluated (Finkelstein et al. 1986), which can take days. With the existing communication technologies the patient information can be transmitted to health personnel in seconds, improving the conditions for constant remote monitoring.

4.2. Studies of telehomecare

The field of telehomecare has not seen comprehensive research on the effects of quality and cost-effectiveness. It has been discussed in home care literature and conferences since the mid-1990's, but studies of the outcomes have only been reported since the beginning of last decade. Moreover, many of the studies have been small-scale, based on fewer than 100 patients. (Franz 2004)

However, most of these smaller studies report positive outcomes. Technology applications can reduce the need for actual home visits (Britton et al. 2000, Bowles et al. 2001) and prevent acute health complications in advance. In studies concerning heart failure patients telehomecare has resulted for instance in reduced number of unscheduled nurse visits and emergency room visits (Home Care Automation Report 2003), cost savings (Dimmick et al. 2000), and better access to care (Cordisco et al. 1999). In a pilot where congestive heart failure patients were provided comprehensive home care via two-way video telehealth, there was 82 per cent decrease in hospital admissions and 77 per cent decrease in emergency room visits (Chetney 2003). Telehealth studies are often focused on heart failure patients and they form an appropriate target group for disease management intervention programs due to the high prevalence and treatment costs (Rogliere et al. 1997). (Frantz 2004)

A home care agency University Home Care (UHC) in eastern North Carolina implemented several TeleHomecare projects and evaluated their effectiveness (Britton et al. 2000). They investigated the option of replacing some of the traditional home visits by TeleHomecare visits from distance with the help of telecommunications technology. Their projects dealt with pregnant women experiencing pregnancy-induced hypertension, children with respiratory conditions, congestive heart failure patients and also patients who do not qualify for traditional home care but who have ongoing health care needs. After the projects, they state that with TeleHomecare programs both the patient satisfaction and the financial health of the home care agency may be improved. For example, UHC concluded that a nurse who only provides TeleHomecare visits can typically make 15 visits per day while a nurse providing traditional home care can typically only make six of them. This is mainly due to the reduced travel time. Furthermore, while the nurses became more productive, the financial travel costs were reduced at the same time. They also report that the patients were satisfied with TeleHomecare and that the ability to use the equipment successfully gives them a sense of independence and accomplishment. Moreover, the unnecessary emergency room visits can be reduced as well as the hospital stays that are extended beyond the reimbursable period. Overall, these projects had very positive results. (Britton et al. 2000)

Another TeleHomeCare project was realised in north-central Minnesota, by the University of Minnesota and four urban health home care agencies and several technical industry partners. They explored the effects of video conferencing (virtual visits), Internet access (learning about the disease and communicating online) and physiological monitoring (blood pressure monitors, pulse oximeters etc.) in three patient groups: congestive heart failure, chronic obstructive pulmonary disease and chronic wound healing disease patients. They were able to demonstrate that the technology actually works and can be easily installed. They also remark that the cost for the patient home base equipment is relatively modest. However, they conclude that based on their experiments, one cannot determine the real impact on the cost and quality. (Finkelstein et al. 2001)

Also a systematic literature review was published in July 2008. They went through articles published between 1999 and 2007 that focused on the effects on quality of care and the financial effects of telehomecare. This research supports the positive effects of telehomecare on both quality and the costs of care. (Atteberry 2009)

Nevertheless, not all the results have been positive. A European study of telehealthcare provided via video conferencing found that the patients stopped using the link after one month as they did not find this part of the system useful (deLusignan et al. 2001). Problems have come up also considering the use of the technology, as a researcher in Washington, DC found when exploring the use of ICT in the case of recent stroke victims and their care givers. The care givers were too overwhelmed to learn to use new technology despite the possibility of being quickly connected to nursing personnel (Tran 2002). As the elderly are a major target group of home care, complicated technology can pose serious barriers. (Frantz 2004)

5. Telehomecare and dementia

The rest of this thesis will deal with information and communications technology in the home care of elderly suffering from memory disorders. None of the above mentioned studies dealt with home care for the patients with memory disorders. The potential of ICT and different forms of smart technologies has been acknowledged, but real-life studies rarely focus on this field of health care. Nevertheless, due to population ageing, increasing prevalence of dementia and its treatment form a big societal and economic question.

5.1. Dementia challenging health care

Dementia will pose a major challenge for future health care. It is estimated that in 2010 there are 35.6 million people worldwide living with dementia. This number is estimated to nearly double every 20 years, rising to 65.7 million in 2030 and to 115.4 million in 2050. Particularly Alzheimer's disease is the most common reason to cause disability among the elderly representing 55-75 per cent of all dementia cases. As noted before, the population in developed countries is ageing rapidly and Finland is among the first countries to face this problem. Consequently, there will be more people suffering from dementia in the population. The prevalence of dementia increases sharply with age as 4 per cent of the people aged 65-74 years, 10 percent of people aged 75-84 years and a third of people over 85 years suffer from moderate or severe dementia (Sulkava 2005). Dementia is the most common cause of being institutionalized long-term and most of the oldest patients are treated in institutions. It is predicted that in 2030 the dementia patients alone will occupy the same number of beds in institutions as exists in Finland today (Pulli 2008). With the reduced number of health personnel relative to patients, Finland is facing the challenge of providing high quality care to all patients suffering from memory disorders. (World Alzheimer Report 2009)

The costs per bed in an institution are high and the need is increasing. To cope with the rising demand and limited resources, the role of ICT has received attention. Can technology help dementia patients to live independently longer before being institutionalized? Can technology reduce the costs of home care and at the same time improve the quality of life for the patient? These are important questions, and have been under a lot of discussion but have not been extensively studied.

5.2. The costs of dementia

There are different perspectives that can be adapted when presenting a health economic analysis. Most economists recommend the societal point of view, which takes all the relative outcomes and both direct and indirect costs into account. Services and material that are explicitly exchanged for money belong to direct costs, covering diagnostic work-up, hospital care, nurse visits, medication costs, paid home-care aid, transportation and other components of care of the dementia patient. Indirect costs refer to uncompensated care, including the lost earnings and time due to informal care provided by family members and friends (Beeri et al. 2002). Alternatively, the analysis can be done from the payer's point of view, such as municipality, an insurance company, caregiver or patient. Obviously, different perspectives may yield very different results. (Wimo 2009)

The total economic burden - i.e. the direct costs - of dementia was estimated to be 71.7 billion euros in the 27 countries in European Union in 2008. When the estimated costs of non-compensated informal care are included, the total costs account for 160.3 billion euros. In Finland the direct costs of dementia are 1 513 million euros and informal costs 609.2 million euros, resulting in total of 2 122.2 million euros. Thus dementia poses substantial costs to the societies. (Wimo 2009)

It is typical, that the costs of dementia increase steeply with the disease severity (Jönsson et al. 2009, Langa et al. 2001), and this is true for both direct and indirect costs. If there is a possibility to prolong the period of home care before being institutionalized or reduce the need for home visits, considerable savings could be made. This is again a motivator for developing technology to help to improve the independency of the elderly with dementia.

5.3. The costs of informal caregiving

When considering the costs of dementia, it is important to take the informal caregiving into account. The costs from care provided by family members and friends are substantial as in many areas they make up more than half of the total costs. Langa et al. (2001) have investigated these costs on national level in the United States for elderly with normal cognition, and for elderly suffering from mild, moderate and severe dementia. The first group received approximately 4.6 hours per week of informal care, and those with dementia received an additional 8.5, 17.4 and 41.5 hours per week, respectively. According to their estimations, the additional yearly cost from informal caregiving was 18 billion dollars, representing the opportunity cost of lost productivity and absenteeism of family caregivers. Moore et al. (2001) estimated that the informal costs per patient were 18 385 dollars per year in 1998, comprised largely by caregiving time and lost earnings. Both of these researchers also remarked that the costs of informal care increase strictly as the condition of the dementia patient worsens. Moving from the US to Europe, the costs of informal care in EU-27 in 2008 were 88.6 billion euros representing 55.3 per cent of the total costs. There was also an interesting regional pattern, as the Southern European countries tend to have higher informal costs than the Northern countries; in Southern Europe these costs represent 80.5 per cent of the total costs while in Northern Europe they account only for 32.6 per cent. In Finland, the informal care makes up 28.7 per cent. (Wimo 2009)

In addition to lost free time and earnings, the caregivers may face other inconveniences and problems as well. Some caregivers report that they have had to turn down promotions or take early retirement, or that they just need more time (Lange et al. 2001). The family members delivering care are also more likely to encounter physical and mental problems. The caregivers are often elderly spouses, and the mental and emotional strain increases the risk for worsening of physiological condition and even mortality (Schultz 1999). There is also compelling evidence that links dementia caregiving to negative mental health outcomes such as depression and anxiety (Connell et al. 2001). For both economic and ethical reasons, these societal costs of informal care of dementia should be taken into consideration. If the remote care can be facilitated by technology, the conditions for caregivers could possibly be improved as well.

5.4. Smart living environments

In the field of telehomecare, research on smart living environments has received more and more attention during recent years (e.g. Manning et al 2006, Yamazaki 2007). Technological components of smart living environments are constantly developing, maturing towards wearable applications that can monitor location on map, heartbeat, blood pressure, oxygen saturation and so on. With the growing interest in smart living environments, there have been many smart house projects that aim to monitor and help the living of the resident. However, there are few projects aiming to help the elderly to manage with daily activities like housework, preparing meals and going outside of home. The field of so called Instrumental Activities of Daily Living (IADL) focuses rather on empowering people than controlling them, by providing information when and where the decisions can be made (Intille 2006). The ideal would be to provide the senior citizens with means to go out and be social independently. So far, however, practical experiences and thus significant breakthroughs supporting and motivating senior citizens' outdoor activities have not been reported in large projects. This field needs to be researched in a multidisciplinary cooperation as a lot of knowledge is needed from different areas, including technical and medical aspects without forgetting the needs of the elderly. All in all, at the moment many commentators are convinced of the potential of smart living environments. Smart living environments substitute for work inputs, which increases the productivity of home care. This is crucial to overcome the problem of limited resources to provide good quality home care to all. (VESC)

Smart living environments can possibly help the elderly to manage with their daily activities better than before. In a report published by the Finnish Government Institute for economic research, they calculated what happens to the need for health and social services in 2040 with two alternative assumptions: keeping the need for these services on the same level as it was in 2006, and assuming that the need for care of people over 65 years is delayed by five years. In the first case the consumption would grow by 55 per cent and we would need 200 000 more employees in health and social services. But when, for instance, the 65-year-olds are assumed to consume health and social services as much as the 60-year-olds today, the consumption would grow by 20 per cent and the need for additional work force would be slightly over 70 000 employees. Thus, according to these estimations, for example a successful technology solution that reduces the need for care would relieve the burden of future home care. (Parkkinen 2007)

Information and communications technology solutions that reduce the need for help and home visits can also have a positive impact on the health of the senior citizens. The elderly can possibly manage more independently with their daily activities, which enables them to stay active. In many cases staying active can, in turn, delay the weakening of the memory. In the case of Alzheimer's disease there is not much to do and staying active does not affect the memory. However, when it comes to other, benign memory disorders - especially the ones that appear along with the ageing – it is important to keep mental agility up to prevent the deterioration of memory. Thus, memory can be affected by mental efforts, social interaction, maintaining the physical condition, early prevention and treatment of diseases, and avoiding unnecessary medication (but taking the necessary ones) (Sulkava 2005). In the city of Oulu, for example, the elderly are every once in a while participating to activity days in the service centres with other senior citizens and they tend to remember these days and the activities well, also the next week (Jyrkäs 2009). This activating effect is not only good for the senior citizen him or herself but also in the economic sense as the weakening of the condition might be slowed down. (Therapia Fennica)

Loneliness is a very common problem among the elderly. It has been estimated that half of the people aged 80 or more feel lonely or that they have no friends (VESC). The feeling of social loneliness was found to be more common among the demented than non-demented elderly people (Ericsson et al. 2000). If home visits are reduced, this can mean even fewer social contacts. However, the advocates of smart living environments have envisioned that information and communications technology can empower the senior citizens to go outdoors more and safely (VESC). If this becomes a reality, the elderly have more possibilities to go out and see other people and encounter more in social interaction. As dementia in itself does not cause physical impairment, the elderly with (only) memory disorders do not have moving restrictions and might be very motivated to move. In addition, the feeling of independency and experiences of success can also be very satisfactory and motivating, and thus improve the quality of life (VESC).

6. Smart living environments in the home care of memory disorder patients in Oulu

The ageing population is challenging the home care also in the city of Oulu. This can be seen in statistics, as the number of over 65-year old home care customers is steadily increasing every year. In 2008 there was a total of 1 160 home care customers which was 160 more than in 2004, implying a 16 per cent increase in four years. At the same time the whole population of Oulu has grown, however at a lower – 4,5 per cent – rate. (Kuusikko 2009)

It is clear that the home care for the elderly is becoming more and more encumbered. The possibilities of information and communications technology are acknowledged, and several projects and pilots have been run during recent years. A few technology applications are already in use and the experiences have sometimes been promising.

This chapter deals with home care of the elderly in the city of Oulu and a particular technology project called “Value Creation in Smart Living Environments for Senior Citizens” (VESC). VESC project aims to improve home care process by developing information and communications technology solutions for home care of elderly. The project focuses on the elderly with memory disorders in the city of Oulu. The idea is to roughly assess the cost effects of some technology solutions.

Next, I will briefly present the organization of the home care of the elderly in Oulu – the environment where the technology solutions would be applied. After introducing the home care process, I will present the VESC project and a simplified way to assess the cost effects of the technology solutions and rough calculations.

6.1.1. Home Care in the City of Oulu

The work with the elderly consists of two service units: regional work with the elderly and the care in a hospital or an institution. Home care belongs to the regional work with the elderly and is our main focus.

Home care includes home service, home nursing and the support services defined in the social welfare law. These support services include among others food, clothing, bathing, cleaning, transportation as well as escort and security services. Home care services are provided round-the-clock and during all weekdays. In addition to the public provision home care services can be purchased from private providers as well.

Home care in Oulu is divided into two regions: the Southern and Northern regions that are divided into separate service units (13 altogether) serving a defined set of customers. Home care employs more than 300 people (Kustannusraportti 2005, Rita Oinas 2010), most of them being practical nurses. As for the costs of home care, according to the Service Chief Rita Oinas, approximately 80 per cent of the costs are personnel costs. In 2009, the average cost per visit was 21.83 euro and the average length 24 minutes (6.11.2009).

The home care process in Oulu seems to be relatively cost-effective. After the year 2008, six major communities in Finland (Espoo, Helsinki, Oulu, Tampere, Turku, Vantaa and Oulu) collected information of their social and health services for the elderly and combined it in a comprehensive report called *Kuusikko 2009*. The objective was to make the data of the costs, customers and services as comparable as possible between the communities. The report showed that the average cost per visit in 2008 (without support services) was 21 euros in Oulu, when the average of all six communities was 42 euros. In the Helsinki metropolitan area the cost per visit was 48 to 49 euros. This is very interesting; why are the costs so much higher in other cities? The difference is probably partly explained by some statistical discrepancies and higher wages in the Helsinki area, but as the costs are more than double, there is likely to be some other explaining factors. As the process seems to be much more effective in Oulu, it might be that other communities could benefit from exploring the differences and find some major problems in their processes. This would be an important field for further research, since the industry seems to be in continuous difficulties and fails to provide adequate services with reasonable costs to all in need. Moreover, the problems of the already struggling industry are likely to get worse along with the ageing population. (Kuusikko 2009)

6.1.2. Classifications of Clients in Home care in Oulu

The client structure and the condition of individual clients are being followed actively. In Oulu – as in many other cities or municipalities and countries around the world - this is done by Resident Assistance Instrument (Rita Oinas 2009). RAI was originally developed in United States as a part of a set of reforms enacted by the United States Congress in 1987 (OBRA-87) to facilitate the assessment and care screening as well as to deal with major problem areas and risk factors for nursing home residents (Hawes et al. 1997). RAI has proven to be a useful instrument and has thus spread around the world, by now being familiar also to the nurses and the administrative side in Oulu.

RAI consists of the Minimum Data Set 2.0 (MDS) questionnaire and appropriate manuals and guidelines. MDS is used to collect information of the clients and to identify the care needs of older persons. Together the MDS and the guidelines and manuals form the RAI assessment tool that provides a comprehensive picture of the person's condition. The data of each individual client is collected by the nurse or the nursing team. When filling in the Minimum Data Set questionnaire, the information is attained by observing and interviewing the client, from client's documents or by discussing with a doctor, relative or some other relevant person. The MDS form contains almost 400 factors from 18 different areas, covering physiology, cognition and behaviour as well as the medication and other treatment information. In Oulu, the information is updated twice a year. At the moment RAI is used mostly for clinical purposes and administratively to follow the customer structure, but according to Rita Oinas the goal for the future is to use the tool also for cost analysis and other administrative purposes.

Also for the cognition and memory disorders that we are especially interested in, RAI provides valuable information and assessment tools. When all the information of the client is collected and entered in the database, software called RAIsoft calculates automatically the scoring on the Cognitive Performance Scale (CPS) that measures the cognitive condition and the symptoms of dementia. There are seven different CPS levels: 0) Intact, 1) Borderline Intact, 2) Mild Impairment, 3) Moderate Impairment, 4) Moderate Severe Impairment, 5) Severe Impairment and 6) Very Severe Impairment. In Oulu, however, the fourth level - Moderate Severe Impairment - is not in use.

The CPS score depends on five parameters: comatose, problems with short-term memory, cognitive skills for daily decision making, being understood by others and self-performance in eating. Based on these factors and calculated by RAIsoft, the homecare clients in Oulu fall into CPS categories in the following way:

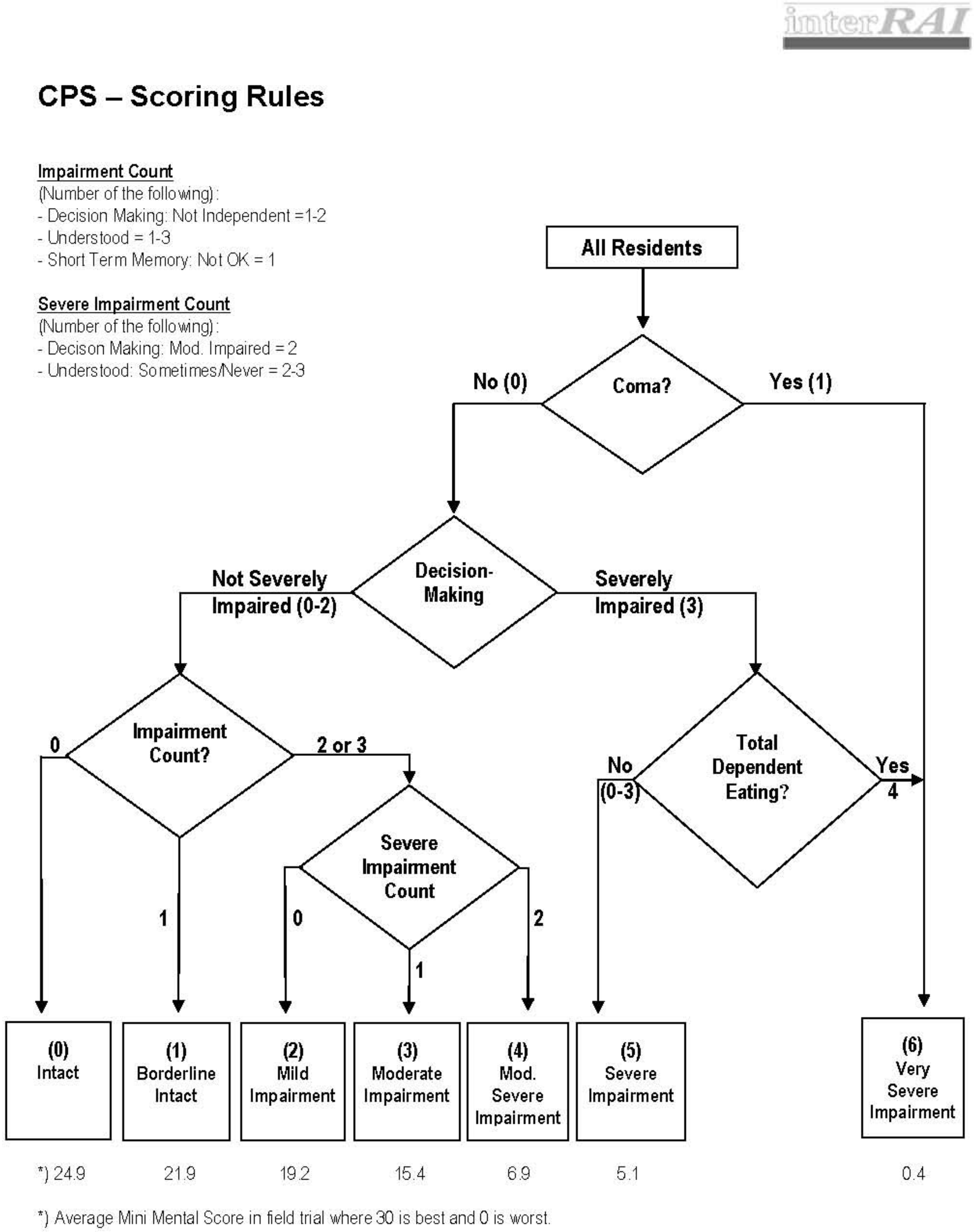
Table 1.The number of home care clients by CPS levels in Oulu. January 2009.

CPS level	Number (n=1226)
CPS 0	**405**
CPS 1	**233**
CPS 2	**356**
CPS 3	**147**
CPS 5	**86**
CPS 6	**12**

Source: RAI-database, Oulu

This data of the amounts of home care clients in each CPS level can be used to assess the cost effects of new technology solutions.

Figure 5 CPS Scoring rules



Source: Morris et al. 1994

6.1.3. Home Care Process

All the work days of the nurses tend to be very similar. A typical work day starts from the office, where the nurse takes the keys to customers' homes and receives the list of visits and their contents and leaves for the tour. In the half way of the day there is a 20-minute lunch break after which the nurse starts the home care visits again. In the end of the day the nurse returns to the office and enters the client information that came up during the day to the database. (Kaisu Jyrkäs 2009)

The clients differ in their needs greatly. The most independent ones are visited only once a day, while some clients need four nurse visits per day. In addition to these visits the night patrol may pay a visit and the customer may also receive a meal service from the city. Also the content and duration of the visits differ. Sometimes it takes only five minutes to deal out the medication and have a quick discussion to make sure everything is fine. On the other hand, some customers need an hour of nurse's time. Typical home care tasks are dealing out the drugs, bathing (once a week), dressing up, warming up the meals, grocery shopping (once a week), changing the diaper and chatting with the customer. In addition there are nursing tasks that include among others catheterization, insulin injections and wound care. (Kaisu Jyrkäs 2009)

6.1.4. Technology applications in home care in Oulu

Oulu is already using some technology solutions in home care. These are safety wristband, door alarms and "Mobiili". Safety wristband is a portable wristband with one button that alarms the security patrol. According to nurse Kaisu Jyrkäs this solution has proved to be useful if the elderly learn how to use the button. Especially in the case of falls the wristband has been very useful. However, in the case of clients with memory disorders, the benefits are not that obvious. They may not easily learn how to use the device, or have been making emergency calls when they are hungry or lonely. They might also get scared of the voice of the answerer. On the other hand, the door alarms are useful especially with the ones with memory disorders as they sometimes tend to wander. The alarm is set to alarm the night patrol if the outdoor is opened between programmed time intervals. The third technology solution is "Mobilli" that is for nurse use only. It contains information of the visits and their contents in electronic form and works as a working time follow-up. However, there are sometimes problems with Mobiili as the network is often overloaded and nurses are still using parallel paper versions. (Jyrkäs 2009)

6.2.1. Value Creation in Smart Living Environments for Senior Citizens (VESC)

In addition to separate devices like the ones described above, there has been discussion on the potential of ubiquitous smart living environments. Smart living environment technology has potential to support elderly in their daily activities and thus possibly enabling them to live at home longer. As discussed in the previous chapter, this is likely to result in economic benefits. Keeping aged persons active also has many positive health outcomes and it might improve the quality of life by enabling more social interactions and giving them a feeling of independency. As noted before, keeping an old person active can also slow down the weakening of the memory. As the name already tells, project VESC (Value Creation in Smart Living Environments for Senior Citizens) is involved with developing smart living environment technology as well as assessing its outcomes.

VESC is a four-year project that will end on 31.12.2012. VESC is based in Oulu and done in cooperation with the Departments of Information Processing Science, Medical Technology, and Architecture as well as the State Technical Research Centre and the Oulu Deaconess Institute. Thus, the project is multidisciplinary including several researchers and specialists from architecture, community planning, clinical medicine, medical technology, mobile technology, telehealthcare and information processing. The objective of VESC is “to develop analysis methods, frameworks and optimization tools, which can be used to demonstrate and analyze the value creation of the scenarios and smart environment technologies in the life of senior citizens”. VESC will also test the hypothesis: “A ubiquitous smart living environment will motivate and empower senior citizens to overcome their daily activities and thus lead a more independent life as long as possible.” If this hypothesis is proven to hold and the elderly are able to stay home longer and survive with less home care, it implies that smart living environments may well help in overcoming the challenges for health care caused by the ageing population. As smart living environments may help the senior citizens to become more independent, it may consequently also improve quality, efficiency and productivity of elderly care and the quality of life and safety. VESC aims to investigate these aspects and also the ways to assess and validate the positive impacts. (VESC)

The smart environment technology that VESC is developing relies among others on portable sensors that monitor personal processes. Also a cellular multimedia phone with a big display can be one of the peripheral VESC devices and so on. With the help of technology it is possible to monitor the living environment, the movement, some vital functions etc. to make sure that everything is in order. If something is out of line, the home care professionals are alarmed. It is also possible to arrange different kinds of guidance for the clients. The goal is to develop a guiding system that enables the elderly to move to places outside of home, for example to go shopping or to have a walk. With the help of peripheral devices the unexpected and critical situations could be prevented or safely dealt with.

As memory disorders are posing one of the biggest challenges for future health care, they have been taken as the main focus also in project VESC. One way to assess the impact of smart living environments is to consider the CPS classifications presented above. With the help of a smart living environment solution the independency of a senior citizen would increase, for example by facilitating the daily decision making. We can think of this as a movement (together with the peripheral devices) to a lower CPS level. This can happen if some tasks where the client used to need help for can be done independently with smart environment solutions. Consequently less home care would be needed at certain stages of the memory disorder and potentially the clients would need an institution place in a later phase.

6.2.2. Potential cost savings from VESC solutions

Cognitive Performance Scale classification can be used to assess the cost effects of VESC solutions. When the VESC system is developed, the effect on the independency of the client and the changes on the CPS classifications need to be concretely specified. Here we provide an example assuming that the clients on CPS levels 2 and 3 (Mild Impairment and Moderate Impairment) can be “moved” one level lower as they become more independent with the peripheral devices. In this case class CPS 1 grows.

One way to calculate rough estimates of the cost effects is with the help of these CPS changes. We need the information of the number of clients in each CPS level, the (average) number of daily visits in each CPS level and the average cost of a visit. It is true that the length and thus the cost of a visit can systematically vary between the CPS levels (higher level associated with higher cost), but we have to settle with averages. The idea is only to get very rough, suggestive results.

The following figures are from Oulu (2009):

CPS level	*Clients*[i]	*Clients with VESC*	*Visits/day*[ii]
CPS 1	**233**	**589**	1,42
CPS 2	**356**	**147**	1,68
CPS 3	**147**	**-**	1,62

The average cost per visit in 2009 was the above mentioned 21,83 euros.

	Without VESC	*With VESC*
CPS 1:	233 x 1,42 x € 21,83 = € 7 223	589 x 1,42 x € 21,83 = € 18 258
CPS 2:	356 x 1,68 x € 21,83 = € 13 056	147 x 1,68 x € 21,83 = 5 199
CPS 3:	147 x 1,62 x € 21,83 = € 5 199	-
Total:	**€ 25 477**	**€ 23 649**

Daily costs without VESC – Daily costs with VESC = € 1 828

Annually, the costs would be reduced by

€ 1 828 x 365 = € 667 236

The costs with VESC solutions are in this estimation 667 000 euros less. This can be thought of as the maximum price for VESC investment.

When comparing the reduced costs to the model without VESC, the result would be

[i] January 2009

[ii] Illogically, the average visits per day are less for CPS 3 than CPS 2. This is probably due to the fact that there were 109 281 of the total of 730 574 visits in 2009 for which the CPS class was not defined.

€ 667 000 / (€ 25 477 x 365) x 100 = 7,2.

Thus, the costs for CPS classes 1-3 would be reduced by 7 per cent.

Annually this would correspond to

€ 667 236 / € 21,83 = 30 565 visits

and daily

30 565 visits / 365 = 83,74 visits.

And, to be able to compare the cost savings to the total costs of all home care services (730 574 visits) in Oulu in 2009, we first need to calculate them

730 574 visits x € 21,83 = € 15 948 430,42

The total costs of home care services were approximately 15,9 million euros in 2009. This is also consistent with the costs for 2008, that were 15 026 461 euros (Kuusikko 2009).

Consequently, the savings would be

€ 667 236 / € 15 948 430,42 = 0,042

Thus, the total costs of the home care services would be reduced by 4,2 per cent.

Even though the calculated cost savings are not percentually huge, they would be enough to provide care for many new customers - depending, of course, on the investment and maintenance costs of the new technology.

There are other positive effects that might follow from increased client empowerment and independency. Staying active may delay the deterioration of the disease (depending on the cause of the memory disorders), and this may delay expensive institutionalization in the future, in the best case even prevent it. A successful smart living environment solution may also influence directly the need for institutional care, if it helps the senior citizens who would otherwise already live in an institution or service home to cope with their daily activities independently. As institutional care is very expensive, this is associated with considerable savings.

6.2.3. Technology solutions for medication and lunch

We have decided to roughly evaluate the effects of two possible changes brought by new technology in the home care process. First, the smart living environment technology that VESC is developing could possibly be used to monitor that the clients take their medication when they are supposed to, instead of sending a nurse to do it. Second, with some sort of navigating system, part of the clients could find their way to a lunch place outside of their homes, where they could meet each other and have a meal instead of getting it delivered at home. To evaluate the change in the amount of home care needed and the overall usefulness of these applications, I have interviewed two nurses and got some help from a geriatrist in Oulu. However, to get more accurate results, a pilot would be needed. For now, I will use estimations of these home care professionals and aim to get only rough, suggestive results.

I will calculate the cost savings from the reduced home visits. These cost savings come from the reduced personnel costs. This number can also be thought of as the maximum price for the technology investment, including the personnel costs as well as the equipment costs. This calculation is extremely simplified and it is good to remember that I only take the average cost (that comes from the personnel costs) of the visit into account. In addition there are travelling, administrative and many other costs that will be affected, but I have no means to estimate them. As mentioned earlier, the personnel costs make up the majority, approximately 80 per cent, of the total costs.

6.2.4. The medication

Controlling that the senior citizen actually takes the necessary medication can be done for instance by wireless sensors that track the movements of the person or, alternatively, there could be sensors on the bottom of the medicine cup that make sure that it is empty and so on. However, this should be technically feasible with current technology. Dealing out the drugs is a big part of home visits. Both of the nurses believed that home visits would be reduced and that technical monitoring would be useful, at least in the case of mild or borderline moderate dementia. Seija Mustaparta-Tikkanen believed that this could be applied with almost all of the clients who still live at home. She roughly estimated that 1-2 visits per day could be replaced, depending on the case and the amount of scheduled daily visits. She stresses that a pilot would be needed to get reliable results, as the clients are very different. In the next calculation, I will simplifiedly assume that one visit could be reduced, since the average number of daily visits was only 1,42-1,68 in our target groups.

To make rough calculations for the city of Oulu, I will use the estimate that one visit would be replaced, the number of home care clients in CPS levels 1-3 (mild-moderate), and the average cost of 21,83 euros per visit.

Thus, the visits would be reduced by:

1 visit x 736 clients = 736 visits per day

And, consequently, the savings would be:

736 visits x € 21,83 / visit = 16 067 € per day.

This multiplied by 365 yields:

€ 16 067 x 365 = € 5 864 455.

Thus, according to these estimations, the annual costs from home visits would be reduced by 5,9 million euros. As a portion of the total costs this corresponds to

€ 5 864 455 / € 15 948 430 = 0,37

The costs would be reduced by 37 per cent. If a technology solution like this can be developed, the cost savings may be considerable. Even if the solution could be offered only to half of the customers with mild and moderate dementia, the savings would be substantial, since

1/2 x € 5 864 455 / € 15 948 430 = 0,18

corresponding to 18 per cent decrease in costs.

6.2.5 Lunch outside of home

Some of the home care clients receive a delivered meal once day. It could be possible that, instead of this, the client goes to eat outside if an appropriate navigating device (or other) is developed. The senior citizen would be able to go and have lunch every day in a certain place and meet other people who also come and eat there. One home visit could possibly be replaced, if there is a nurse at the “lunch location” who talks with the clients and evaluates the change in their condition and reacts if there is something alarming, or if someone does not show up. The biggest part of the savings would come from reduced home visits. Also the meal deliveries from the city would be reduced, but the food still has to be prepared and there is personnel needed at the location. On the other hand, this arrangement can also bring other than direct economic benefits. As noted before, social interaction and moving are good for the health of the senior citizen and are likely to slow down the weakening of the memory (except for Alzheimer’s disease). Also the quality of life might be improved.

Based on a pilot (2006) that was examining people with mild and moderate memory disorders living at home in Oulu (Winblad), 18 out of 35 were able to go outdoors independently. Based on the notes made along the pilot, geriatrist Ilkka Winblad estimates that 13 more would be able to go out if they had appropriate guiding. Thus, in this pilot, 31 out of 35 people suffering from mild or moderate dementia would be able to navigate to the lunch location independently.

To roughly assess the cost reduction, we assume that one visit per day would be replaced. We assume that 88,6 per cent (31/35) of the people with mild and moderate memory disorders are able to move with guidance to the location where the lunch is served. And as we did above, we use the number of home care clients in CPS levels 1-3 and the average cost per visit, 21,83 euros.

First, if one home visit is replaced in the case of 88,6 per cent of the clients, the visits will be reduced by:

1 visit x 0,886 x 736 clients = 652 visits per day

Consequently, the daily savings would be:

652 visits x € 21,83 = € 14 233

Multiplying this by 365 yields:

€ 14 233 x 365 = € 5 195 045

Thus, the annual savings from reduced home visits would amount to 5,2 million euros. Furthermore,

€ 5 195 045 / € 15 948 430 = 0,33

which corresponds to a cost reduction of 33 per cent. Again, even if only half of the customers were able to use the technology to navigate to the location, the costs would be reduced by

1/2 x € 5 195 045 / € 15 948 430 = 0,16

This 16 per cent decrease would also mean significant improvement in productivity.

Of course the new arrangement would bring some additional costs. The city would have to pay for the location (rent, furniture etc.) and the employees there. These and other relevant costs are hard to estimate and we cannot draw very strong conclusions from this calculation.

Here it is good to mention, that in the case of memory disorders, it is important to start using the device in a very early stage of dementia. Both of the nurses stressed the fact that it is hard for a person with memory disorders to learn new things. If the device is taken into use in an early phase, it is possible that the client will be able to continue the use when the disease develops into moderate or severe dementia.

6.3. The informal costs

As noted before, the informal costs should be taken into account when making an economic analysis from the point of view of the society. The informal costs are primarily concerned with the opportunity cost, most often measured by lost earnings. However, due to methodological difficulties it is very hard to estimate the amount and costs of informal caregiving. As a consequence, these costs have often been ignored in economic analyses, leading to socially misleading outcomes. (McDaid 2009)

To be able to estimate the informal costs of home care in Oulu, I have decided to use the estimate of Alzheimer Europe for year 2008. They have made calculations for the costs of dementia for European countries. According to their estimations the annual informal cost per demented in Finland was 7 844 euros in 2008. (Wimo 2009)

Using this estimate, the annual informal costs of memory disorders (CPS 1-6: n=834, 1/2009) in Oulu would be

834 x 7 844 € = € 6 541 896

Comparing this to the total direct costs of home care (also for the non-demented) we find that

€ 6 541 896 / € 15 948 430 = 0,41

Thus, the informal costs of memory disorders are two fifths of the size of the direct costs.

However, the effect of VESC technology solutions on the costs of informal care is difficult to estimate. It is already hard to find reliable estimations of the amount of informal care in the current situation, which makes it even more demanding to make estimations of the cost effects with the smart living environment technology. Nevertheless, the effect on informal costs should not be ignored in the future as the costs seem to be substantial.

7. Conclusions

Our health care processes will be facing major challenges in becoming decades. Ageing population will demand more health and social services parallel with decreasing labor supply. As the Finnish constitution states, public authorities must provide adequate health and social services to all citizens. To be able to do so, the productivity of our health care sector needs to grow.

Our economic growth rest more and more on the contributions of information and communications technology. Investments in ICT have helped to increase productivity in many sectors and have brought almost half of our labor productivity growth over recent years. However, health industry has so far seen relatively few investments in ICT, and many commentators believe that here is the key to overcome the awaiting health care crisis.

ICT has a lot of potential. For health industry electronic storing of the data means considerably less paper work, faster access to information, avoiding unnecessary tests and so on. Modern communication technologies enable real-time communication and remote monitoring and thus faster reaction when needed. One objective of health ICT is to move from acute type of care towards more self-care and preventing actions. In the long run, this is likely to bring cost-savings as serious health problems can be prevented or taken care in an earlier stage.

Despite all the potential, the adoption of health ICT has been slow. The reasons behind this are among others the lack of demonstrated cost-effectiveness, compatibility problems as well as privacy, confidentiality and security issues. Also the fact that the industry is very information-intensive and health customers are very heterogeneous complicates the adoption process. Unlike in the case of automated banking services for example, the doctor needs to have plenty of information of the client before delivering the service. Also the risks of adopting new kind of technology are particularly high in health care. The medical errors caused by break-downs or other technology related problems can have very serious consequences that are not tolerated by the society (e.g. premature death). However, despite all these inconveniences large-scale health information and communications technology is on its way. European Union is promoting health ICT in the area with their eHealth Action Plan (2004) and Finland is building a National Archive of Health Information including among others electronic health records and ePrescribing. Whether the productivity will be improved is left to be seen.

ICT and smart living environments are also likely to play an ever bigger role in the home care of the elderly. Especially in the home care of the demented, ICT has been projected to increase independency and help the elderly to cope with daily activities. This would obviously lead to reduced costs as the home visits could be reduced (approximately 80 per cent of the total costs are personnel costs). In addition, when the elderly can survive at home more independently, they stay more active. Staying active, for one, delays the weakening of the memory. Thus, in the long run, the need for expensive institutional care may be reduced and the quality of life improved. Furthermore, the informal costs – i.e. the uncompensated care provided by family members and friends – would be affected as well. Uncompensated care has to be taken into account as they are considerable costs to societies, often estimated to make up more than half of the total costs of dementia (EU-27). Improving productivity is important in this field of health and social work as well, as the prevalence of dementia is increasing sharply along with the population ageing.

In any case, health care process needs to be improved. It will be left to see if health ICT will live up to its expectations in improving the productivity of the sector. In the best case the lack of compatibility and other adoption problems will be overcome and the productivity gains of ICT as a "general purpose technology" will be substantial. Furthermore, with the help of ICT the whole health care may move towards more preventing care and patient education that can – in the long run – bring both considerable economic savings and health benefits.

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