HELSINKI UNIVERSITY OF TECHNOLOGY
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A User-centred Approach to Healthcare ICT Development

Licentiate's Thesis

Espoo, May 18th, 2009

Supervisor and instructor: Professor Marko Nieminen
Reviewer: Professor Pirkko Nykänen

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ABSTRACT OF LICENTIATE THESIS

Author Johanna Viitanen	Date 18.5.2009
	Pages 93+30
Title of Thesis A User-centred Approach to Healthcare ICT Development	Language English
Professorship Usability Research	Professorship Code T011Z
Supervisor Professor Marko Nieminen	
Instructor Professor Marko Nieminen	

Healthcare information and communication technology (ICT) is thought to have the potential to transform healthcare delivery and improve the quality of care. Today, hundreds of healthcare information systems are used in hospitals to serve numerous groups of healthcare professionals in their daily work with patients. The inclusion of patients and other "healthcare consumers" as ICT users is already occurring. The current changes in the field offer new opportunities for healthcare delivery, but, on the other hand, indicate challenges for traditional ways of developing healthcare ICT applications.

The hypothesis of this research is that the user-centred design (UCD) approach has a fundamental role in understanding the current challenges and developing healthcare information (ICT) solutions for divergent users and uses. However, the area of user-centred healthcare ICT design seems to stand for a novel field of research. Therefore, the aim of this thesis was to find out how the UCD approach has been applied in the design of healthcare ICT solutions and how it could be included in the development.

The thesis starts with a literature review, which summarizes the backgrounds and challenges of ICT development in healthcare, and provides an overview of user-oriented research conducted in the target domain. The review findings indicated that many of the current challenges in development are related to the changing role of healthcare ICT. Thereby, the need for a user-oriented approach has been widely recognized; however, no research has been conducted to systematically and extensively support the user-centred design of healthcare ICT applications. To address these issues, this thesis applied a user-centred design approach to conceptually and thematically analyze the research area of healthcare ICT development.

The main contributions of this thesis are: 1) the descriptions of healthcare ICT design contexts and 2) the user-centred design framework for healthcare ICT development. Based on the reviews and descriptive analysis, three distinct contexts of design were identified: 1) Healthcare professionals as ICT users in the healthcare environment, 2) eHealth services for citizens' use, and 3) ICT support for cooperative care. These contexts are included in the DeHus design framework, which describes the characteristics of each context with reflections on ICT development in healthcare field, and summons up the research contributions.

Of all the three design contexts, the third one "ICT support for collaborative care" seems to be both the most interesting and the most important with regards to the future of healthcare delivery and UCD research contribution. In the near future, more practical studies will be performed to evaluate and develop the presented framework further.

Keywords: user-centred design, healthcare ICT development, healthcare information system, usability, health informatics, DeHus framework

TEKNILLINEN KORKEAKOULU
Informaatio- ja luonnontieteiden tiedekunta
Tietotekniikan laitos

LISENSIAATTITYÖN
TIIVISTELMÄ

Tekijä Johanna Viitanen	Päiväys 18.5.2009
	Sivumäärä 93+30
Työn nimi Terveydenhuollon tieto- ja viestintäteknologian käyttäjäkeskeinen suunnittelu (Englanniksi: A User-centred Approach to Healthcare ICT Development)	Kieli Englanti
Professuuri Käytettävyystutkimus	Professuurin koodi T011Z
Työn valvoja Professori Marko Nieminen	
Työn ohjaaja Professori Marko Nieminen	

Tänä päivänä tieto- ja viestintäteknologiaa (TVT) hyödynnetään laajasti terveydenhuollossa: sairaaloissa on käytössä satoja tietojärjestelmiä ja uusia potilaille suunnattuja ratkaisuja kehitetään parhaillaan. Uuden teknologian hyödyntämisen avulla tavoitellaan sekä hoitotyöhön liittyvien prosessien uudistamista että laadukkaampaa terveydenhuoltoa. Uusien TVT-ratkaisujen suunnittelu laajoille käyttäjäjoukoille vaihteleviin käyttötilanteisiin haastaa kuitenkin perinteiset tavat kehittää terveydenhuollon tietojärjestelmiä.

Käyttäjäkeskeinen suunnittelu on avainasemassa kun tavoitteena on kehittää uusia, käyttäjien tarpeisiin vastaavia ratkaisuja terveydenhuollon haastavista lähtökohdista käsin. Terveydenhuollon TVT:n käyttäjäkeskeistä suunnittelua ei kuitenkaan ole tutkittu aiemmin. Tämä lisensiaattityö pureutuu tähän uuteen tutkimusalueeseen. Työn tavoitteena on selvittää, 1) millaista käyttäjänäkökulmat huomioivaa tutkimusta terveydenhuollon tietojärjestelmien tutkimusalueella on aiemmin tehty ja 2) miten käyttäjäkeskeinen suunnittelu voi tukea uusien ratkaisujen kehittämistyötä.

Näitä tutkimusongelmia lähestyttiin aluksi kirjallisuuskatsauksen keinoin tutustumalla terveydenhuollon TVT:n kehityksen taustoihin ja nykypäivän haasteisiin. Käyttäjänäkökulmasta toteutettuihin tutkimuksiin pureutuneen kirjallisuuskatsauksen myötä selvisi, että tarve käyttäjiä huomioivalle suunnittelu- ja tutkimustyölle on tunnistettu, mutta keinoja tämän toteuttamiseen ei ole juuri nostettu esiin. Tähän tarpeeseen työssä vastattiin käsitteellisen jäsennyksen ja kuvailevan analyysin avulla: käyttäjäkeskeisen suunnittelun periaatteita hyödyntäen työssä kuvataan keskeisimmät lähtökohdat terveydenhuollon TVT:n käyttäjäkeskeiselle suunnittelulle. Analyysin tuloksena tunnistettiin kolme erilaista terveydenhuollon TVT:n suunnittelun kontekstia: 1) TVT terveydenhuollon ammattilaisten työvälineenä, 2) uusien terveysteknologiapalvelujen suunnittelu kansalaisille, ja 3) yhteistoiminnallisen hoitotyön tukeminen TVT:n avulla.

Työn lopussa esitelty DeHus-suunnittelukehys kokoaa yhteen tutkimuksen keskeisimmät tulokset. Kehyksessä kuvataan kolme suunnittelun kontekstia ja niihin liittyen terveydenhuollon TVT:n käyttäjäkeskeisen suunnittelun lähtökohdat. Näistä konteksteista yhteistoiminnallisen hoitotyön tueksi kehitettävien ratkaisujen suunnittelu näyttäisi olevan erittäin tärkeä alue erityisesti tulevaisuuden terveydenhuoltoa, mutta myös käyttäjäkeskeisen suunnittelun metodiikkaan pureutuvaa tutkimusta ajatellen. Työssä kuvatut jatkotutkimuksen teemat liittyvätkin kiinteästi empiiristen tapaustutkimusten toteuttamiseen ja näiden pohjalta karttuvien kokemusten hyödyntämiseen suunnittelukehyksen arvioinnissa ja edelleen kehittämisessä.

Avainsanat: käyttäjäkeskeinen suunnittelu, terveydenhuollon tieto- ja viestintäteknologian kehitystyö, terveydenhuollon tietojärjestelmät, käytettävyys, terveydenhuollon tietotekniikan tutkimus, DeHus-suunnittelukehys

Preface

This thesis introduces a user-centred approach to healthcare ICT design. The thesis is a contribution of the work I have conducted within recent years in the field of healthcare technology research. Due to wide adaptation and current changes in the use and impact of healthcare technologies, there seems to be a growing need for a user-centred design approach. This need has been strongly supported by my experiences in researching information technology usage in the hospital environment, applying user-centred methodologies in research, observing and facilitating healthcare ICT related web discussions, and participating in a number of project planning groups (e.g., KaTRI project). Discussions with people working in different fields of healthcare have provided me with valuable insights into the challenges of healthcare technology development.

Interestingly, interest in technology support for healthcare delivery and related interaction is currently increasing in the fields of usability research and human-computer interaction (HCI) also. As presented at the CHI2009 conference in the panel discussion session on the theme "Interacting with Health":

> *Now is the time for eHealth to come to the forefront of the HCI research agenda, and to look towards establishing grand challenges for HCI in eHealth.*

I would especially like to thank Marko Nieminen, my supervising professor, for many things: collaboration in research actions, co-authoring the research articles, and valuable comments regarding this thesis. Marko has gently guided me forwards during the post-graduate process, and made me believe that writing a licentiate's thesis actually is not such a big deal. Many thanks also to Professor Pirkko Nykänen for reviewing the thesis and for the provided comments. In addition, I wish to thank my colleagues working in the Strategic Usability Research Group and SoberIT for support, understanding, and inspiring discussions.

Furthermore, I would like to express my sincerest appreciation to my beloved ones: Otto, Arttu, Emmi, Lauri, and my parents Päivikki and Eero. Without you this thesis could not have been initiated or finished.

Although this thesis does not complete my mission yet, I think it does get me one step closer to the goal of making the world a better place for patients, healthcare professionals, and all of us, who are surrounded by information and communication technology and interested in taking care of ourselves and others around us.

Sundsberg, May 18th, 2009

Johanna Viitanen

List of Publications

The following papers are included in this thesis:

Paper I: *Viitanen, J., & Nieminen, M. (2009) Terveydenhuollon tietojärjestelmien käytettävyys (in English: Usability of Healthcare Information Systems). SoTeTiTe[1] research seminar 2009 (submitted and accepted).*

In the health informatics research field the concept "usability of healthcare information systems" is often referred to and mainly associated with evaluation activities. However, researchers do not have proposed definitions for this concept, nor have they considered usability from a more extensive viewpoint. In this paper the authors apply a user-centred design approach to describe the usability of healthcare ICT from the perspectives of design and development. The author was responsible for conducting literature reviews, preparing the article, and writing the article with the advice of the co-author.

Paper II: *Viitanen, J. (2009) Redesigning Digital Dictation for Physicians: A User-Centred Approach. Health Informatics Journal (submitted and accepted).*

This paper reports a study that employed a contextual inquiry method to research physicians' work and dictation practices in the hospital environment. The aim of the study was to gather information about the healthcare professionals' daily work with healthcare information systems, evaluate the prevailing dictation procedures, and describe the user requirements for a dictation solution. Earlier versions of the article were published in spring 2008 at the SoTeTiTe[1] research seminar and at the International Symposium of Health Information Management Research (ISHIMR) conference in autumn 2008.

Paper IIIa: *Viitanen J., & Nieminen, M. (2008) Avoin vuorovaikutusfoorumi käyttäjäkeskeisen kehittämisen tukena – tapaus Tervesysteemi.info (in English: Open Interaction: Describing a New Methodology Approach for User-centred Design). SoTeTiTe[1] research seminar 2008. Stakes, Työpapereita 19/2008, pp. 90-96.*

Paper IIIb: Viitanen, *J. (2008) Open Interaction: A User-Centred Approach for Healthcare Information System Development (poster abstract). Proceedings of the 13th International Symposium of Health Information Management Research conference (ISHIMR'08), Auckland, New Zealand.*

These two papers introduce a novel idea of utilizing an "open interaction" approach in the field of user-centred design. The idea behind open interaction is to combine three approaches: an open innovation ideology, online communities, and active user involvement in system development. The papers describe an exploratory research case that aimed at: 1) conceptualizing an open interaction forum to enable the healthcare-related parties to contribute to the discussion of innovation, design, and development of healthcare ICT, and 2) to gather experiences of an innovative research approach. The author planned and conducted the research case together with co-author. The author analyzed the results and was responsible for preparing both publications.

[1]*Sosiaali- ja terveydenhuollon tietojenkäsittelyn tutkimuspäivät (SoTeTiTe)* is a yearly seminar on health informatics research in Finland organized by Sosiaali- ja terveydenhuollon tietotekniikkayhdistys ry.

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Definitions

Consumer health informatics

Consumer health informatics is the branch of medical informatics that analyses consumers' needs for information. Consumer informatics stands at the crossroads of other disciplines, such as nursing informatics, public health, health promotion, health education, library science, and communication science, and seems to be one of the most rapidly expanding fields in health informatics. (Health Canada, 2000)

Context of use

Context of use describes the circumstances in which a specific system, product, or service is used and includes the following four elements: user, her tasks, equipment, and the physical, organizational, and social environmental aspects. (ISO 9241-11, 1996)

DeHus framework

This thesis presents an initial version of a user-centred design framework for healthcare ICT development. The framework includes three contexts of user-centred healthcare ICT design and describes the fundamentals and challenges for design in each context. The framework aims at increasing the understanding of user-centred issues of design and thereby provides support for system and service design in the field of healthcare.

eHealth The concept of eHealth has many definitions, which all share the idea of eHealth covering the applications of information and communication technologies across the whole range of functions that affect the health of citizens and patients.

EHRs Electronic Health Record system. In the literature, the concept of an electronic health record system covers a wide range of different information systems. Healthcare professionals use EHRs as their principal information repository. In healthcare organizations, EHRs are used for purposes of setting objectives, planning patient care, documenting the delivery of care, etc.

Healthcare ICT

Healthcare Information and Communication Technology is used to describe a broad concept of technologies which enable people to conduct various healthcare-related actions, for example to gather information, access stored data, communicate, and interact with distant services without limits of time and space.

Healthcare professionals

Healthcare personnel responsible for medical and care-giving activities in hospitals. Healthcare professionals include people with various areas of expertise: clinicians, physicians, nurses, radiologists, pharmacists, laboratory technicians, radiographers, etc.

IT Information Technology

ICT Information and Communication Technology

Health informatics

The discipline of health informatics can be considered as a combination of computer science, information science, and health science. The evolving scientific field deals with the collection, storage, retrieval, communication, and optimal use of health-related data, information, and knowledge. (e.g., HISA website)

PHR Personal Health Record or Patient Health Record. Both of these concepts are used to describe healthcare information systems, which help the patients to become participants in their own care. Compared to EHRs, PHRs are to provide the patients and citizens with novel access to their health information, an opportunity to interact with health related parties, and utilize the electronic healthcare services integrated in PHRs.

Patient-centred care

The idea behind patient-centred care is to treat patients as partners, involve them in planning their healthcare, and encourage them to take responsibility for their own health. The visions of patient-centred care are characterized with the following aspects: a) information delivery and communication between clinicians and patients and other involved parties, b) coordination of care, and c) cooperative care.

UCD User-Centred Design is an approach to interactive system development that focuses upon users and usability throughout the entire development process. The four principles of user-centred design are appropriate allocation of functions between users and technology, early focus on users and continuous testing, iterative design process, and multidisciplinary and cooperative design. ISO 13407 (1999) and ISO 9241-11 (1996) standards provide guidance on user-centred design.

Usability The objective for designing systems for usability is to enable the users to achieve the goals and meet their needs. The definitions of usability emphasize the relationship between usability and context of use; the level of usability achieved will always depend on the specific circumstances in which a system, product, or service is used. Usability has multiple components: efficiency, effectiveness, satisfaction, learnability, memorability, low error rate, etc. These are the usability attributes, which are typically evaluated and measured in usability evaluation studies.

User The end-user of a specific device, system or service. The main users of healthcare ICT are: a) healthcare professionals who work with healthcare information and communication technology applications in hospitals and other healthcare organizations, b) patients, c) all citizens (regarding the eHealth services), and d) other supportive parties (e.g., parents, family, social care workers).

1. Introduction

In spite of the global economic recession, healthcare providers are continuously investing considerable resources in healthcare information and communication technology (ICT). Significant benefits are expected as the healthcare industry implements large-scale electronic health records, provides remote diagnostics via telemedicine, upgrades hospital information systems, and enables information sharing and distribution among key stakeholders through public networks (Beaver, 2003). Indeed, ICT is thought to have enormous potential to improve the quality of healthcare.

Among other industries, healthcare has already profited extensively by the development of ICT. Today, electronic information systems have a key role in patient care. Both stand-alone and integrated applications are widely implemented and adapted. In the 21st century, many developed countries, including Finland, have invested considerable amounts of money in the development of electronic health record (EHR) systems and national health record infrastructure.

The effects of new healthcare technology adaptation seem to be manifold. When integrated properly, information technology is said to provide solutions to the increased demands for quality, efficiency, and improved workflow to help streamline healthcare operations (Beaver, 2003). In hospitals, healthcare information technology has already been shown to improve quality by increasing adherence to guidelines, enhancing disease surveillance, and decreasing medication errors (e.g., Chaudhry et al., 2006). In the near future, emerging ICT is expected to have the capacity to empower patients and enable them to become active participants in their healthcare.

Although healthcare information technology benefits are obvious in theory, it seems that they are not clearly associated in the operating situations in the healthcare context of use. Studies have shown both positive outcomes and serious challenges in adapting and developing applications for healthcare purposes. Due to the contradictory results, several researchers (e.g., Chaudhry et al., 2003; Häyrinen et al., 2008; Goldschmidt, 2005) have emphasized the need for further research in order to realize the practical benefits of, and challenges for, technology adaptation.

1.1. Motivation

In recent years, there has been much public debate about healthcare information systems. This debate has occurred in several levels of healthcare-related sectors and various forums ranging from public Internet discussions to newspapers and academic articles.

In Finland, public discussions have pointed out several interesting experiences and observations. The adoption of electronic information systems has in several ways influenced clinical work practices. Patients have noticed that instead of communicating with them, healthcare workers concentrate more and more on working with computers during the doctor's appointments (Karismo, 2008). Among others, physicians have argued that information technology adaptation has dramatically increased the time dedicated for clinical documentation and supportive tasks (Lindqvist, 2008; Muuronen, 2008; Lindberg, 2008; Kaarto, 2008; Strann 2007). Some have expressed their concern about reliability and patient safety issues related to these systems and their use in care delivery (Strann, 2008; Vuorenmaa & Kontio 2008). Furthermore, a recently published research report (Mykkänen, 2008) about information technology usage in healthcare organizations and related experiences describes findings with high concern. The survey results showed that over 70% of the respondents (n = 550) felt that electronic health record systems had not decreased the healthcare workers' work load, and about 80% disagreed with the statement that electronic systems enabled the healthcare workers to spend more time with patients.

Some arguments have stated that the increased time for computer use derives from the systems being incomplete and poorly designed (Vierola, 2008; Lamminkari, 2009; Strann, 2007). It seems that the currently used healthcare information systems and experiences have had strong effects on healthcare workers' attitudes towards technology adaptation. In one hospital district the adoption of a new information system was delayed due to low acceptance and initial negative experiences in the information systems' use (Valtavaara, 2009).

Academic research conducted in the health informatics domain partly supports these point of views and arguments. The success of healthcare information systems has been questioned by a few researchers. Studies have indicated severe usability problems (Kjeldskov et al., 2008; Walldén et al., 2007a; Walldén et al., 2007b; Rose et al., 2005; Patterson et al., 2005) and pointed out increases in physician time related to computer use (Pizziferri et al., 2005; Overhage et al., 2001). One of the main concerns has been with the ease of use of electronic patient record systems and the amount of time taken up by clinical documentation and record-keeping (Häyrinen et al., 2008; McDonald, 1997; Spies et al., 2004; Reuss et al., 2007a; Poissant et al., 2005).

These findings indicate that the need for a good fit between the information systems and routine clinical practices is recognized as essential. Accordingly, time efficiency seems to be one of several factors used to assess the quality of integration and adaptation. In several contexts and discussions, the concept of *usability of healthcare information systems* has occurred with a variety of meanings. In general, usability is associated with ease of use and

user-oriented development. Various stakeholders working in the healthcare domain share the aim of designing and developing healthcare information systems with high usability; however, the approaches and procedures on actions seem to be poorly understood.

1.2. Thesis Scope

In recent decades research conducted in the field of healthcare information system development has mainly concentrated on technical issues. While many technical problems still remain unsolved (e.g., Braller, 2005; Kuhn & Guise, 2001; Gides & Rivera, 2008), there seems to be a growing interest towards people-oriented perspectives. Several researchers have pointed out the need for usability studies (e.g., Chaudhry et al., 2006; Paulus et al., 2008; Gruchmann & Borgent, 2007; Zhang, 2005; Glasgow, 2007), methodology considerations (e.g., Häkkinen & Korpela, 2007; Zhang, 2005), and user perspective-related research (e.g., Berg et al., 1998; Rector et al., 1992; Shah & Robinson, 2006; Poissant et al., 2005; Kuhn & Giuse, 2001).

The user-centred approach has proven its success broadly in various areas of system development, but has not been applied widely in the health informatics domain. Experiences in applying the research methodology in healthcare information system development have been encouraging (e.g., Karasti, 2001; Brender, 1998). Nevertheless, relatively little is found in the literature on the question of user-oriented development of healthcare information and communication technology (ICT) applications.

This thesis concentrates on exploring the evolving area of healthcare ICT development from a user-centred design perspective. The questions underlying the research are:

> *What are the main challenges in designing healthcare ICT applications for divergent users?*
>
> *How can user-centred design help to address these challenges?*

In literature, several concepts are used to describe technology adaptation and various information and communication technology (ICT) systems to support healthcare-related activities. Typically, healthcare information technology (HIT) is associated with hospital computer systems with functions like patient admission and discharge, order entry for laboratory tests or medications, and billing functions (Coeira, 2003). In this thesis, healthcare information and communication technology (ICT) is used to cover a broad concept of technologies that enable people to conduct various healthcare-related actions – for example to gather information, access stored data, and communicate and interact with distant services without limits of time and space.

By definition, *health informatics* is an evolving scientific discipline that deals with the collection, storage, retrieval, communication, and optimal use of health-related data, information, and knowledge (HISA website). Health informatics, often referred to as medical informatics, is a combination of computer science, information science, and health science, and has a number of sub-domains, including among others clinical informatics, telemedicine, consumer health informatics, and healthcare management informatics (Conrick, 2005; Coeira, 2003; IMIA website, AMIA website). The scope of health informatics is thus enormous.

Although the discipline of health informatics is rather young, many research territories have already gained wide acceptance and are attracting the interest of research groups working in the field. The research has tended to focus on information and care delivery management and technical development of applications, rather than on human or end-user aspects. In recent years, several conferences (e.g., HIMMS[1], ISHIMR[2], ITCH[3] and e-Health[4]) have among other themes appreciated implications of human-computer interaction (HCI) and usability considerations. These themes have also occasionally appeared in articles published in healthcare technology-related journals (e.g., International Journal of Quality in Health Care, Journal of Biomedical Informatics, Studies in Health Technology and Informatics, Health Informatics Journal, Journal of the American Medical Informatics Association, International Journal of Medical Informatics, and International Journal of Technology Assessment in Health Care).

[1] Healthcare Information and Management Systems Society (HIMSS), conference www-pages: http://www.himssconference.org/

[2] International Symposium for Health Information Management Research, conference www-pages: http://www.massey.ac.nz/~wwiims/research/iSHMIR%202008/Home.html

[3] An international conference addressing Information Technology and Communications in Health (ITCH), www-pages: http://itch.uvic.ca/index.php

[4] IADIS Multi Conference on Computer Science and Information Systems, e-Health Conference www-pages: http://www.ehealth-conf.org/

1.3. Thesis Objectives and Structure

The goal of this thesis is to bring two interdisciplinary research areas, health informatics and user-centred design, closer to each other by improving the understanding of how a user-centred approach could be utilized in healthcare ICT development. The intention is to discuss a group of findings to support the need for such an approach, elicit a fresh perspective to the research areas already established, and introduce a work in progress.

This thesis has the following objectives:

i. Find out how user-centred design (UCD) is applied in healthcare information and communication technology (ICT) development. Acquaint ourselves with the domain of user-oriented research in the health informatics field by the following:
   - Describe the *healthcare ICT development* research domain and identify the main challenges underlying the healthcare ICT development, and
   - Conduct a "state of the art" literature review and describe the current state of *user-oriented research* in the healthcare technology domain.

ii. Conceptually and thematically analyze the research domain of healthcare ICT development from a user-centred design perspective.

iii. Describe an initial conceptual framework for a user-centred approach to healthcare ICT development.

iv. Based on the findings, illustrate directions for further scientific contribution.

The reminder of this is divided into seven chapters:

Background: This chapter gives an overview of healthcare information technology development and the adaptation phenomenon through a focused literature review, and describes the changing role of healthcare ICT and the main challenges for ICT development.

Review of User-oriented Research in the Healthcare ICT Domain: After outlining the fundamentals, this chapter aims at increasing the understanding of healthcare ICT use and development from the users' perspective by describing the "state of the art" research reviews. Based on the literature review and analysis, the current state of user-oriented research in the healthcare ICT field is described. The analysis provides brief answers to the following questions: What has been studied and how? What are the main results? What are the indications for further research? What is the current state of user-oriented research in healthcare ICT development in general?

Analyzing the Healthcare ICT Development from the UCD Perspective: The importance of, and the need for, a user-oriented approach to healthcare ICT development seems to be commonly understood; however, the academic researchers have proposed few concrete suggestions for courses of action and approaches how to systematically analyze the research area. To bring the two research areas of health informatics and user-centred design closer to each other, this chapter introduces a user-centred design approach on interactive system development with reflections on the healthcare context.

DeHus – A User-centred Framework for Healthcare ICT Design: This chapter describes three distinct contexts of healthcare ICT design and presents an initial conceptual framework of a user-centred approach for healthcare ICT development. The objective is to ground the fundamentals for applying a user-centred design approach in the development of healthcare information and communication technologies.

Conclusions, *Discussion*, and *Thesis Summary and Further Research:* These chapters present the main contributions of the work, discuss several themes related to the conducted research, summarize the thesis, and describe how the user-centred framework for healthcare ICT design is to be evaluated and developed further.

2. Background

A revolution is taking place in the healthcare industry, with information and communication technology (ICT) playing an increasingly significant role in its delivery. *Healthcare information technology* is typically used to describe hospital computer systems with functions like patient admission and discharge, order entry for laboratory tests or medications, and billing functions (Coeira, 2005). These systems include electronic patient record systems, clinical decision support systems, computerized provider order entry, and picture archiving and communications systems (Hackbart et al., 2004).

Today, healthcare ICT covers a wide range of systems, applications, and services targeted for a variety of users for diverse purposes of use. The question arises: How has the development of healthcare technology gotten here and where is it going next? This section gives an overview of technology development and adaptation in the field of healthcare delivery through a focused literature review. The story of healthcare ICT development starts in the early 1960s and ends up with a discussion about the prevailing trends. This chapter covers the following themes: introduction to information system development in healthcare, challenges in healthcare information technology (IT) development from the user's perspective, the patient-centred approach in healthcare, emerging ICT advances, eHealth and consumer health technologies, an overview of healthcare ICT use and development in Finland, and future views in healthcare ICT development.

2.1. Introduction to Information System Development in Healthcare

According to Davis (1973), the timely delivery of relevant needed information to the appropriate healthcare professional is what healthcare information systems are all about. The definition highlights some of the specific characteristics that differentiate the healthcare delivery organization from other service and product organizations. These specific characteristics are related to the complexity and diversity of healthcare production (PAHO, 1999), resource constraints (Nemeth et al., 2005), and governmental and professional regulation (Nemeth et al., 2005). Likewise, clinical processes share characteristics that are only typical for the healthcare delivery domain: a high degree of communication and cooperation among professional workers (Lenz et al., 2002) and diverse and dynamic working practices (PAHO, 1999; Davis, 1973).

The requirements for an appropriate healthcare information system derive from these previously described characteristics and can be summarized as follows: To support healthcare delivery, healthcare information systems need to

- be highly interoperable (Weber-Jahnke & Price, 2007),
- have the ability to capture and deliver data at the point of service (PAHO, 1999),
- support concurrent and multicentric clinical and administrative information utilization (PAHO, 1999),
- effectively manage complex information of great sensitivity (Weber-Jahnke & Price, 2007),
- support healthcare processes by enabling a seamless information flow between different participants and different locations (Lenz et al., 2002),
- support intensive data manipulation (PAHO, 1999), and
- provide facilities to support synchronous decision making (PAHO, 1999).

2.1.1. *History of Healthcare Information System Development in Brief*

The history of healthcare information system development reaches about 50 years back. Experiments with computerized medical record keeping began in the 1960s (Goldschmidt, 2005). At the same time, the concept *health informatics* seemed to find a permanent position amongst academic interest groups (Wilson et al., 2004). By the mid-70s, computers were widely used in hospitals (Goldschmidt, 2005), as the benefits of using information technology to manage the complex and diverse work environment of hospitals became evident. In the early 80s, the framework of medical information science was vacillating (Blum, 1984), although it was clear that the use of computers would continue to have a major impact on medicine and healthcare delivery.

In the 1980s healthcare organizations followed the introduction of personal computers, and physicians began adopting electronic health record systems (Goldschmidt, 2005). Since then various healthcare information systems and applications for diverse practice settings and physician specialties have been developed to serve the healthcare professional's needs. However, these stand-alone applications poorly supported patient data exchange between hospital units and healthcare parties. The quest for integrated records that could follow the patient within the healthcare delivery system was announced. In the early 1970s, Davis (1973) described the reasons underlying this fundamental challenge as follows: Because there is no operational comprehensive healthcare information system, there is little realistic insight or understanding of their full potential.

2.1.2. *The Holy Grail of Electronic Healthcare – EHRs*

In the literature, the concept of the electronic health record system (EHRs) covers a wide range of different information systems, from files compiled in single departments to longitudinal collections of patient data (Häyrinen et al., 2008). Already in the late 1990s, EMRs were identified as "essential" (Dick et al., 1997) or "at the heart of the application of IT in healthcare" (Grimson et al., 2000).

Today, the range of EHR applications already in place is described as being huge (Wilson et al., 2004). Healthcare professionals use patient records as their principal information repository. In primary, secondary, and tertiary care EHRs are used for purposes of setting objectives, planning patient care, documenting the delivery of care, and assessing the outcomes of care (e.g., Häyrinen et al., 2008). Because EHRs are designed and targeted for hospital inside use, healthcare professionals are the primary users of such systems. In addition to physicians and nurses, EHR systems are used by laboratory and radiology staff, administrative staff, and secretarial staff (Häyrinen et al., 2008).

2.1.3. *Current State of Information Technology Exploitation*

Healthcare information technology development has followed the general evolutionary trends of all information systems. This evolution has been characterized with a shift from an extensive use of central computer stations to microcomputers, connecting these into networks, and developing multimedia-enhanced workstations (PAHO, 1999). New technological advances are continuously occurring in healthcare. Consequently, health informatics is seen to have an important role in the future shaping of our healthcare delivery system (Berg, 2002).

By the 21st century, information technology in healthcare has gained widespread usage. Today EHRs are widely adopted in rich countries. While nation-wide EHRs are still less common, various kinds of organization-wide and departmental record systems have now been in use for a long time. For instance, in Finland, EHRs are now in comprehensive usage both in hospitals and primary care, and electronic information exchange between organizations has progressed rapidly (Winblad et al., 2008). Nation-wide healthcare information infrastructure projects and strategies are under development in many countries, including England (Health Committee, 2007) and Finland (Ruotsalainen et al., 2008; Iivari & Ruotsalainen, 2007).

2.1.4. *Reasons behind Technology Adaptation*

Many countries have invested significant resources in EHRs to provide clinicians with improved access to relevant patient data and decision support. But, what are the main reasons for adapting information technology in healthcare? What benefits are expected from healthcare information technology usage?

The principal forces driving the adaptation of healthcare information technology are the transformation of healthcare delivery systems and productivity growth (Goldschmidt, 2005). A vision of changes presumes that information technology can transform the healthcare delivery systems – thereby simultaneously improving quality and productivity. The expectation of product growth achievements seems to derive from other industries that have made extensive use of information technology. Besides, promises and possible benefits underlying healthcare information technology adaptation are manifold (Goldschmidt, 2005): reduced experiences associated with record keeping, improved workflows, automated sharing of information among providers and patients, direct access and instant updates to records, more accurate and better structured clinical data and documentation, automatic sorting and summarization of data, fewer dangerous medical mistakes, and continuous improvement in clinical decision making.

Healthcare information technology adaptation has inspired many researchers to explore this evolving area and associated benefits. Literature reviews have indicated that benefits are clear, at least in theory. Chaudhry et al. (2006) explored the effects of healthcare information technology on quality and efficiency of healthcare, and found evidence for technology adaptation decreasing medication errors and increasing the adherence to guideline-based care. Additionally, compared to paper-based information management, technology seems to provide support for new ways of delivering care. Furthermore, several studies have indicated that the use of an information system was conductive to more complete documentation by healthcare professionals (Häyrinen et al., 2008). In this sense, the success of EHRs depends on the quality of the information available to healthcare professionals in making decisions and communicating with each other during patient care.

Although healthcare information technology benefits seem to be obvious in theory, they are not clearly associated in operating situations in a healthcare context of use. Several studies have pointed out increases in physician time related to computer use (Tierney et al., 1993; Overhage et al., 2001; Pizziferri et al., 2005; Poissant et al., 2005). There also seems to be a lack of evidence of the value of healthcare information technology in support of decision making (Johnston et al., 2002; Chaudhry et al., 2006). Researchers have argued that electronic healthcare records need to be better adapted in the way that relevant information is

recorded (Spies et al., 2004). Additionally, study results indicate that physicians may be reluctant to implement an IT system that interferes with their traditional routines (Chau & Hu, 2002). Interestingly, however, some studies have indicated that the user's attitude towards the healthcare information systems seems to be positive (van der Meijden et al., 2003; Moody et al., 2004; Häyrinen et al., 2008), while others have reported negative experiences (Darbyshire, 2004; Jensen et al., 2007).

Based on their systematic reviews, both Chaudhry et al. (2006) and Häyrinen et al., (2008) concluded that technology-related effects on efficiency in use were mixed. Likewise, the impacts on other aspects of information system success factors were not obvious. These confusing findings encouraged the researchers to argue that there is no reliable data available about: 1) the effectiveness of healthcare information technologies in the practice settings where most healthcare is delivered, and 2) how these tools are used and the context in which they are implemented (Chaudhry et al., 2006). This argument has been supported by Jaded and Delamonte (2004), who became disappointed because their research about "How had the innovations lived up to their promise?" did not result in any evidence on whether the technology use had actually improved patient care in practice. Although the adoption of healthcare technologies is widely supported, the critical question remaining is: What will be the benefits of these initiatives?

2.2. Challenges in Healthcare IT Development from a User´s Perspective

It has been argued that successful implementation of information systems in healthcare organizations appears to be a difficult task, with many issues of integration still remaining to be solved. Kuhn and Giuse (2001) have stated that in spite of demonstrated healthcare information systems benefits, there are even more severe problems than the reports on success suggest.

Several researchers have pointed out challenges for healthcare information system development. In 2000 Grimson et al. (2000) stated that, due to the special traits of the healthcare sector, the main challenges related to the use of information technology in healthcare are: a) the complexity of medical data, b) data entry problems, c) security and confidentiality concerns, d) the absence of a unique national patient identifier, and e) a general lack of awareness of the benefits and risks of information technology. According to Berg (2003), information technology can bring true process support to healthcare only when two principles are taken into account: 1) the appropriate distribution of tasks between professionals and the IT applications, and 2) sufficient resources and skills for healthcare professionals to adapt IT application's demands to the needs of their work practices. Also,

Nemeth et al. (2005) have argued that understanding the role of IT in healthcare requires knowledge of the cognitive work that the system is intended to support. Taken together, several currently established challenges seem to be related to user issue considerations in healthcare IT development. In the following sections these challenges are described in more detail.

Interoperability and integration of separate systems

Several researchers have suggested that the issues of interoperability and integration of separate healthcare information systems remain generally unsolved as of today (e.g., Chaudhry et al., 2006; The Joint Commission, 2008; Khoumbati & Themistocleous, 2006; McDonald, 1997; Lenz et al., 2002; Kuhn & Giuse, 2001). Constructing EHRs has proven difficult because of the existing electronic data sources. A lack of interoperability between healthcare information technology systems and devices slows the workflow of healthcare providers (The Joint Commission, 2008) and has effects on successful utilization of new electronic services in hospitals (Lähteenmäki et al., 2008). To accelerate the EHR deployment, McDonald (1997) has suggested that instead of focusing on the EHRs, the attention should be paid to the development of interfaces. According to Braller (2005), interoperability is a fundamental requirement for the healthcare system to derive the benefits promised by the adoption of EHRs.

Implementation

Also, successful healthcare information system implementation in healthcare organizations appears to be a difficult task. Berg (2001) has discussed three myths that often make the implementation processes difficult. Those myths are: 1) During the implementation process, both the organization and the technology transform each other. 2) A process requires proper support by both central management and future users. 3) The appropriate management actions should concentrate on balancing initial organizational change and information system-oriented change. This argument has been supported by other researchers: successful implementation of healthcare information technology is not possible if its developers and users do not work together to have comprehensive insight into its capabilities and limitations (Thielst et al., 2008; Lenz et al., 2007).

User issue considerations

According to Zhang (2005), designing and implementing a healthcare information system is not so much an IT project as a human project. Supported by several other researchers (Kuhn & Giuse, 2001; Gruchmann & Borgert, 2007; Paulus et al., 2008), Zhang has emphasized the need for human factor considerations and promoted the adoption of usability aspects during the healthcare information system development process.

One of the biggest risks faced in healthcare information technology development seems to be the insufficient understanding of complex healthcare environments and processes. In the early 90s, Rector et al. (1992) wondered about the possible explanations for the undeniable fact that the healthcare information community has not been notably successful in producing systems that are widely used in routine medical practices. They came to the following conclusions:

> *It is all too easy to blame the doctors for the difficulties, adopting wrong attitudes. The alternative explanation for this lack of success is that our systems have rarely actually met medical requirements or been usable in clinical conditions.*

Many researchers have strongly emphasized that the healthcare information systems should be understood as complex sociotechnical systems (Berg et al., 1998; Effken 2002; Kuhn & Giuse, 2001; Giuse & Kuhn, 2003). Therefore, the software development and integration in healthcare have to be based on an understanding of a variety of user groups and their needs, and the dynamic context of healthcare work that is characterized by a diversity of processes (e.g., Häkkinen & Korpela, 2007; Häyrinen et al., 2008; Tang et al., 2006). According to this view, new analytical approaches are needed to encompass the complexity of changing systems and multiple interacting users (Effken, 2002). For the reason that much of the healthcare work is collaborative, the information system should support communication among healthcare professionals as its core mission (Walldén et al., 2007a; Weng et al., 2007; Giuse & Kuhn, 2003).

Sufficient level of expertise and cooperative development

Interestingly, both Jaded and Delamothe (2008) and Hersh and Wright (2008) have recently expressed their concern about the lack of expertise and specialized workforce dealing with healthcare information technology development. Hersh and Wright (2008) insist that increasing attention must be paid to the workforce development, implementation, and evaluation of applications.

Tang et al. (2006) have argued that multiple stakeholders – patients, providers, employers, payers, governments, and research institutions – must play key roles in developing healthcare information technology more fully and to overcome the barriers to widespread adoption. The argument has been supported by other researchers (Kuhn & Giuse, 2001; Giuse & Kuhn, 2003; Häkkinen & Korpela, 2007), who also have suggested several concrete actions: the adoption of highly participatory and evolutionary software engineering processes, cooperative work practices, and methods combining user participation with recognition of the specific healthcare context.

2.3. The Patient-centred Approach in Healthcare

In the year 2002, Haux et al. (2002) suggested that three major goals will guide the healthcare delivery development in the near future: patient-centred recording, use of medical data for cooperative care, and a framework for networked patient-centred healthcare. In the early 2000s, several visions of patient-centred healthcare were presented (e.g., Davis et al., 2004; Delbanco et al., 2001; Haux et al., 2002). These visions are characterized by the following aspects: a) information delivery and communication between clinicians and patients and other involved parties (e.g., family and social workers), b) coordination of care, and c) cooperative care. The visions also share the opinion of ICT having an important role in supporting the aspects of patient-centred care in practice.

Davis et al. (2004) have not only shared visions of patient-centred healthcare but also have provided ideas how to get to a patient-centred practice. The suggestions related to information technology use and rethinking of healthcare models can be summarized as the following:

- Easy access implementation on supportive resources: the physicians must be given an easy access to resources and tools they can implement easily in their practice.
- The development of new tools that give patients an access to their electronic medical records.
- Redesign of the care provided in the outpatient, hospital, and nursing home settings.
- New models of team work.

Alongside with the idea of patient-centric practices, the development of healthcare information systems is heading towards more open access on healthcare information and records. Tang et al. (2006) have described the fundamental intention of patient health record systems (PHRs), often referred to as personal record systems, as follows:

> *Patient health record systems (PHRs) are more than just static repositories for patient data; they combine data, knowledge, and software tools, which help patients to become active participants in their own care. When PHRs are integrated with electronic health record systems (EHRs), they provide greater benefits than would stand-alone systems for customers*.

Compared to EHRs, PHRs are to provide the patients with novel access to their health information and an opportunity to add their own information. Technically, PHRs can take three approaches: 1) stand-alone (customer assumes responsibility for entry and maintenance of personal health information), 2) tethered (secure access on stored information), and 3)

interconnected (consumer can access and share data from multiple sources across organizations) (Tang et al., 2006). The core functionalities of PHRs include the ability to share test results and medication information, while the more specialized take account of functions like electronic appointment scheduling, e-visits, and interacting by email with the doctor (Dimick, 2008; Wiesenthal, 2009). Accordingly, many PHRs put the patients in control of who can access their records, allowing them to share their information with providers, payers, and caregivers.

PHRs are expected to improve healthcare by sharing patient information among authorized providers. For patients and citizens, PHRs provide a great access to a wide array of credible health information, data, and knowledge. The possibility to leverage that access, together with the improved communication between healthcare professionals and patients, has the potential to improve the citizens' health and manage their diseases. PHRs are said to benefit healthcare professionals also. If the patients could do part of the documentation themselves, this would reduce the workload of healthcare professionals (Häyrinen et al., 2008). Also, the PHR-enabled communication can provide the healthcare professionals with more flexible working procedures and free resources to improve efficiency of such personal contacts (Tang et al., 2006; Wiesenthal, 2009).

However, many challenges to the deployment of PHRs seem to be similar to those for EHRs. Additionally, new potential groups of users – patients, other citizens and their supportive parties – usher in new challenges for healthcare IT development. According to Tang et al. (2006), several issues specific to PHRs are not yet well understood. These issues include citizen- or patient-related interface, technology, and access considerations on healthcare IT use. They suggest that the developers and users of EHRs and PHRs should understand individuals' and healthcare workers' mental models of healthcare process and the related workflows. Furthermore, they emphasize the need for developing an understanding of how the PHRs can fit into the flow of what individuals do on a day-to-day basis (Tang et al., 2006).

What is the current state of the patient-centred approach in healthcare? The fact that patients have a very limited access to their own health information can be considered as one salient implication of the failure of today's healthcare to provide patient-centred care and information. The widely adopted EHR systems are designed and targeted for healthcare organization's and hospital's inside use. These currently used systems do not support interaction or collaborative actions between patients and healthcare workers. They do not allow the clinicians to link the patients into their own decision-making process or collect patients' self-reported impressions of how they're doing. Nor do they support the clinicians to electronically interact with patients using smart interactivity and content.

In many rich countries the need for more open healthcare information delivery has been recognized and the idea of patient-centred healthcare is beginning to take root. Along with a number of ongoing projects in several countries, Finland and England are to develop an infrastructure for national healthcare information (Ruotsalainen et al., 2008; Health Committee, 2007). These projects share in common many elements, including the aim of involving patients in the use of their own health records. However, the question of benefits and evidence on increased quality of healthcare remains valid: What are the expected PHRs benefits and how to get there?

2.4. Emerging ICT Advances

Easy access to patient information inside hospitals seems to be one of the driving forces in healthcare technology development. Clinicians should be able to deliver and view the right information whenever and wherever it is needed: at the patient's bedside, on a doctor's desk, or anywhere in the halls. Traditionally, healthcare technology development has concentrated on developing computer-based applications and has not paid much attention to other areas of modern technologies. However, interest in the adoption of wireless and mobile technologies has recently increased in the healthcare ICT development domain.

Wireless technology and thereby enabled ubiquitous access to medical information is said to have the potentiality to meet some aspects of the growing demands on healthcare systems. The role of wireless infrastructure in healthcare applications is expected to become more prominent with an increasingly mobile society and the development of mobile and wireless networks (Vaschney, 2007). The visions of ubiquitous access to health information (Abraham et al., 2008) and pervasive healthcare (Vaschney, 2007) share many aspects in common. Ubiquitous access provides healthcare professionals with essential information and the point of care and can help reduce documentation errors and preparation time while improving information quality and nurses' working environments (Abraham et al., 2008). Pervasive healthcare means healthcare for anyone, anytime, and anywhere by removing locational, time, and other restraints while increasing both the coverage and the quality (Vaschney, 2007). Pervasive healthcare applications include pervasive health monitoring, intelligent emergency management system, pervasive healthcare data access, and ubiquitous mobile telemedicine (Vaschney, 2007). The visions also share the same challenges: lack of comprehensive coverage of wireless and mobile networks, uncertain reliability of wireless infrastructure, general limitations of handheld devices, privacy and security, and payment and management issues.

As the technologies underlying mobile phones are becoming more powerful and cheaper, the potential use of mobile phones for the delivery of healthcare services and the promotion of personal health is becoming evident. Several aspects of the impact of mobile phones on personal health are self-evident, e.g., greater ease with reaching, messaging, and utilizing mobile phone applications in care (Patrick et al., 2008). Currently, many rich countries are investing heavily in the communication infrastructure of their healthcare delivery system. Communication technology has provided standardized healthcare-related communication protocols, which enable the exchange of all kinds of information among healthcare parties (Ammenwerth et al., 2004). Healthcare organizations are concerned with each other and how they can exchange services and necessary patient information (PAHO, 1999).

2.5. eHealth and Consumer Health Technologies

The development of technologies to support citizen knowledge and participation in healthcare has increased dramatically since the advent of personal computers and mobile devices. The widespread adaptation of healthcare information and communication technologies is said to have the potential to transform healthcare delivery and change the traditional roles and responsibilities of healthcare professionals. These implications include the idea of providing citizens an active role in their own wellbeing and care, and shifting more care to the home. Indeed, in the discussions of healthcare ICT future the concepts *eHealth* and *citizen involvement* are often referred to.

eHealth, telehealth, and telemedicine – these are the often used concepts describing the emerging ICT-supported practices and activities in healthcare. *Telehealth* is generally understood as "healthcare at a distance" and compared to telemedicine emphasizes the inclusiveness of telehealth in contrast to the medical focus (Mitchell, 1999). The concept of electronic health or *eHealth* has many definitions (Pagliari et al., 2005) and is often used as an umbrella term to encompass ICT and telehealth (Mitchell, 1999).

According to Mitchell (1999), eHealth describes the combined use of electronic communication and information technology in the healthcare sector for clinical, educational, and administrative purposes, both at the local site and at a distance. This definition shares many features with the one provided by the European Commission (2003):

> *e-Health refers to the use of modern information and communication technologies to meet needs of citizens, patients, healthcare professionals, healthcare providers, as well as policy makers.*

A research report provided by the European Institute of Public Administration (Wilson et al., 2004) considers the concept from various perspectives, and thereby supplements the previous definitions by stating that

> *eHealth is a shorthand label for the wide range of uses to which information technologies are put in the healthcare settings.*

In general, most conceptualize eHealth as a broad range of healthcare technology applications that facilitate the management and delivery of healthcare (Pagliari et al., 2005). eHealth is said to cover applications ranging from simple administrative tools, such as booking and referral systems, to integrated information tools that allow secure access to personal health data for those delivering healthcare (Wilson et al., 2004). Additionally, from the viewpoint of healthcare workers, eHealth is thought to cover complex clinical applications which can support the clinicians in diagnosis and treatment. For citizens and patients, eHealth could provide ultimate support for their own treatment (Wilson et al., 2004).

Generally speaking, eHealth is expected to improve the quality of care, while simultaneously lowering costs for complex cases (e.g., Pagliari et al., 2005). In many European countries a number of eHealth information tools and services for citizens are already in use (Wilson et al., 2004). These tools include portals and websites to deliver information and applications that support healthcare professionals in the delivery of care. Some evidence on the expected benefits have already been established: over the last few decades, eHealth has shown successful examples particularly in areas where low population density makes it necessary to find alternatives to long transportations (Clemensen et al., 2004).

Along with eHealth the involvement of citizens in healthcare is now policy within many countries (Boote et al., 2002; Health Committee, 2007; Ruotsalainen et al., 2008). Many envision a healthcare industry that is citizen-centric and information-rich, producing a world in which the support for wellbeing and healthcare follows the citizens and information tools guide medical decisions (Thompson & Bailer, 2004).

Today, several concepts are used to describe these evolving trends in healthcare. These concepts include consumer health informatics, patient-centred medical home, and citizen empowerment. The concept *consumer health informatics* has been presented to describe the *citizen empowerment* and their access to healthcare through the use of emerging information and communication technology (Health Canada, 2000; McDaniel et al., 2008). *Patient-centred medical home* represents a new idea of a transformative healthcare innovation (Berenson et al., 2008) and is taking center stage in discussions of primary care innovation as a new delivery model that provides comprehensive, coordinated care over the lifespan

(Rittenhouse et al., 2008). Beal et al. (2007) have defined *medical home* as a healthcare setting that provides patients with timely, well-organized care and enhanced access to providers. By definition, the medical home would have the following characteristics: citizens have a regular provider or place of care; they experience no difficulty contacting their provider by phone; they experience no difficulty getting care or advice on weekends or evenings; their office visits are always well-organized and on schedule.

In general, the adaptation of consumer health technologies and medical home has been strongly supported. The report, provided by The Commonwealth Fund, suggests that all providers should take steps to help create medical homes for patients (Beal et al., 2007). The consultative report describing the value of provider-to-provider telehealth technologies (Cusack et al., 2007) supports this suggestion and encourages the healthcare stakeholders, providers, and payers not to worry whether telehealth might lead to an increase in the number of visits or increase utilization from demands previously unmet. The report assumes that any of those increases are to be overshadowed by the dramatic reduction in costs associated with decreased unnecessary tests, improved disease prevention, and improved chronic disease management. At the present state, however, there seems to be a gap between current and potential use of healthcare ICT among healthcare organizations and practitioners. Rittenhouse et al. (2008) have found that although the large medical groups have the highest levels of medical home infrastructure, the adoption is slow and the extent to which the infrastructure is in place to function as medical home is not known.

2.6. An Overview of Healthcare ICT Use and Development in Finland

Nation-wide healthcare information infrastructure projects and strategies are under development in many countries. In England the new national broadband network has been completed but completing the important components of the national care record has proved to be challenging (Health Committee, 2007). Also in Finland, the implementation of the national healthcare information infrastructure has turned out to be demanding (Ruotsalainen et al., 2008), although EHRs are in use at almost every health centre (Iivari & Ruotsalainen, 2007).

In Finland the strategy for utilizing information technology in the field of social welfare and healthcare was published in 1996 and redefined in the year 2006 (Ruotsalainen et al., 2008). The updated strategy defines the principles for how digitized health records should be stored, accessed, disclosed, and archived. The implementation of citizens' access to health information – including the patient's and other citizens' access to their own EHRs, ePrescriptions and audit-logs via the Internet – is also a part of these future actions.

At the present state, the Finnish EHR-archives contain only information created by a healthcare professional. As argued in the paper about Finland's strategy and implementation of citizens' access to healthcare information (Ruotsalainen et al., 2008), more comprehensive information is needed for healthcare promotion, proactive prevention, and health prediction. Therefore, the next step is to develop legislation and to build a trusted environment for the use and access of heterogeneous healthcare and welfare information.

Finland has taken the initiative to build a national archive for electronic healthcare data with citizen access by the year 2011 (Reponen et al., 2008). The aim of these actions is to 1) create a new working environment for professionals by incorporation of innovative information and communication technology, new organization of work and re-engineering of workflows and 2) offer the citizens a possibility to actively participate in decisions on their care, carry out guided self-care, and take steps of proactive prevention (Harmo & Ruotsalainen, 2006). In more detail, the plan is to provide citizens with

- reliable information on the following: health promotion, the symptoms and treatment of illnesses, service providers in the public, private, and third sectors, the content, availability, cost, and quality of service, and their benefits and rights, and
- a variety of interactive services, such as appointment booking, consultation, interpreter services, Q&A, virtual discussion forums, and self-help systems for chronic illnesses. (Iivari & Ruotsalainen, 2007)

In recent years, the following progression has been reported. In 2003, a national EHR system development project (2003–07) was set up as part of the National Health Program (Iivari & Ruotsalainen, 2007). In 2005 the usage of eHealth applications had greatly progressed throughout the entire healthcare delivery system (Reponen et al., 2008). By 2007, EHRs were in use at almost every health centre. At the same time, the already comprehensive basic IT infrastructure in healthcare was seen as a strength in the further development of eHealth. Likewise, electronic information exchange between organizations had progressed rapidly: at the present moment, fully interoperable patient data exchange is regionally in operational use in most of the healthcare institutions (Winblad et al., 2008).

Nevertheless, some shortcomings and disappointments have appeared. By the year 2007, direct eServices to citizens (such as electronic appointment services, e-mail, or text-message communication of information exchange through web pages) were used only in a few institutions (Winblad et al., 2008). Also, significant increases in total ICT costs were reported (Winblad et al., 2008). In the year 2008 researchers reported both technical and "people"-related challenges concerning the national healthcare information infrastructure development. Based on experiences so far (2008), the implementation of a national

healthcare information infrastructure has proven demanding (Ruotsalainen et al., 2008). Beyond technical issues, it seems to be even more challenging to understand: what are the impacts of citizen access to personal health information, and what kind of services need to be developed (Ruotsalainen et al., 2008)?

2.7. Scoping the Future Views in Healthcare ICT Development

As described earlier, the areas of healthcare delivery and ICT development are both continuously evolving. Healthcare information technology has the potential to transform healthcare delivery by bringing information where it is needed and refocusing healthcare delivery around the healthcare customers.

As far as the current key challenges in healthcare sector are concerned, some changes in healthcare delivery are definitely needed. Among all others, the key challenges that healthcare sector is facing today include rising costs, medical error prevention, demanding citizens and patients, and an ageing population. It seems that several consultative reports (Wilson et al., 2004; Adams et al., 2006; The Joint Commission, 2008) argue especially on behalf of the first two challenges: rising costs and medical error prevention. These challenges are closely related to healthcare information technology development and regarding the presented review are easily agreed with.

However, the latter two challenges are not as obvious, but are easily understood in light of earlier sections about eHealth and consumer health technologies. It is a well-known fact that in Europe the society is ageing. This places high demands on the healthcare and long-term care sector and thus represents one of the key challenges for future healthcare delivery and arrangements (The Joint Commission, 2008; Gupta, 2006). Today patients are encouraged and supported in taking an active role in their own health. At the same time, it has been noticed that citizens want to be better informed about their health options and thereby ensure they have choices in treatment and support for decision making (Wilson et al., 2004). Without a doubt, citizens are becoming more demanding partners in healthcare.

Empowering and activating citizens is considered as a key competence for the healthcare future (Adams et al., 2006). One of the prerequisites for innovative care process change is engaging the citizens in behavior that mitigates disease or improves purchasing (Paulus et al., 2008). Broad integration of eHealth technologies into clinical practice could produce significant improvements in the efficiency of the healthcare system and care delivery (The Joint Commission, 2008). The increasing prevalence of chronic illness among patients served by hospitals and an ageing population should compel hospitals to pursue models of

care that would best meet the needs of patients across the care continuum, wherever those services are delivered (The Joint Commission, 2008).

The previously discussed challenges in the healthcare sector indicated rapid changes. The trajectories suggest that the benefits of healthcare information technology adaptation will be mostly realized in the next decade (Goldschmidt, 2005). The implications are likely to be so pervasive, and their primary, secondary, and subsequent-order effects so penetrating, that they will touch everyone's life and affect virtually every aspect of society.

The future scenarios describing healthcare by the year 2013 suggest that consumers will assume much greater financial oversight and responsibility for their healthcare, which, in turn, will drive the demand for value data that is readily accessible, reliable, and understandable (Adams et al., 2006). Accordingly, by 2015 chronic patients will be empowered to take control of their diseases through IT-enabled disease management programs that improve outcomes and lower costs (Adams et al., 2006). As suggested, in the future, a healthcare organization may be defined by its intellectual property, rather than its physical facility (The Joint Commission, 2008).

2.8. Summary and Concluding Remarks

Although the history of healthcare information technology reaches about 50 years back, the extent to which healthcare has adopted the use of ICT seems to be 10 to 15 years behind other industries such as banking and airlines. The evidence on benefits supporting the criteria for investments and decision making are lacking. Chaudhry et al. (2006) describe the consequences of poor data to support the decision making with the following statements. Without better information, stakeholders interested in promoting or considering adoption may not be able to determine 1) what benefits to expect from healthcare information technology use, 2) how best to implement the system in order to maximize the value derived from their investment, or 3) how to direct policy aimed at improving the quality and efficiency delivered by the health care sector as a whole. Also, Tang et al. (2006) have argued that with better understanding of the needs and benefits of electronic health record systems we could develop better enabling policies.

Patient-centred care ideology challenges the traditional ways of delivering care; the processes need to focus on communication, collaboration, and shared decision making with the patient. The applications of digital technologies are already extending the reach of hospital care into the community and into the home. Patient health record systems (PHRs) can increase a patient’s awareness of her health and help in making informed decisions. The access to one's own health information could motivate the patients or their supportive parties to actively participate in the treatment. By sharing the information and using the ICT systems

collaboratively, healthcare professionals could interact with patients in a smoother way in the doctor's reception, patient's bedside, or at medical home environments.

Although the majority of challenges related to healthcare information technology development still center on technical aspects, "people" -issues also are strongly emphasized among the research themes in general. Citizen involvement and related healthcare technologies, such as PHRs and emerging mobile health services, offer new opportunities for healthcare delivery, but raise challenges for traditional ways of developing healthcare ICT applications.

The inclusion of patients and health consumers as healthcare ICT users, besides healthcare professionals and administration, is already occurring. National healthcare information technology projects aim at developing nation-wide health record databases. However, many of those are struggling with serious challenges, a number of which are related to citizens' access to their own health information and the delivery of new eHealth services (Health Committee, 2007; Ruotsalainen et al., 2008). These projects strive for more open and interactive healthcare by providing the in-hospital records outside the walls within citizens' reach. Also, commercial organizations, notably Google and Microsoft, have launched their own online patient health records: GoogleHealth[5] and HealthValue[6]. These organizations are working in cooperation with a wide variety of partners to populate the record with useful medical data. It is interesting to see how these different strategies of citizen empowerment and thereby developed ICT infrastructures will shape the future field of healthcare delivery and services.

In words by Gupta (2006), there seem to be many opportunities which need to be explored in order to ensure that affordable, high-quality healthcare will continue to be available to all citizens. Many questions related to citizen involvement remain unanswered and bring to light concerns of patient privacy, data security, and ethical issues (Raghupathi, 1997). Also, Berg (2002) has discussed the uncertainties around citizen empowerment and easy access to one's

[5] Google Health www-pages: https://www.google.com/health

[6] Microsoft HealthValue www-pages: http://www.healthvault.com/

own health information. He does not want to question the right of the patient to own his or her own data, but is concerned about how to design this and find the right balance between legal prerequisites, the needs of citizens, and the realities of healthcare work.

Interestingly, the discussions of patient-centred care, customer health technologies and citizen involvement in healthcare raise the question of which is the appropriate term to be used when talking about these new users of healthcare ICT systems and services. It seems that each of these terms (patient, citizen, and customer) slightly emphasize different viewpoints, but none of these is quite appropriate to describe an individual healthy person, who is interested in actively participating and promoting her own health and wellbeing together with healthcare workers as well as with other related parties.

In conclusion, potential benefits of ICT-supported services in healthcare are evident, but more evidence is needed. Several studies have emphasized the need for further research in order to realize the practical benefits of technology adaptation in healthcare. A key question is: How can ICT support the healthcare sector in offering new services and becoming more efficient and effective?

As Lamminen et al., (2001) suggest in their report about follow-up study:

> *The relative benefits of various healthcare applications remain to be proven in well-conducted assessment studies, for which there is a great need in the field of healthcare ICT development.*

Indeed, the very basic questions of *for whom*, *under what conditions*, and *how* these services may relate to health outcomes, often remain unanswered.

3. Review of User-oriented Research in the Healthcare ICT Domain

What is the current state of user-oriented research in the healthcare technology domain? This chapter aims at increasing the understanding of healthcare ICT use and development by providing a general view of user-oriented study aims, approaches, methods, and results. For the purposes of the review, articles describing user-oriented studies were searched from the most essential forums of health informatics research. The criteria for selecting the articles were: a) the study has its focus on usability or user-oriented approach on healthcare ICT use and development, b) the study was reported with sufficient accuracy, and c) the article was published in recent years (in the 21st century).

Altogether 61 articles, of which 52 reported user-oriented study experiences and nine related literature surveys, were included in the review and analysis. This group was supplemented with 15 papers, reporting methodology approach on user-oriented research and development in the health informatics domain. The selected articles illustrated a variety of qualitative and quantitative research approaches on healthcare ICT use and development.

The following sections describe the review findings within three categories: use-related studies, studies reporting the development of ICT applications, and methodology considerations. The later sections discuss and summarize the findings.

3.1. Use-related Studies

A group of studies have explored users' opinions about the adaptation and use of healthcare technologies. As expected, most of the studies concentrate on healthcare professionals' viewpoint. Interestingly, both negative and positive attitudes and experiences have been reported.

3.1.1. User Acceptance and Attitudes

Moody et al. (2004) and Darbyshire (2004) explored nurses' attitudes and preferences towards EHRs. Moody et al. (2004) applied a quantitative research approach and questionnaire survey in their study. The results showed that a large percentage of the nursing staff held a positive view of the impact of EHRs on patient care. "EHR use was more of a help than hindrance to care" claimed 81% of the responders, and 75% thought EHR had improved documentation. Sixty-four percent indicated they believed the EHR system had not decreased the nursing workload. In general, nurses thought that in time, the EHR system would have a positive effect on improving patient care.

On the contrary, results by Darbyshire (2004) indicated less positive experiences. Darbyshire used a qualitative approach and focus group method in research. According to his results, nurses' experiences were characterized by digital disappointment rather than electronic efficiencies. Nurses felt that computerization had neither enhanced their clinical practice and patient care, nor had it improved patient outcomes.

Studies about healthcare workers' attitudes on healthcare technology adaptation have shown that physicians may be reluctant to accept implementation of an IT system that interferes with their traditional routines. Chau and Hu (2002) investigated physicians' decisions to accept healthcare ICT. They concluded that in regards to technology acceptance this group of healthcare professionals appears to be fairly pragmatic, concentrating on the technology's usefulness rather than on its ease of use. Furthermore, the physicians seemed to be relatively independent in making technology acceptance decisions, for instance not attaching much weight to suggestions or opinions from others.

Studies by Moody et al. (2004) and Darbyshire (2004) are not the only ones reporting mixed findings. Also Jensen and Morgunn (2007) reported both positive and negative attitudes after studying the adoption of EHRs among surgeons. Altogether, several literature reviews have confirmed mixed results (e.g., Häyrinen et al., 2008; van der Meijden et al., 2003). For example, van der Meijden et al. (2003) reviewed articles published between the time period 1991–2001 to identify attributes that were used to assess the success of patient care information systems. Their results indicated rather high user satisfaction in all but one study.

Some studies about user acceptance and attitudes have concentrated on researching communication technology use and patients' perspectives. Ilvonen et al. (2006) applied observation and interview methods to understand healthcare workers' attitudes towards a web messaging system. Their results showed that online messaging systems have improved physicians and nurse productivity, and that in physicians' opinion the online system was found suitable for replacing the more time-consuming communication practices. Hassol et al. (2004), on the other hand, conducted an online survey to research the patients' and healthcare professionals' experiences about PHRs and linked web messaging. Their findings indicated differences between the user groups. Patients' attitudes towards web messaging and online access on their electronic health records were mostly positive. This finding has been supported by Liederman and Morefield (2003), who found a high demand by patients to communicate electronically with their doctor. Instead, according to the study by Hassol et al. (2004), clinicians were less positive about using electronic communication than their patients.

3.1.2. *Experiences on Healthcare ICT Use*

Many studies of ICT use and related experiences have especially focused on healthcare information systems and studied the experiences from the healthcare professionals' perspective. In general, "ease of use" has been one of the main concerns related to healthcare information system adaptation.

Several results have indicated incompatibilities between healthcare professionals' practices and currently used information systems. In their systematic literature review analysis, van der Meijden et al. (2003) found studies that reported users' complaints about the complicated methods to enter patient data electronically. Furthermore, other studies suggested that rigidity and factors intrinsic to the system created extra work and accounted for the inconvenience. These findings might partially explain the findings reported by Hackbart et al. (2004), which indicate that physicians are more likely to use IT for administrative functions (e.g., billing and scheduling), than for clinical functions such as using health records or clinical decision support systems, or accessing to formularies or other references.

Regarding the "ease of use" of healthcare technologies, the main concern related to EHRs use seems to be the amount of time taken up by record-keeping (Häyrinen et al., 2008). Thereafter, a number of studies have especially concentrated on examining whether the use of information systems increases or decreases the documentation time in clinical settings. Based on their findings and analyses, Häyrinen et al. (2008) concluded that there is no reliable evidence that information systems can help to save time or that documentation takes more time. Results by Pizziferri et al. (2005) confirm these findings: only a third of their survey respondents reported that the EHR took the same amount or less time than paper records, although the majority of them believed that the EHR resulted in better care quality. Likewise Spies et al. (2004) found that compared to medical records, physician self-recording had more potential for valid review of a broad range of clinical decisions. Their results suggested that physicians are not prepared to invest extra time in the recording of data that do not serve immediate and clear clinical goals. Based on these findings Spies et al. (2004) emphasized the need for adapting medical records in a way such that relevant information is recorded.

To clarify the confusion and explain the mixed results, Poissant et al. (2005) examined the impacts of EHRs on documentation time. They systematically reviewed the literature to identify factors that may explain efficiency differences across studies. They found that time efficiency is only one possible outcome for which the success of EHR integration can be assessed. Accordingly, other outcomes were in-direct patient care time, user satisfaction, accuracy of the information, completeness of data entered, and the overall impact on

workflow. Poissant et al. (2005) also found that their review results indicated differences between the used ICT applications and contexts. For instance, bedside terminals and central station desktops saved nurses time spent documenting during a shift. Nevertheless, using bedside or point-of-care systems increased documentation time of physicians, and the use of central station desktops was found to be inefficient.

Although most of the previously discussed studies have focused on EHRs, other use-related experiences have been reported also. A paper by Patterson et al. (2005) studied the barriers of the effective use of clinical reminders. Despite evidence that clinical reminder systems improve adherence to guidelines, there appeared to be some challenges in having the providers to consistently use the clinical reminders as intended. Altogether 10 barriers for explaining this phenomenon were identified. Nearly all of the barriers seemed to be caused by user, social, organizational, educational, and other nontechnology factors.

The study about electronic medical summaries (Ward & Innes, 2003) is one of the few studies which has considered the patients' contribution. Using semi-structured interviews, the researchers aimed at eliciting patients' ideas about their personal medical summaries, specifically considering accuracy, level of agreement, and patients' concerns about computerization and access to their records. The results indicated that most patients welcomed the opportunity to discuss the content of the summaries with doctors, but saw the currently used summaries as a tool for the doctor's use, not for their own purposes.

3.2. Studies Reporting the Development of ICT Applications

Studies of healthcare ICT technology development cover a wide range of research approaches. Based on the review, it seems that the main reasons for conducting user-oriented studies in the healthcare ICT field are: a) to design information tools and systems for healthcare professionals, b) to research the usability and use of new technologies, and c) to investigate healthcare professionals' working practices. To give an overview of the studies, the articles were divided into five thematic groups based on their focus and the specific phase of development these studies dealt with. The following sections describe the studies and their main results. First, there is a description of the studies conducted in the early phases of system development. This section is followed by the ones reporting design and evaluation phases. Lastly, two special areas of healthcare ICT development, which currently seem to be in great interest among researchers working in the field, are presented: technology support for diabetes care and studies reporting the development of electronic health record systems.

3.2.1. Studies Conducted in the Early Phases of System Development

The studies of physicians' and nurses' working practices are the few ones reporting healthcare professionals' daily work with information systems. In their study, Reuss et al. (2007a, 2007b) applied interviews and observations in wards. Their results describe interesting findings about healthcare professionals' working practices. The healthcare professionals' work is characterized with a number of interaction patterns (Reuss et al., 2007a). Recording information can't be considered as a standardized process: the study demonstrated a variety of documenting practices (Reuss et al., 2007b). The role of worksheets in nurses' work proves to be critical as nurses use sheets during their whole shift to manage all relevant information (Reuss et al., 2007a). Based on their analysis, the researchers identified tens of requirements for systems replacing the traditional nurses' practices and interaction routines with the patient records (Reuss et al., 2007a). After these studies the researchers came up with the following conclusion: only a system that reflects the professionals' working practices will encounter their acceptance (Reuss et al., 2007a).

A group of studies have focused on investigating the healthcare professionals' information needs in order to outline fundamentals for technology development. Häkkinen and Korpela (2007) reported a study that utilized a participatory approach in describing information needs and communication problems to support the system integration in maternity clinics. Weng et al. (2007) used semi-structured interviews, observational studies, and work artefact analysis to understand the group work for a collaborative clinical trial protocol writing system development. Furthermore, Kyhlbäck and Sutter (2007) investigated the development of a municipal wound care practice using ethnographic studies before and parallel to design work. Interestingly, Kyhlbäck and Sutter found that nurses' work is essentially different from the work of office workers and machine operators, and that work practices of the municipal nurses are characterized by three distinctive features: high mobility, the need for face-to-face interaction in different locations, and a great variety of artifact usage.

Elf et al. (2007) reported a study to plan and create a conceptual model of a new stroke unit. They applied workshops and interviews to facilitate the discussions about the stroke care process as a base for decisions about the physical design. Likewise, Gil-Rodríguez et al. (2007) used an ethnographic methodology to gather information about organizational, contextual, user, and technical aspects to address key requirements for the further design of eHealth services. The study by Braun et al. (2007) is interesting in the way they investigated physicians' information needs with the objective to describe a method for formulating needs automatically. However, this attempt proved to be demanding: although a physician's information needs can be generalized, a number of identified needs are hardly manageable or even unmanageable.

3.2.2. *Studies Reporting the Design Phases*

A group of studies have reported positive findings and success in development. The Gravi project (Pohl et al., 2007) aimed at developing an information visualization application for the analysis of questionnaire data stemming from the therapy of anorectic young women. The design of the application incorporated three evaluation cycles, during which the application was redesigned and improved considerably. The researchers found the developed application very successful and proposed it could easily be used for other application areas in medicine also. Likewise, the developed palliative care severe pain management tool was found ideal for its purposes (Kuziemsky et al., 2006). The researchers believed that the information system tool was to meet the medical, technical, and social needs of a palliative information system, and thereby help to address issues of context around problematic models of care. Moreover, Gammon et al. (2005) conducted a study in a formative stage of development to test a prototype of an application designed to automatically transfer readings from a child's blood glucose monitor to their parent's mobile phone. Experiences on prototype uses, questionnaires, and interviews suggested high user enthusiasm and indicated that the developed systems might find a consumer market. Also, Nischelwitzer et al. (2007) reported positive experiences on designing a healthcare ICT application to help deal with chronic diseases in home environments. The design of a MyMobileDoc application incorporated card sorting, paper prototyping, and evaluation methods with patients and nurses during the development. The project's outcome was a simple and flexible mobile tool, which, according to the researchers, had the potential to increase patient compliance and raise acceptance.

Several studies have applied participatory assessment in the design of healthcare ICT systems (e.g., Kyhlbäck & Sutter, 2007; Waller et al., 2006; Karasti, 2001; McKay et al., 2001; Elf et al., 2007). Waller et al. (2006) developed a text message scheduling system to deliver automated text messaging support for young people with diabetes. Experiences on the project and a participatory approach on development were positive and, since then, the developed prototype has been extended to facilitate support and communication. Also, the redesign of a telecardiology system appeared successful (Karasti, 2001). To support the design process, Karasti first arranged workshops to gather information about radiologists' work practices. Potential users were actively involved in the design process. The advantages of a participatory design approach were seen as manifold: practitioners' active participation opened possibilities for design considerations and improved opportunities to avoid the presumed gap in actual design situations.

3.2.3. *Evaluation Studies*

A considerable number of user-oriented studies has concentrated on the later phases of healthcare ICT development and evaluated the usability of a system already in use. Typically, evaluation studies have focused on healthcare information systems, particularly EHRs, and their use in clinical settings (e.g., Walldén et al., 2007a; Walldén et al., 2007b; Kjeldskov et al., 2008). However, examples of other kinds of evaluations can be found also. For example, Kushniruk et al. (2005) studied the usability of a handheld prescription-writing program.

Most of the evaluation studies have applied traditional usability evaluation methods: usability inspection methods (e.g., Pohl et al., 2007; Becker, 2004) and tests with users (e.g., Nunnally et al., 2004; Kjeldskov et al., 2008; Peters et al., 2009). In contrast, studies by Giménez-Pérez et al. (2002) and Walldén et al. (2007) represent slightly different approaches. Giménez-Pérez et al. (2002) used questionnaires to evaluate the accessibility and use of new communication technologies in patients with type 1 diabetes. Furthermore, Walldén et al. (2007a) applied a variety of evaluation methods. They evaluated the usability of the information system from three perspectives, and used heuristic evaluation and observation, interviews, and questionnaire methods.

The evaluations' results have indicated a variety of usability problems and emphasized the need for usability consideration in healthcare ICT design. Among others, the following problems have been reported: complexity of information and system functions (Kjeldskov et al., 2008; Walldén et al., 2007b; Nunnally et al., 2004), poor relation to work activities (Walldén et al., 2007b; Kjeldskov et al., 2008), lack of support for mobility (Kjeldskov et al., 2008), lack of support for physician-patient communication (Walldén et al., 2007a). Researchers have also pointed out poor usability having an effect on the quality of care: careful concentration on computer use hinders the healthcare workers' ability to give care and communicate with the patients (Walldén et al., 2007a). A longitudinal study of usability suggested that some problems disappear over time, but far from all of them (Kjeldskov et al., 2008).

A few studies have evaluated the use of healthcare information systems from patients' and other citizens' viewpoint. A study by Peters et al. (2009) researched the usability of PHRs and found that from the citizens' perspective most of the usability problems were associated with navigation, data entry, and medical terminology issues. Furthermore, Becker (2004) conducted a usability evaluation study to seek the potential usability barriers facing older adult users when using www-sites that offer health resources. As a result, many of the

evaluated www-sites appeared to be not senior-friendly. In addition, approximately a third of the sites were evaluated as extremely difficult to use regarding the intended purposes.

3.2.4. Healthcare ICT in Diabetes Care – Experiments and Experiences

When considering healthcare ICT development, it is interesting to take a closer look at the field of diabetes care. The area of diabetes care seems to fascinate numerous researchers. The review indicated that a considerable number of studies, which have concentrated on examining the patients' perspective, are related to this specific area.

Diabetes mellitus continues to be one of the major chronic diseases of Western societies. The need for ICT support in diabetes care has been recognized years ago and there has been a trend towards supporting not only the members of the clinical team, but also the patients (Andreassen et al., 2002). Within the 21st century a variety of healthcare ICT applications have been under development to support diabetes care. These applications range from internet-based applications (McKay et al., 2002; McKay et al., 2001) and text messaging systems (Waller et al., 2006; Franklin et al., 2008), to stand-alone programs and systems (Keyzer, 2008; Fernandez-Luque, 2006; Gammon et al., 2005; Pendley et al., 2002).

Several researchers have reported success stories in developing healthcare ICT applications for diabetic patients. Franklin et al. (2008) developed a "Sweet Talk" text messaging system based on the idea of integrating diabetes-related information and communication into young people's everyday living. Experiences of the study encouraged the researchers to suggest that the "Sweet Talk" system had the potential to be adapted to suit other chronic disease models and age groups. Likewise, experiences on the diabetes-network solution, targeted for diabetes self-management support, emphasized the social aspects of care: the majority of participants enjoyed the interactions with their coach and other participants over the Internet (McKay et al., 2002). Results by Pendley et al. (2002) support these findings, but on the other hand argue, that to be effective, interventions aimed at peer support must mobilize the supporting actions in a way that is beneficial to the daily care regimen.

Research findings have also indicated technology solutions having a positive effect on care. McKay et al. (2001) found that regular use of an internet-based supplement to usual care derived significantly greater benefits compared to a control condition. As a conclusion, a systematic review of interactive computer-assisted technology in diabetes care, conducted in 2006 by Jackson et al. (2006), supports these study findings by indicating that in general, information technology-based interventions seem to improve healthcare utilization, behavior, attitudes, knowledge, and skills.

3.2.5. *Fundamental Challenge: Clinical Documentation and EHRs*

EHRs are increasingly being deployed within healthcare organizations to improve the safety and quality of care. However, to achieve these goals, the EHR systems must be used by clinicians. As pointed out by Poissant et al. (2005), this remains a major challenge. The question is: why? The following findings and experiences related to EHRs' use and development give some explanations for this argument.

Complete and accurate documentation is a central focus in current efforts to improve patient safety and healthcare quality (Hurley, 2008). From the beginning, EHR systems have been developed to support the documentation and information delivery between different healthcare professionals. In the late 90s Healthfield et al. (1998) and McDonald (1997) analyzed the current state of EHRs use in clinical documentation and clinical use as follows. Healthfield et al. (1998) argued that the failure to view the hospital as a system has contributed to the practice of inefficient and ineffective clinical documentation. In their opinion the current systems might improve the hospital's short-term profits, but they fail to support the best patient care overall. Likewise, in his article about "Barriers to EHRs and how to overcome them" McDonald (1997) identified two grand challenges to be solved for the ultimate medical records: 1) the efficient capture of physician-gathered information and 2) the identification of a minimum but affordable set of variables needed to assess quality and outcomes of care.

Several studies conducted in the 21st century have emphasized the need for a good fit between the EHR system and routine clinical practices (e.g., Poissant et al., 2005; van der Meijden et al., 2003; Pizziferri et al., 2005; Spies et al., 2004). However, these clinical practices are not easily defined, for the reason that EHRs are used by many different healthcare professionals. As pointed out by Häyrinen et al. (2008), the needs and requirements of all EHRs users should be taken into account in the development. Their literature review indicated that the nurses and doctors currently on the wards typically record patient data in their own separate information systems. Due to this, the use of another's documentation is difficult, which might also have an effect on patient care. Based on this and other findings presented in earlier sections, it seems that the development of EHRs to serve the healthcare workers in their operative work with patients still remains a fundamental challenge for healthcare ICT development.

3.3. Methodology Considerations

The conducted literature review indicated that from the methodology viewpoint several trends in the field of user-oriented healthcare ICT development can be identified. This section examines those trends and discusses the literature review findings within two themes: 1) summation of applied research approaches and methods, and 2) suggested methodology approaches.

3.3.1. Summation of Applied Research Approaches and Methods

As the previous sections have indicated, a number of methodology approaches have been applied when involving users in healthcare ICT development. A considerable number of the reviewed studies reported evaluation of a system already in use (Walldén et al., 2007a; Walldén et al., 2007b; Kjeldskov et al., 2008; Nunnally et al., 2004; Peters et al., 2009; Moody et al., 2004), testing on trial stages (Waller et al., 2006; Gammon et al., 2005; McKay et al., 2001; Liederman & Morefield, 2003; Franklin et al., 2008; McKay et al., 2002), or prototype evaluation (Weng et al., 2007; Kyhlbäck & Sutter, 2007; Nischelwitzer et al., 2007; Gruchmann & Borgent, 2007).

Many of the studies applied traditional usability evaluation methods, which have been described in the area of usability research; usability tests with users (Nielsen, 1993) and usability inspections (Nielsen, 1993). However, also methods and approaches to support the design phases were reported. Based on the review, it seems that participatory assessment, described by Schuler and Namioka (1993), has gained interest within recent years in the healthcare field, whereupon a group of studies reported participatory design activities (Kyhlbäck & Sutter, 2007; Weng et al., 2007; Waller et al., 2006; Nischelwitzer et al., 2007). Also, other methods such as card sorting (Nischelwitzer et al., 2007), paper prototyping (Nischelwitzer et al., 2007), focus groups (Pohl et al., 2007; Darbyshire, 2004), and ethnographic studies (Kyhlbäck & Sutter, 2007) were mentioned.

Especially the studies conducted in the early phases of design emphasized a qualitative research approach. These studies focused on investigating the healthcare professionals' working practices (Reuss et al., 2007a; Reuss et al., 2007b; Braun et al., 2007; Elf et al., 2007) and requirements elicitation (Gil-Rodriquez et al., 2007; Häkkinen & Korpela, 2007; Kuziemsky et al., 2006), and mostly applied variations of observation and interview methodologies. However, some of the studies applied a quantitative approach on research and analysis (e.g., McKay et al., 2001; Kyhlbäck & Sutter, 2007; Moody et al., 2004). A quantitative research approach was particularly emphasized on studies that focused on citizens' or patients' perspectives (Franklin et al., 2008; Liederman & Morefield, 2003;

McKay et al., 2001; McKay et al., 2002; Hassol et al., 2004). Furthermore, qualitative methods used for investigating the patients' or citizens' perspective included questionnaires (Giménez-Peréz et al., 2002; Clemensen et al., 2004), interviews (Clemensen et al., 2004, Ward & Innes, 2003; Gammon et al., 2005), observation (Clemensen et al., 2004), usability tests (Peters et al., 2009), and focus groups (Hassol et al., 2004).

As the previous findings indicate, in the field of healthcare ICT development the significance of evaluation studies has grown within the past decade. Also, literature reviews have shown that today usability tests and inspections methods, together with interviews and questionnaire surveys, are the most commonly used methods for capturing users' perspectives (Shah & Robinson, 2006; Peute et al., 2006). These reviews have also pointed out that at present users are involved mainly during the later phases of healthcare technology lifecycle: in the testing and trial stages of development. Interestingly, however, the nature of evaluation seems to be slowly changing. In 2004 Ammenwerth and Keizer (2004) found that although evaluation studies have for long been dominated by quantitative measurements (such as time measurements, user acceptance measurements, length of stay measurements, and error rate scores), qualitative methods and research approach are slowly entering the field together with the increased interest in adequate methods and approaches for evaluation.

3.3.2. Suggested Methodology Approaches

Already in the year 1990 Lowery and Martin (1990) argued that usability is a key concept in the evaluation of healthcare software. They described six major areas of healthcare software usability: logical organization of procedures, screen design for data entry, error handling, data retrieval and report generation, learning and help, and consistency. By providing a framework for evaluation, their objective was to stress usability issues of particular importance in the system evaluation and selection process, and to consolidate usability issues into categories more meaningful to healthcare managers. Since then, several researchers have in their articles discussed challenges and suggestions related to healthcare ICT design and evaluation.

Among several other researchers (e.g., Alsos & Dahl, 2008; Edwards et al., 2008), the researcher Andre Kushniruk has in his several articles (Kushniruk et al., 1997; Patel & Kushniruk, 1998; Kusniruk, 2001; Kushniruk et al., 2005) expressed his concern about the evolving field of healthcare information technology and the evolution of evaluation methods. As information technology becomes more complex, evaluation methodologies will need to be continually refined in order to keep pace (Kushniruk, 2001). Therefore, effective design and evaluation of healthcare technologies is a challenging and continually evolving process. In his article about “Evaluation in the design of health information systems” Kushniruk

(2001) argues that evaluation must be considered throughout the entire systems development: methods emerging from the field of usability engineering, in particular usability testing, are essential for conducting evaluations during the rapid development and iterative prototyping. This claim has been recently supported by Edwards et al. (2008), who have emphasized the need for predictive evaluation methods in accurately identifying usability issues that arise from the interaction, sharing, and communication requirements of clinical work. Furthermore, according to Edwards et al. (2008), future work is needed to further refine the usability evaluation methodologies for EHRs and other commercial systems.

Besides the evaluation methods, a number of researchers have concentrated on the methodology to elicit users' needs and requirements in the healthcare context. Both Malhotra et al. (2005), and Croll and Croll (2007) have stated that the methods used to derive the requirements for healthcare systems are often inadequate. According to them, the biggest risk faced in developing information systems and tools for a healthcare setting is to understand the complex environments that our health services present and ensure that the users appreciate and comply with any policies set. Within these claims, the researchers have proposed a framework for building trustworthy solutions. The model by Croll and Croll (2007) aims to provide a framework for building trustworthy solutions and is based on the investigation of four critical attributes: quality, usability, privacy, and safety. Another model, presented by Malhotra et al. (2004), differs from the traditional information system development cycle in that it includes an additional segment named "situational research". This segment is to generate knowledge pertaining to the users, policies, protocols, administration, and setup of the system.

Following the previously described examples of suggested methodology approaches, Staccini et al. (2001) have argued that the elicitation of the requirements has to meet users' needs in relation to both the quality (efficacy, safety) and the monitoring of all healthcare activities (traceability). Hence, the developers need methods to conceptualize clinical information systems that provide actors with individual benefits and guide behavioral changes. Based on these arguments, Staccini et al. (2001) have proposed a methodology to elicit and structure users' requirements. However, they concurrently admit that some aspects of activity, such as "where", "what else" and "why", are poorly represented in the suggested data model.

In contrast to other researchers, Toivanen et al. (2004) and De Rouck et al. (2008) have focused on the design of home care services and eHealth applications, and emphasized the need for a systematic approach on understanding and effectively assessing citizen users' needs and expectations. The method presented by Toivanen et al. (2004) for requirements

elicitation was based on activity theory and guided the modeling of the present state and needs from the viewpoint of the domain work activity as a whole. Likewise, De Rouck et al. (2008) have suggested a practical framework for understanding and considering user perspectives. The framework consists of three phases: 1) identify and select potential patient groups for which the technology will be developed, 2) assess the needs of selected groups, and 3) develop social use cases for a plenary discussion with the technology developers. Experiences of these actions appeared to be promising. Open interviews with real users were found useful. Social use cases proved to be an important tool to picture the daily use of potential functionalities. On the other hand, the methodology was found to be time-consuming and was thought to require scientific input to assess and to document potential user needs.

Although in the 21st century discussions about user involvement in healthcare ICT development have been dominated by evaluation methodology considerations, in recent years a participatory design approach has gained interest. Clemensen et al. (2007) have proposed that participatory design holds the potential as a research approach that might effectively merge computer technology and health-related interventional research. Also, Pilemalm and Timpka (2007) have strongly argued on behalf of participatory assessment, and suggested the use of a participatory design-based method, action design, in the design of a large-scale healthcare information system.

3.4. Discussing the Arguments for User Involvement

This section discusses the arguments on behalf of user involvement as they are presented in the reviewed articles. First, the established reasons for user involvement are described as they were presented in the reviewed articles. Then, there is a discussion about the established need for user-oriented research. Furthermore, the last section deals with experiences on user involvement and applied methods.

3.4.1. Reasons for Involving Users in Studies

Some of the reviewed articles described reasons for involving users in research and development studies. The reasoning for involving users in studies before or in the early phases of the development included the following:

- Understand the healthcare workers' attitudes towards healthcare ICT systems (Thielst et al., 2008).
- Provide information on healthcare workers' daily practices (Reuss et al., 2007a; Reuss et al., 2007b).
- Deeply understand the driving forces of change and transformation of work (Kyhlbäck & Sutter, 2007).
- Identify physicians' information needs (Braun et al., 2007).
- Understand and elicit design requirements for design (Kuziemsky et al., 2006; Gil-Rodriquez et al., 2007; Elf et al., 2007).
- Generate innovative thoughts (Häkkinen & Korpela, 2007).
- Learn more about the user's satisfaction and system use (Hassol et al., 2004).

Instead, other studies hardly presented any argumentation for involving users in research, rather described some argumentations for selected methodology approaches. Participatory methods were thought to help deliver a prototype for a medical software product with high functionality and usability (Waller et al., 2006). Some of the studies applied a variety of evaluation methods, including inspections and interviews with users, to perceive a comprehensive picture of the evaluated system and its use (Pohl et al., 2007; Walldén et al., 2007a).

These findings suggest that the reasons for involving users in development are not explicitly articulated, and thus the inclusion of user participation in development process seems to be less systematic. Interestingly, the objectives of user involvement were more clearly expressed in studies that were conducted in the early phases of development. Compared to

the findings of user-oriented review, this is a rather contradictory result, hence other studies (Shah & Robinson, 2006; Ammenwerth & Keizer, 2004; Edwards et al., 2008) have indicated that most commonly used methods for capturing users' perspectives are usability tests, and that users are typically involved in the later phases of development.

3.4.2. *Experiences on User Involvement and Applied Methods*

Experiences on user involvement and applied methods were encouraging, if only a few articles described or evaluated the effects of these actions. The ethnographic approach and therewith applied methods (interviews, observations, and artifact analysis) helped to efficiently explain the relevant work practice (Weng et al., 2007). Paper prototyping proved an effective and inexpensive way to evaluate both content and navigation structure (Nischelwitzer et al., 2007). Card sorting illustrated how users categorize potential system functions and menu entries, and thus provided the researchers some understanding of the mental models of the potential users (Nischelwitzer et al., 2007).

Experiences on an participatory approach on development and evaluation were highly positive. Participatory design methods were thought to engage users in design (Weng et al., 2007), bring out the users' tacit work knowledge (Weng et al., 2007; Hyysalo et al., 2007; Kyhlbäck & Sutter, 2007), and open possibilities for design considerations (Hyysalo et al., 2007; Kyhlbäck & Sutter, 2007). Furthermore, participatory design was supposed to provide opportunities for avoiding the presumed gaps in actual design situations (Hyysalo et al., 2007; Kyhlbäck & Sutter, 2007). Pohl et al. (2007) concluded that usability evaluations with users, conducted in various phases of a project, enabled the researchers to improve the developed application considerably.

Only a few studies reported challenges for applying user involvement methods. Spies et al. (2004) pointed out that observation of practices is very time-consuming, and thus used structured recording forms and non-participating observation in their study. Walldén et al. (2007a) argued that since the usability of a system is closely related to the context of use, it is difficult to generalize the results. For this reason, several evaluation methods were used to complete each other with their different outcomes.

Based on user-oriented review analysis, only a few researchers have systematically investigated the practices and effects on user involvement in the healthcare technology domain. Shah and Robinson (2006; 2007) conducted literature reviews to research the practices on involvement and associated benefits and barriers of these actions. Their review (Shah & Robinson, 2007) on the benefits of and barriers to involving users in medical technology development and evaluation revealed that the main benefits of user involvement were associated with an increased access to user needs and experiences, enhancements in

design and user interfaces, and improvements in the functionality, usability, and quality of applications. On the other hand, the literature review found some key impediments to involving users: lack of resources, communication and cooperation between users and developers, attitudes of technical developers, lack of understanding and appropriate knowledge about methods to be used (Shah & Robinson, 2007).

The presented user-oriented research review findings are consistent with those of Shah and Robinson (2006; 2007), although the reviewed studies did not report negative experiences or barriers to user involvement. The results by Shah and Robinson are important and interesting from the viewpoints of both healthcare ICT development and user-centred design research.

3.4.3. Established Need for and Challenges of User-oriented Research

Why bother considering users in healthcare ICT development? The reviewed articles suggested among all the following reasons:

> *The starting point for development should be through insight into the healthcare work practices where the information systems are to be used*. (Nykänen & Karimaa, 2006)
>
> *Only a system that reflects the professionals' working practices will encounter their acceptance*. (Reuss et al., 2007a)
>
> *Factors of usability and ergonomics are of key importance for the adoption of medical information system solutions in practice.* (Weber-Jahnke & Price, 2007)
>
> *In order to avoid the currently faced dissatisfaction and abandonment, significant attention should be paid to user-centred design guidelines during healthcare information system development*. (Johnson et al., 2005)
>
> *The design of successful user interfaces poses one of the most important challenges in the area of health informatics*. (Patel & Kushniruk, 1998)
>
> *Commitment to usability in medical product design and development offers enormous benefits, including greater user productivity, more comprehensive products, lower support costs, and more efficient development process*. (Gruchmann & Borgent, 2007)

The need for user involvement seems to be clearly established, however, several researchers working in the area of user-oriented healthcare ICT domain have highlighted the need for a more systematic approach on user perspectives throughout the development process. Among

others, Zhang (2005) has expressed his concern and experiences on the current state of user considerations in healthcare technology development as follow:

> *In healthcare the culture is still to train people to adapt to poorly designed technology, rather than to design technology to fit people's characteristics.*

This claim has been supported by De Rouck et al. (2008), who argued that healthcare users still seem to be lagging behind in participation in the development of technologies. Unfortunately, these claims accord with the findings of the described user-oriented review, which clearly showed that healthcare ICT applications need to be better adapted with healthcare professionals' working practices and environments. But, how to proceed and what are the concrete actions?

Gruchmann and Borgert (2007) have suggested that the integration of usability approach is not easy, nor a straight-forward process, but requires the involvement of trained and experienced human factors specialists. Chaudhry et al. (2006) have pointed out the need for additional studies in workflow redesign and human factors realizing benefits from healthcare information technology, and consumer health technologies. Among others, Gil-Rodríguez et al. (2007) argue that the study of organizational, contextual, and user variables affecting the technological innovation implementation is vital in order to guarantee that those innovations respond to existing problems in the healthcare system. Similarly, Paavola (2008) has concluded that the success in IT projects often requires knowledge not only of the technology – the applications, hardware and architecture – but also of the users, the procedures, and the business.

The reasons for considering the healthcare professionals' perspective in development seem to be well explained. However, in the near future, healthcare technologies will be increasingly integrated in the daily lives of patients and other citizens. Chaudhry et al. (2006) have argued that the main challenge for ongoing national healthcare technology projects is to take into account the different types of currently used information systems and the needs and requirements of different healthcare professionals and citizens. This argument has been supported by Jaded and Delamonte (2004), who have pointed out that to make sure all users can make use of healthcare ICT applications it is important to consider the role of the different modalities, the user-friendliness of different devices, and the devices' ability to meet the needs of people with disabilities.

3.5. Summary and Conclusions

From the viewpoint of user-oriented research, the experiences on EHRs adaptation and use are interesting and thought provoking. Results suggest that currently used EHRs need to be better adapted to the needs of various healthcare professionals working in clinical surroundings. Interestingly, however, many of the evaluation studies have focused on a single group of users, particularly nurses or physicians, and only a few of the studies have considered the use of EHRs in various use contexts. As pointed out by several researchers (e.g., Kjeldskov et al., 2008; Walldén et al., 2007a; Walldén et al., 2007b; Rose et al., 2005), usability problems are to hinder the use of computer systems considerably. It can therefore be assumed that major human resources in healthcare are wasted, while healthcare professionals record, search, view, and modify patient information using these poorly designed information systems.

Within recent years, usability evaluation studies have gained importance in the field of healthcare. Many researchers (e.g., Kjeldskov et al., 2008; Walldén et al., 2007a; Walldén et al., 2007b; Rose et al., 2005) have explored the use of a large-scale healthcare information systems and reported usability problems. In addition to problems, some evaluators have even suggested concrete ideas for improvements. However, little information is available to describe the effects of such actions and implications for further design and development. This discovery goes for other studies as well. In general, the reviewed user-oriented studies seemed to be narrowly-focused – aside from Kyhlbäck and Sutter (2007) and Weng et al. (2007), all other articles reported findings from short-term studies.

Interestingly, many studies about user acceptance applied quantitative research methods (e.g., Barr, 2002; Hassol et al., 2004; Franklin et al., 2008), whereas the ones concentrating on use-related experiences used a qualitative research approach (e.g., Häkkinen & Korpela, 2007; Reuss et al., 2007a). The used methodology approach and applied analysis may explain at least some of the contradictory findings and results. Generally speaking, quantitative studies, for instance structured online questionnaires, usually do not provide information that is rich enough to support design decisions during the development. In order to gather information about user and contextual aspects to address key requirements and support the development, user-oriented research needs to be explanatory or interpretative by nature. In this sense, the findings of the described user-oriented review seem to be somehow inconsistent with the literature review described by Ammenwerth and Keizer (2004), which argued that explorative studies are already common in the healthcare ICT domain.

Chaudhry et al. (2006) have argued that the benefits of healthcare information technologies are clear in theory, but there is no reliable data available about a) the effectiveness of

healthcare information technologies in the practice settings where most healthcare is delivered or b) how these tools are used and the context in which they are implemented. Findings of the described user-oriented review support this argument. While conducting the review, a miscellaneous group of articles describing healthcare ICT use and development related case studies were found. Surprisingly many of the articles pointed out the increasing demand for incorporating user perspectives in the design and development.

Taken together, it seems that the field of healthcare technology research is hungering for more systematic and extensive adoption of the user-oriented approach. The described user-oriented research review and analysis indicated that, in general, user-oriented research in the field of health informatics is characterized by the following aspects:

- *Short-period research projects*. Most of the reviewed articles describe short-term studies. The studies focus on a particular phase of development, instead of describing long-term operating cycles or experiences (e.g., Kuziemsky et al., 2006; Gammon et al., 2005; Elf et al., 2007; Nunnally et al., 2004).

- *Narrow focus on user issues*. The studies do not consider user issues broadly, but instead, focus on one of the many user-oriented aspects: a single end-user group perspective, (e.g., Reuss et al., 2007a; Moody et al., 2004; Kyhlbäck & Sutter, 2007; Spies et al., 2004), user interface components (Nischelwitzer et al., 2007; Waller et al., 2006), usability statement (Becker, 2004; Nunnally et al., 2004; Walldén et al., 2007b), or system use in a specified context (Kjeldskov et al., 2008; Weng et al., 2007).

- *Healthcare professionals as the primary research subjects*. Studies emphasize the physicians' and nurses' perspectives on ICT development (e.g., Reuss et al., 2006; Braun et al., 2007; Reuss et al., 2007; Ilvonen et al., 2006; Walldén et al., 2007a; Waller et al., 2006). Considerable less attention is paid to the other user groups for example, a) other personnel working in the healthcare environments, b) patients and their supporting parties e.g., family members, or c) citizens.

- *Isolated system development*. Studies, which report system design and evaluation activities (e.g., Pohl et al., 2007; Elf et al., 2007; Kjeldskov et al., 2008), rarely discuss a) the relationship between a single system development and the existing technology surroundings in healthcare or b) the characteristics of various use contexts.

- *Emphasis on information delivery and system development*. Although a considerable amount of research has been devoted to information system development in a

healthcare context, rather less attention has been paid to the investigation on communication technologies and their potential for supporting the healthcare professionals' work and patient-provider communication.

It would seem that the field of user-oriented research in the health informatics domain is widely recognized, but currently appears to be an unorganized area of scientific research. This is illustrated by many findings. First, while searching articles, relatively few references on a user-oriented approach on healthcare ICT development were found, although the history of health informatics reaches about 50 years back and during that time a considerable amount of research has been dedicated to technology research. Second, the current academic research seems to be dispersed on multiple publication forums, of which none specifically focuses on user-oriented research issues. Third, the studies indicated somewhat contradictory findings: they reported both positive and negative effects of healthcare ICT adaptation and development, and partly these results appeared to be mixed. Fourth, the topics of the reviewed articles reflected the versatile nature of user-orientedness. The research topics ranged from usability considerations (Patel and Kushniruk, 1998; Weber-Jahnke and Price, 2007), and user involvement activities (De Rouck et al., 2008, Karasti, 2001, Lenz et al., 2007), to the investigation of current working practices in hospitals (Nemeth et al., 2005; Berg, 2003; Darbyshire, 2004) and suggestions for enhanced cooperation between the users, technology developers, healthcare leaders, and usability specialists (Nemeth et al., 2004; Kuhn & Giuse, 2001; Thielst et al., 2008). Fifth, the described review and analysis revealed a wide divergence of terminology, applied research approaches and methodologies, and established practices. And lastly, given that the area of informatics and user-oriented research is currently evolving, there seems to be unexplored areas of research which reach behind the identified and earlier (in the previous paragraph) discussed characteristics of user-oriented research.

In conclusion, the area of user-oriented research in the health informatics field seems to be in the process of establishing an identity based upon demonstrated results and findings. The situation resembles those times 25 years back (Blum, 1984), when the beginning of medical information science as an identifiable discipline alongside of computer science was facilitated by academic discussions.

4. Analyzing the Healthcare ICT Development from the UCD Perspective

As presented earlier, there are two questions underlying this thesis. Those questions are: What are the main challenges in designing healthcare ICT applications? How can user-centred design help to address these challenges? The previous chapters (2. Background and 3. Review of User-Oriented Research in the Healthcare ICT Domain) described the results of the focused literature reviews and thereby gave us an overview of the healthcare ICT development domain and related user-oriented research. Based on these reviews it seems that many of the current challenges in development are related to the changing role of ICT in healthcare and its delivery. Especially the following three themes seem to be closely related to these challenges: the lack of evidence on practical benefits of healthcare technology adaptation in hospital surroundings, ICT support for patient-centricity in care, and citizen involvement in health delivery and preventive actions.

The reviews also indicated that the importance of a user-oriented approach in healthcare ICT development seems to be commonly understood. Within recent years, the field of user-oriented research has strongly emphasized the evaluation perspective on development. In general, the importance of, and the need for more comprehensive and design-oriented approach has been recognized; however, academic researchers have proposed few concrete suggestions of action or approaches how to systematically analyze the evolving research area and the current changes.

To address these established issues, this chapter introduces a user-centred design (UCD) approach on interactive system development with reflections on the healthcare ICT development domain. The analysis to be described aims to a) increase the understanding of how a user-centred design approach could be applied in the health informatics domain, b) structure both conceptually and thematically the research area of user-oriented healthcare ICT development, and thereby c) intertwine these two discrete research perspectives, health informatics, and user-centred design, closer to each other. This section is structured as follows: after briefly introducing the fundamentals of user-centred design, the following sections apply a UCD approach and available literature in describing the healthcare context of use, the usability of healthcare ICT systems, and the fundamentals for user-centred healthcare ICT design.

4.1. User-centred Design in Brief

ISO 13407 standard (ISO 13407, 1999) describes user-centred design (UCD) as an approach to interactive system development that focuses specifically on making systems usable. The objective of designing systems for usability is to enable the users to achieve the goals and meet their needs in a particular context of use (ISO 9241-11, 1996).

Probably the best known definition of usability is by the ISO 9241-11 standard (1996):

> *Usability is the extent to which a system can be used by specific users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.*

The other, also widely quoted definition is presented by Jakob Nielsen (1993), who states that the two most important issues for usability are the users' tasks and their individual characteristics and differences:

> *Usability has multiple components and is traditionally associated with the five usability attributes, which are learnability, efficiency, memorability, errors, and satisfaction.*

The framework presented in Figure 1 describes the components of usability and the relationship between them as presented by ISO 9241-11 and Nielsen.

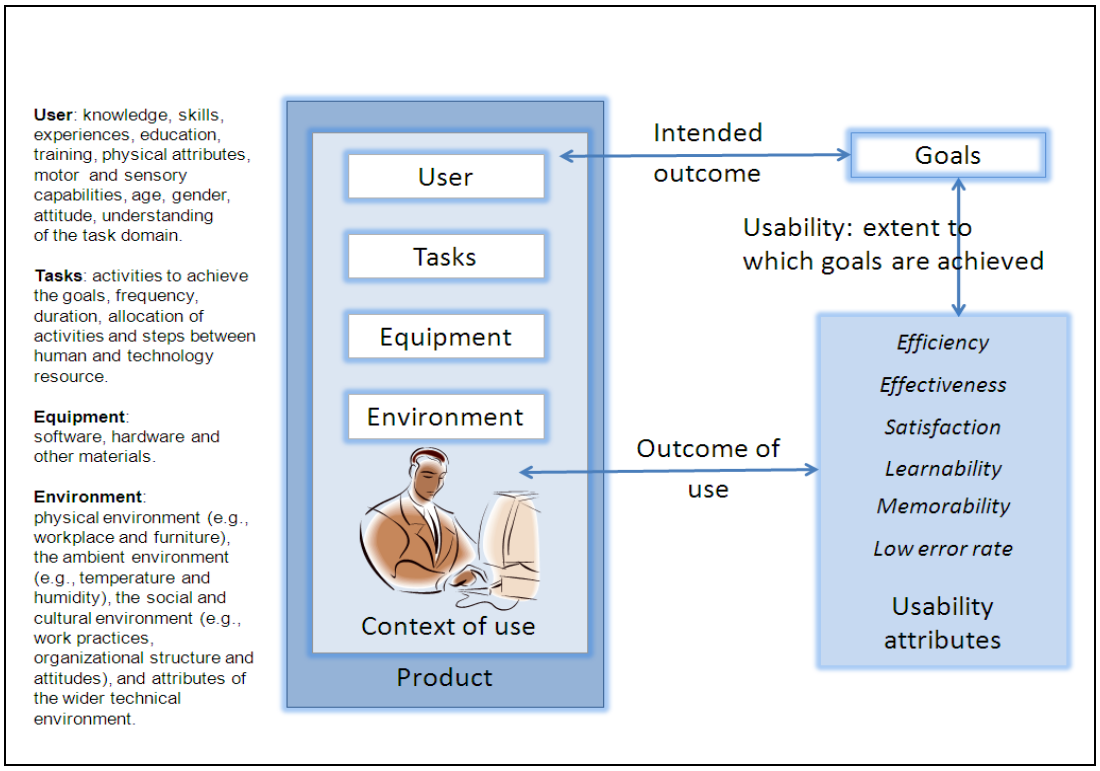

Figure 1. The components of usability and the relationship between them (ISO 9241-11, 1996; Nielsen, 1993).

The definitions of usability by ISO 9241-11 and Nielsen both emphasize the relation between usability and context of use; the level of usability achieved will always depend on the specific circumstances in which a product is used. These specific circumstances can be described as the elements of context of use: users, tasks, equipment, and the physical and social environments in which a product is used or is intended to be used (ISO 9241-11, 1996). Both of these definitions also consider the aspects of user experience slightly. They describe satisfaction as: "freedom from discomfort, and positive attitudes towards the use of the product" (ISO 9241-11, 1996), and "subjective satisfaction, referring to how pleasant it is to use the system" (Nielsen, 1993).

How to develop systems with high usability? Both the previously described definitions for usability already include some guidance for design and evaluation. However, it is the ISO 13407 standard (1999) "Human-centred Design Process for Interactive Systems" that incorporates the ISO 9241-11 definitions for usability and context of use, and provides guidance in designing systems with high usability. As indicated in the ISO 13407 standard, the rationale for adopting the UCD process is to a) make systems easier to understand and use, b) improve user satisfaction and reduce discomfort and stress, c) improve the productivity of users and the operational efficiency of organizations, and d) to improve product quality and appeal to the users towards competitive advantage.

Together with Gould et al. (1991), the ISO 13407 standard (1999) describes general principles that characterize UCD. These principles are: appropriate allocation of functions between users and technology, early focus on users and continuous testing, iterative design process, and multi-disciplinary and collaborative design. Therefore, planning for usability as part of the design and development of systems involves the systematic identification of requirements and verifiable descriptions of the context of use. Accordingly, the four user-centred activities to be fitted into the overall development process are: 1) understand and specify the context of use, 2) specify the user and organizational requirements, 3) produce design solutions, and 4) evaluate designs against requirements. These phases should be repeated iteratively until the system meets the requirements.

Generally speaking, the ISO 13407 standard is intended to provide general guidance for the planning and management of UCD, not to incorporate detailed coverage of the methods and techniques. Although the standard specifically applies to office work, the contents of usability guidance are said to be applicable also in other situations where a user is interacting with a system to achieve goals.

4.2. Describing the Healthcare Context of Use

What does the concept of healthcare context of use stand for? Several researchers refer in their articles about healthcare information system development to this concept, but do not explain the concept thoroughly.

> *The main challenge for information system design in healthcare is to interconnect the medical, technical and social contexts*. (Kuziemsky, 2006)

> *Organizational, contextual, user, and technical aspects need to be studied to elicit the key requirements for eHealth service design.* (Gil-Rodriguez, 2007)

What are the aspects of healthcare context, which need to be considered when designing ICT systems for usability? Generally speaking, a hospital context of use is characterized by a hectic atmosphere, ever changing working environments, altering practices, diversity of technology applications, and heterogeneous hospital staff with various skills and experiences. However, the contexts in which other users, patients, and citizens, use healthcare technologies are without exceptions totally different. The following sections will utilize the previously described usability framework and consider the aspects of use context before describing the overall picture of healthcare ICT system usability.

4.2.1. Users

Users of healthcare ICT systems are not homogenous but heterogeneous, in several aspects, and their needs, skills, and environments vary. Users of healthcare ICT technologies include healthcare professionals, patients, and others. Healthcare professionals, particularly clinicians and nurses, are the primary users of current healthcare information systems: electronic health record systems (EHRs), clinical decision support systems (CDSs), and other applications. Secondary users – other care workers, healthcare administrators and researchers – use healthcare information systems for various purposes.

Today, also patients and other citizens are considered as healthcare technology users, although thus far their access to these systems appears to be very limited. Communication technologies and related applications have the potential to provide support for alternative ways of communication between healthcare workers and patients. These technologies will continuously empower citizens and provide them, and their supporting parties, increased possibilities for collaboratively participating in care activities and promote wellbeing.

4.2.2. Tasks

In hospitals, physicians' and nurses' main goal and responsibility is to take care of and cure patients. Nevertheless, different groups of healthcare professionals have various working practices.

For example, nurses, when working on the wards, perform a diverse range of tasks: they manage a substantial part of the patient record, prepare and administer medications for patients, participate in the ward rounds, and record vital signs (Reuss et al., 2007a; Potter et al., 2004; Manias et al., 2005). Nurses use patient records during all three phases of their shift and apply different kinds of interaction routines with the records during morning and evening shifts (Reuss, 2007a). In mobile contexts, nurses usually do not make extensive data entries; in other words, they just write down a few words on the record form, worksheet, or memo (Reuss, 2007a).

This short description illustrates a small group of tasks and functions that nurses perform while working on a ward. Accordingly, physicians working in various departments have numerous working practices, communication and interaction routines, and ways of interacting with electronic health records and other information systems. Similarly, their habits of dictating and otherwise managing clinical documentation vary depending on the working environment and task at hand (Viitanen, 2009).

Regarding the use of healthcare ICT applications, the goals the patients have significantly differ from those of the healthcare professionals. Therefore, the tasks which patients perform are divergent although they would use the same healthcare systems as the healthcare professionals. Their goals may be related to increasing the understanding of their own health, information retrieval (for example laboratory results), communication with healthcare professionals (discussing about the prescription), independent actions (keeping a diary about diabetic care), or interacting with other patients (discussing online about chronic disease). The same applies to citizens as users of healthcare ICT systems.

The main differences between the healthcare workers and citizens are related to the motivation underlying the action and the tasks or activities that these groups undertake in order to achieve their goals. Healthcare professionals perform certain tasks as part of their work to achieve the specified goals. The procedures and routines that healthcare workers perform are somewhat predetermined. Although they may have various routines, the medical knowledge and education and the environments in which they work strongly affect their ways of taking steps towards their goals of delivering care.

On the contrary, patients are interested in their own health. Thereby, motivation and concern are the necessary conditions for their actions. In the article about “Why people use health

services," Rosenstock (2005) explains health behavior with regards to two classes of variables: 1) the psychological state of readiness to take specific action and 2) the extent to which a particular course of action is believed, on the whole, to be beneficial in reducing the threat. Citizens may have the interest to improve their own health and wellbeing, or support others, for example family members, to proceed towards their intermediate or primary goals. Often, healthcare ICT may provide the patients and other citizens alternative ways of interacting, getting information, and supporting one's own means of preventive care and curative action.

4.2.3. Equipment

New technology and healthcare information systems have changed work practices and procedures in hospitals dramatically. The technology environment in healthcare organizations consists of thousands of healthcare information systems, medical devices, and other technology applications. In general, various IT applications fall into three categories: administrative and financial systems, clinical systems, and infrastructure that supports both the administrative and clinical applications (Hackbart et al., 2004). Additionally, handheld technologies, wireless applications, and mobile support for care delivery are currently entering the field.

As an illustration, physicians use numerous information technology applications for a variety of purposes: receiving laboratory results and other clinical information online, online references such as drug compendia and clinical guidelines, electronic prescribing, computerized provider order entry, clinical decision support systems, electronic health records, and e-mail communication with patients (Hackbart et al., 2004). Along with these technologies physicians utilize a wide variety of other devices, tools, and instruments to support their work. Some of these tools and systems are targeted for patients' use as well. These kinds of applications include for example patient health records, blood pressure apparatus, and systems developed for monitoring, assisting, and educating people with diabetes.

Compared with hospitals, the daily life environment surrounding citizens is equipped with rather different applications than those used in healthcare work-places. Today, a wide range of communication devices are applied for a variety of purposes. Although the communication technology has the potential to support eHealth and wellbeing activities, at the present moment surprisingly few health services are provided to be used with the help of these devices.

4.2.4. *Environment*

According to the ISO 9241-11 standard (1996), the component of environment includes the physical environment (e.g., workplace and furniture), the ambient environment (e.g., temperature and humidity), the social and cultural environment (e.g., work practices, organizational structure, and attitudes), and attributes of the wider technical environment. With regards to these aspects, the environments in which healthcare ICT applications are used vary significantly. Healthcare professionals apply the systems in their working places, whereas patients and citizens do so in their leisure time.

The surroundings in every healthcare organization are greatly similar. As pointed out earlier, the technology environment is a mélange of different systems. Healthcare work is characterized with intensive processes, cooperative activities, and continuous communication between workers. However, it should be noticed that inside a hospital various physical environments for healthcare ICT systems usage can be recognized: wards, operation rooms, control rooms, emergency department, clinics, healthcare professionals' workrooms, corridors, sickrooms, cafeterias, and so forth.

Also patients may use the systems in some of these surroundings or outside the hospital environment. Indeed, it is impossible to describe all the possible environments in which citizens could utilize eHealth services via healthcare ICT applications. As a matter of fact, portable medical apparatus and communication devices like mobile phones, PDAs, laptops, and communicators can be used almost anywhere.

4.3. Usability of Healthcare ICT Systems: Two Supplementary Perspectives

In the field of health informatics the term usability is often mentioned and referred to. Frequently, the term usability is used to indicate the attributes of a system or a product, which make it easier to use. However, in academic research no specific clarification or definition has been given to the concept of *usability of healthcare information system* or *ICT application.*

The definition of usability by ISO 9241-11 (1996) represents an extensive approach to usability; usability is not only a characteristic of a user interface, it is about supporting users in achieving their goals with the support of systems. In the previously presented analysis of the healthcare context of use, two main groups of healthcare ICT users were identified: 1) healthcare professionals and 2) patients together with other citizens. Their characteristics and goals, activities to achieve these goals, equipment in use, and environments of use differ significantly. These findings indicate that the contexts of healthcare ICT usage vary considerably. Hence usability should be understood as a context-dependent property. The following sections describe the usability of healthcare ICT systems from two supplementary viewpoints: healthcare professionals' and citizens' perspectives.

4.3.1. Healthcare ICT System as a Working Tool

Healthcare professionals' goal is to provide the patients with care of a high quality. In clinical environments a variety of computer applications, medical devices, and other tools are used to support healthcare professionals in their work. In general, the technology environment, when considered as a whole, is to serve the ultimate goal: to support the workers in care activities.

It has been stated that the timely delivery of relevant information to the appropriate healthcare professional is what healthcare information systems are all about (Davis, 1973). To support healthcare delivery, healthcare ICT systems need to be effective, efficient, and easy to learn, and furthermore have a low error rate. Effectiveness (ISO 9241-11, 1996) refers to the accuracy and completeness with which healthcare professionals achieve their goals: to provide the patients with healthcare services. The systems need to be efficient (Nielsen, 1993) to use so that a high level of productivity in a hectic and critical environment is possible. The requirement for efficiency of use furthermore indicates that the systems need be adapted to the various use contexts and they should support diverse working processes. In short, the applications should be flexible in terms of their use. The systems should be easy to learn (Nielsen, 1993) in practical terms, in view of the reality that working healthcare

professionals tend to be extremely busy. They do not have time to read manuals or otherwise get familiar with new systems. Instead, they need to be able to rapidly start getting the work done in the way it is supposed to without errors. Sometimes these situations might be deadly serious.

As the previously described literature review about user-oriented research indicated, the current usability-related research in health informatics field mainly concentrates on evaluation activities. In order to support user-centred design from the early phases of development, the usability of a system should be considered from a wider perspective: healthcare ICT applications should be seen as integrated parts of a healthcare context of use. In Paper I: *Terveydenhuollon tietojärjestelmien käytettävyys* (in English: The Usability of Healthcare ICT) the authors discuss the current state of usability research in the health informatics field and apply user-centred design approach to describe the usability of healthcare ICT from the perspectives of design and development.

In brief, the following questions can be used to guide one through the development of healthcare ICT applications: Do the systems support healthcare professionals' operative work? What are the expected healthcare IT benefits from the healthcare professional's viewpoint, and are these goals reached? Do the healthcare workers' experiences indicate that compared to earlier times, significant improvements are achieved and they are able to conduct the work in a more efficient and satisfactory way?

4.3.2. Citizens' Viewpoint on Healthcare ICT Utilization and Usability

One of the emerging fields of healthcare ICT adaptation is electronic service and application development targeted for citizen use. The advent of new communication technologies is expected to improve patients' access to health information (Giménez-Pérez et al., 2002). At the moment several citizen-oriented applications are under development.

Citizens cannot be considered as a homogenous group of users with common goals or shared preferences. Their motivation for use derives from the aim of promoting one's own wellbeing and health. Citizens are already accustomed to using several online services with the help of computers, mobile phones, and other communication devices. Therefore, they appreciate a high quality of service and expect the healthcare services to meet their needs.

Citizens use electronic healthcare services in their leisure time. User experience encompasses several aspects of usability: easy access, satisfaction, intuitiveness, attractiveness, enjoyability, usefulness, and pleasantness of use. Successful healthcare ICT applications and services need to mesh with the familiar processes and tools that citizens rely on in their daily lives.

4.4. Fundamentals for User-centred Healthcare ICT Development

User-centred design (UCD) focuses upon users and usability throughout the entire development process and further throughout the system life cycle (ISO 13407, 1999). In the following sections the UCD principles and the iterative process model are utilized in describing the fundamentals for user-centred healthcare ICT development. The four principles – 1) appropriate allocation of functions, 2) early focus on users and continuous testing, 3) iterative design process, and 4) multidisciplinary and cooperative design – are not bound to any specific phase of development cycle, but instead, can be integrated into different stages of the design process in a way that is appropriate to the particular context (ISO 13407, 1999).

4.4.1. Appropriate Allocation of Functions between Users and Technology

The principle of "*appropriate allocation of functions between users and technology*" is unquestionably one of the most important principles, and emphasizes the philosophy underlying user-centred design. The appropriate allocation of function is to specify which functions should be carried out by the users and which by the technology (ISO 13407, 1999). The ISO 13407 standard states that these design decisions determine the extent to which a given job, task, function, or responsibility is to be automated or assigned to user performance. When making the design decisions, a number of factors such as relative capabilities and limitations of users versus technology aspects need to be considered, and furthermore the resulting user functions should form a meaningful set of tasks.

The principle of appropriate allocation of function also accords with the statement presented by Berg (2003):

> *Information technology (IT) can bring true process support to healthcare when taking the two circumstances into account: 1) The key to a fruitful operation of IT in healthcare work lies in the unraveling of the care process, and the redistribution of tasks between professionals and the IT applications. 2) Professionals should be given the skills and resources to adapt the IT application's demands to the needs of their work practices.*

The appropriate allocation of function in healthcare ICT design can be considered as a key factor with regards to many aspects of healthcare delivery, such as patient safety, efficiency, and accuracy of clinical documentation, and patient health information retrieval. Proper allocation of functionalities has the potential to improve and accelerate the workflow of care providers. Especially those functions that are closely related to reliability of information,

speed, and accuracy, and could be performed by applications and possibly automated, should be carried out by the technology. However, accordingly, the user should always be in control, meaning that technology should continuously inform the user about what it is doing and how it is interpreting the user's input (Nielsen, 1993).

The following examples illustrate actions that seem to be common in healthcare professionals' daily practices, and thereby raise the question of appropriate allocation of functions. Typically, healthcare workers use patient social security numbers to search information. They often need to type the numbers instead of selecting those, although the computer could for example offer the physician a list of patients currently in the ward. Also, lack of interoperability between healthcare information technology systems slows the workflow of care providers. If healthcare information systems cannot communicate with each other, the hospital staff needs to act as an integrator by filling out the patient information in multiple separate systems. These kinds of actions are susceptible to human error and decrease the efficiency of healthcare work.

4.4.2. Early Focus on Users and Continuous Testing

A critical aspect in developing and integrating successful applications is to understand who the potential users are, how they behave, and what they need. "Early focus on users and continuous testing" is one of the key principles of user-centred design (ISO 13407, 1999; Gould et al., 1991). User-centred processes try to include the actual users in the development process at the earliest possible time in an effort to produce systems that correspond to the needs of the users and the restrictions of the context of use. The principle suggests that the potential users and their tasks can be directly linked to the development process: they can have an influence on the design as it emerges and solutions can be evaluated by those who are actually going to use them.

In the field of user-centred design the concept *user research* is used to refer to a process and associated activities that aim to understand the impact of design on an audience (Kuniavsky, 2003). Observing real or potential users acting in a specific context of use reveals problem areas to product designers and often provides clues to addressing the problems. When conducting user research, it is recommended that several research methods be used in order to obtain rich qualitative data and to build a holistic view of the studied user group and context of use (Beyer & Holzblatt, 1998). The most common methods used include interviews, observations, and questionnaires (Hackos & Redish, 1998), with other methods such as cultural probes (Gaver et al., 1999) or artefact analyses (Beyer & Holzblatt, 1998), being applied less frequently.

Characteristics of the healthcare domain raise challenges for healthcare ICT development: along with user requirements, also other requirements (e.g., medical, technical, legal, and organizational) need to be taken into account. In several aspects, users who are working daily in hospital environments can be considered as experts; they have the practical knowledge of which things work and which do not, how tasks are performed, which medical aspects need to be considered, and what are the organizational manners. Often, developers do not have in-depth understanding of these conditions – how could they? Therefore, it is extremely important to involve the potential users, healthcare professionals with expertise in a variety of medical areas, in design activities in several phases of development.

What are the reasons for involving citizen users in healthcare ICT development in its early phases? As discussed earlier, "citizens" as a user group is heterogeneous in several aspects. Cooper and Riemann (2003) have pointed out an interesting issue: if the aim is to develop a product for a wide audience, we should focus on a specific homogeneous user group and their needs. In short, a challenge for the early involvement of citizen users is to identify and to select potential user groups for which the technology will be developed. The second challenge can be seen as an opportunity: harnessing the users as a driving force for the innovation. The ideas of "open innovation" (Chesbrough, 2003) and "user-driven innovation" (von Hippel, 2001) have been presented to involve the users in innovation and thereby "democratize" the innovation work and the production process.

In addition to *early focus on users*, the principle also emphasizes the need for *continuous testing* with users. Continuous testing indicates that small iterative tests on prototypes may be sufficient to meet user needs without lengthy usability testing at the end of the design process (ISO 13407, 1999). Pressman (1992), Nielsen (1993) and other researchers have argued that for each phase of development that proceeds without formal usability testing the cost of fixing usability problems increases considerably, even by a factor of 10.

In general, usability evaluation is considered as being an essential part of the user-centred design process. Evaluations should take place at all stages in the system life cycle in order to influence the system to be developed (ISO 13407, 1999). As the ISO 9241-11 standard (1996) indicates, the context of use needs to be taken into account in design as well as in evaluation. Usability evaluation methods can be divided into empirical user testing and usability inspection without user involvement methods (Nielsen, 1993). Usability testing, in which a participant does given tasks with the system being evaluated, is probably the best known and most commonly used method to evaluate user performance and acceptance of products (Nielsen, 1993). For the reason that different evaluation methods serve diverse evaluation purposes and reveal different problems, methods should be used as a complement to each other.

It should always be remembered that pointless testing is not valuable as such. It is not the amount of tests or involvement of users, but the quality of these activities and outcomes that make the design process successful and user-centric. When planning an evaluation the researchers should carefully consider several aspects: What are the objectives of evaluation? What kind of information needs to be gathered regarding the established objectives? Which methods should be used to gather this information? And how is the data to be analyzed? If the objective is to support the development and provide information for further design, qualitative data and interpretations at the best provide valuable information about the current problematic situations, reasons behind those problems, and ideas of enhancements.

In general, the significance of evaluation studies as well as the interest in adequate methods and approaches for evaluation has grown in the area of health informatics (Ammenwerth & Keizer, 2004). As pointed out by Ammenwerth et al. (2004) evaluation is not just for accountability but to improve our understanding of the role of information technology in healthcare and our ability to deliver systems that offer a wide range of clinical and economic benefits.

Continuous testing and evaluation during healthcare ICT development seems to be somewhat difficult. As supported by Ammenwerth and Keizer (2004), the previously discussed review showed that evaluation studies are rarely carried out during the entire lifecycle, but only after the event and installation. In addition, design and evaluation has for long been struggling with domain-specific challenges. Ammenwerth et al. (2003, 2004) investigated the underlying reasons that make an evaluation of healthcare information technology difficult. They identified several problems and barriers in healthcare information technology evaluation: awareness, methodological issues, practical issues, and dissemination. Furthermore, Healthfield et al. (1998) argued that there is a great need for developing multi-perspective evaluations that integrate quantitative and qualitative methods. In addition, Kushniruk (2001) has pointed out that as the information technology becomes more complex, evaluation methodologies will need to be continually refined in order to keep pace, making design and evaluation of effective healthcare information systems a challenging and continually evolving process.

It is interesting to see that some of the problems addressed in healthcare can also be found in other domains of ICT development. Among others, Shah and Robinson (2006) found that some of the manufacturers and technical partners are not willing to listen to the users and integrate their input into the technology development cycle. Likewise, the nature of the relationship between users and manufacturers can be an impediment on occasion to the type and effectiveness of user involvement. Interestingly, Dumas (1989) has pointed out that an important factor in assessing usability evaluation methods is their ability to facilitate the

working relationship between specialists and developers. If this relationship is based on trust and mutual respect, the likelihood that developers will make changes is increased. From this viewpoint, the best evaluation methods are the ones that provide the most opportunities to build a positive working relationship with developers.

4.4.3. Iterative Design Process

According to Gould and Lewis (1985), iterative design can be described as a cycle of design, test, and measure, and redesign, repeated as often as necessary. The ISO 13407 standard describes a model to support the iterative design. The model incorporates four activities that are intended to accomplish the following: 1) understand and specify the context of use; 2) specify the user and organizational requirements; 3) produce design solutions; and 4) evaluate the design against requirements. When combined with active user involvement, iteration provides an effective means of minimizing the risk that a system does not meet the necessary requirements (ISO 13407, 1999). The design process model is presented in Figure 2.

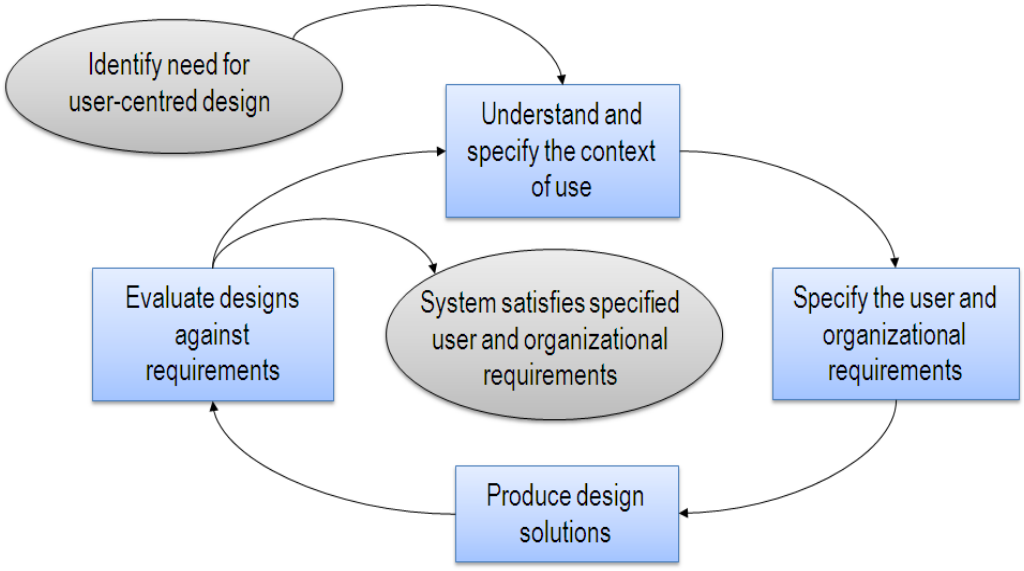

Figure 2. The iterative design process: the interdependence of user-centred design activities (ISO 13407, 1999).

The characteristics of the user, her tasks, equipment, and the organizational and physical environment define the context of use as discussed earlier. The second phase, requirements specification, should be extended to create an explicit statement of relevant user requirements in relation to the context of use description. These requirements should cover multiple perspectives, such as cooperation and communication between users and other

relevant parties, users' work, work design and organization, management of change, feasibility of operation, legislative requirements, required performance, and workstation design. The requirements specification should also define the allocation of functions – the division of system tasks into those performed by users and those performed by technology. (ISO 13407, 1999).

According to ISO 13407 (1999), potential design solutions are produced by drawing on the established state of the art, the experience and knowledge of the participants, and the results of the context of use analysis. The design should utilize the existing knowledge to develop proposals with multi-disciplinary input, then make the design solutions more concrete using prototypes, and discuss the presented design solutions with users. The evaluation feedback should guide the iterative design process.

Rapidly changing demands and requirements put a high pressure on the design and evaluation of new applications in healthcare. Several researchers have pointed out the need for an iterative approach in development of healthcare ICT. Findings by Brender (1998) have indicated the need for an alternative approach to the traditional requirements of engineering and elicitation, design, and development in the field of healthcare information technology development. This claim points at an incremental and iterative approach in agreement with the concept of evolutionary system development combined with constructive assessment. Furthermore, Weng et al. (2007) have argued that especially in the field of healthcare, the conventional ways of defining and specifying large-scale systems are not adequate. The problem in specifying the requirements is that a large portion of system requirements is tacit and hard to articulate at the beginning of a system design process. Their experiences have indicated that user requirements are emergent and change often. Therefore, the specifications should be considered as dynamic requirement specification documents, instead of static ones (Weng et al. 2007).

The overall challenges for an iterative approach in healthcare ICT development can be described as by Berg (1999):

> *How to find the optimal form for the iterative development process in an environment full of economic pressures for "fast result", divergent interests, and inflexible information technology applications? Where to find the optimal interrelation between the formal tool and the healthcare professionals' skills?*

4.4.4. *Multidisciplinary and Cooperative Design*

The dilemma described by Brender (1998) emphasizes the complexity of design and the expectations that the development team members have for each others' abilities and expertise:

> *The present approaches for system development implicitly assumes that documents such as a functional specification and a system specification contain all relevant information about the system being developed. The real case often is that the programmers cannot express their mental image of the IT system in detail in the beginning of the project, but expect the users to be able to express their mental image of their organization, or even worse, formulate it on the premises of the technology. In addition, usually the users have difficulty in explaining their knowledge.*

In the healthcare ICT development field, several researchers have expressed the need for cooperation between patients, healthcare workers, and the technology developers (e.g., Clemensen et al., 2007; Häkkinen & Korpela, 2007; Thielst et al., 2008; Nemeth et al., 2004). Theilst et al. (2008) have pointed out that the successful implementation of any type of healthcare technology is not possible if its developers and users do not have comprehensive insight into its capabilities and limitations. In the future the need for collaboration and shared understanding is likely to be emphasized, as the emerging trends – patient-centred care, eHealth services, and integration of communication technologies, to mention but a few examples – will have an influence on the evolving field of healthcare technology. In the words of Hyppönen (2007),

> *eHealth projects need to build a balanced network of actors who have adequate knowledge about a variety of objects of development and the required skills for constructing and managing the entity so that they can surpass the challenges of co-development of eService and related technologies.*

The fourth principle described by the ISO 13407 standard (1999) deals with the fact that user-centred design needs a variety of skills. A range of personnel is necessary to address a number of skill areas and viewpoints. The roles of the team members can include end-user, manager, application domain specialist, programmer, salesperson, usability specialist, user interface designer, technical author, and support personnel (ISO 1999). However, the roles and responsibilities of the development team members are rarely clearly understood or communicated.

For the development team, users are co-operators and experts in a specific field (Nielsen, 1993). It is commonly agreed that users have the knowledge about domain semantics,

working procedures, and the problem space. Therefore, users are an important source of information: they can provide the development team with the sufficient understanding of the domain, as well as the overall product offering and how it can be extended. However, users are not designers (Nielsen, 1993). User interface design cannot be derived just by asking users what they want. Users are usually wrong in their suggestions as to how best to meet their needs or remedy a problem (Rector et al., 1992). Moreover, users sometimes lack the ability to differentiate between what has been recommended, what they do, and how they express their needs (Gould & Lewis, 1985). As described by Rector et al. (1992), "users' comment are usually concrete and framed in terms of the problem space, whereas a good design solution is likely to be abstract and must be framed in terms of the design space. These claims indicate two important facts: 1) users' ability to analyze their own work and information systems is limited and 2) users cannot be the ultimate decision-makers in development projects.

The paradigm of "users are not designers" holds true also when considered visa versa. Designers are not users, although it can be tempting for designers to trust their own intuition about design issues (Nielsen, 1993). Often designers are different from users in several respects. This holds true especially in the field of healthcare technology development. Software developers and technical designers represent the technical expertise in a development team.

In the development team usability specialists and social scientist often take the role of an intermediary between the users and technical developers. Usability specialists are experts in the area of user-centred design. When evaluating the design, usability specialists often act as impartial experts and thereby create an atmosphere in which users may provide much more frank and honest criticism than in demonstrations or less formal settings (Rector et al., 1992). Nemeth et al. (2004) have discussed the relationship between healthcare workers and usability specialists and pointed out that these parties can also perform their tasks as they study technical work together, and that long-term cooperation between these parties is essential for all progress on user issues in healthcare.

5. DeHus – A User-centred Framework for Healthcare ICT Design

Technological development is often offered as a solution as such. Most modern information and communication technology (ICT) provides many interesting possibilities. However, new technology benefits the activities only if all participants in the different stages of the healthcare process are able to utilize the technology in an efficient and satisfactory way.

It has been argued that only a system that reflects the healthcare professionals' working practices will encounter their acceptance (Reuss et al., 2007a). Therefore, healthcare technology should be designed to support divergent uses in various contexts (Poissant t al., 2005). Studies also indicate that different user groups, patients, and clinicians might differentiate substantially regarding their preferred means of communication for different types of interaction (Hassol et al., 2004). For these reasons, the development of new tools and services needs to be based on the needs of all stakeholders: healthcare professionals as well as patients, other citizens, and their supporting parties.

The previous chapter (Chapter 4 – Analyzing the Healthcare ICT Development from the UCD Perspective) introduced the user-centred design approach in interactive system development with reflections on the healthcare ICT development domain. This chapter continues analyzing and structuring the evolving field of user-oriented research in both the thematic and methodological levels. The first section describes and gives reasons for the classification of three healthcare ICT design contexts. Then, section two introduces an initial conceptual framework for user-centred design of healthcare ICT. Lastly, section three describes how a case study was applied for early framework evaluation.

5.1. Distinctive Contexts of Healthcare ICT Design

Today, technology has a key role in healthcare delivery and patient care. A wide variety of information systems are currently used in healthcare environments. Although currently healthcare workers are the primary users of healthcare information systems, the emerging ICT also has the capacity to empower the patients, enhance the collaboration between healthcare workers and patients, and enable the citizens them to become active participants in their healthcare.

In the near future healthcare technologies are expected to reach patients' and other citizens' everyday lives. Regarding the changing role of healthcare ICT, there are at least two

fundamental questions which need to be answered preparatory to new applications. These questions are: What are the reasons for developing and designing applications for healthcare purposes? What are the main goals these actions strive to accomplish?

The previously presented analysis revealed that the healthcare context is characterized with various user groups, use environments, health-related activities and equipments. These findings indicate that from the design viewpoint, the healthcare context cannot be considered as a coherent entity. It seems that the differences and characteristics of various healthcare contexts have been left out of consideration in the health informatics literature. For example, Malhotra et al. (2005), De Rouck et al. (2008), Toivanen et al. (2004), and Croll and Croll (2007) have discussed methodology approaches to support ICT development in healthcare, but have not considered what are the characteristics of various contexts, how the characteristics of use contexts should be taken into account, or how these characteristics affect design and methodology aspects.

It seems that the evolving field of healthcare ICT development encompasses several contexts of design and use. Also, various objectives are to be served with the help of modern technology. Arising out of this, three categories of intended outcomes of successful design can be identified:

- enhancing the quality of care and clinical documentation provided by healthcare professionals in healthcare environments;
- empowering citizens by means of eHealth services;
- improving ICT support for communication and cooperative care between patients and healthcare providers.

These desired outcomes determine the goals for healthcare ICT design and thereby suggest that the healthcare contexts beneath the design are characterized with fairly distinct features.

The user-centred design analysis described the components of context of use as presented in ISO 9241-11 standard (1996). These components involve the user groups (healthcare professionals, patients, and other users), their environments, and healthcare-related activities and equipments. Based on a) the user-centred analysis, b) intended outcomes of ICT design, and c) the literature reviews presented earlier in this thesis, it seems that three contexts of healthcare ICT can be identified. These contexts are:

- Context 1: Healthcare professionals as ICT users in the healthcare environment.
- Context 2: New eHealth services for citizens' use.
- Context 3: ICT support for cooperative care between patients and healthcare professionals.

Figure 3. The three contexts of healthcare ICT design.

The following sections introduce these three design contexts, illustrated in Figure 3, and describe the related characteristics, and thereby form the bases for the initial conceptual framework for a user-centred design approach on healthcare ICT development.

5.1.1. Context 1: Healthcare Professionals as ICT Users in Healthcare Environment

In the healthcare environment various workers might have different expectations and daily routines, although the objective stays the same – to treat the patients. Healthcare technology is to support these routines by supporting communication and timely delivering the relevant information to the appropriate user at the point of service. The adaptation of healthcare ICT strives to improve quality of care by all means. Therefore, the ultimate goal of healthcare ICT design is to serve the healthcare professionals in their daily work.

Clinical processes are characterized by a high degree of communication and cooperation among healthcare professionals, and diverse and dynamic practices. Traditionally, the concept "healthcare information system" is used in the discussions of technology adaptation; however, as pointed out earlier, the roles of mobile and wireless technologies are increasing and gaining importance. It is somewhat surprising that these specific characteristics of the healthcare domain, a wide variety of healthcare contexts and high degree of communication

and cooperation among healthcare professionals, have generally gone unheeded, although within the past few decades significant effort has been paid to healthcare technology development.

It has been argued that an old-fashioned information system within healthcare work will not successfully be replaced by a new one, unless the new is better "as a whole", that is, it better supports work practices of a range of occupational and professional workers (Kyhlbäck & Sutter, 2007). Malhotra et al. (2005) and Croll and Croll (2007) have supported this argument by claiming that the biggest risk faced in developing information systems and tools for healthcare setting is to understand the complex environments that our health services present.

What are these complex environments about? Hospital-wide information systems are to serve many stakeholders in supporting their daily work. Today, hundreds of information systems are used in hospital environments. Different stakeholders utilize these systems in different environments for various purposes. Therefore, each stakeholder has his or her own requirements for hospital-wide new technologies. These complex standpoints make it difficult to analyze the present state of the work activities, perceive the system under development as a whole, and define the essential needs and the goal state.

Because the healthcare environment is characterized with a variety of use contexts, healthcare ICT systems should be flexible and adapt to the various contexts and purposes of use. When designing healthcare systems and communication technologies, we at first need to understand the requirements for design deriving from the diverse contexts of use. It is essential to study these diverse contexts with regard to the related users, their tasks, equipment, and environments. For example, nurses on the move and on the go need other kinds of technology applications than do physicians and office workers.

While working in a hectic and dynamic environment, healthcare professionals appreciate effective ways of delivering care. Thus healthcare ICT applications need to be carefully integrated into the surrounding technology environment. This technology environment should be seen as a whole: from the user viewpoint, the individual system is only one part of these surroundings, and for this reason a given application is almost pointless, unless it operates seamlessly together with other applications.

In the healthcare environment, users are the vital source of information. As members of a development team, healthcare professionals are the experts of medical experience and knowledge, and they have the most precise know-how about the practical work in a specified healthcare environment. Researchers can elicit valuable information by observing and otherwise studying the work of various healthcare professionals' in their real context of use.

The information may be used to increase the understanding of both the current practices, and the aspects of work procedures and technology applications which need to be redesigned. Without exception, an implementation of a new technology application requires changes in working practices. Therefore, it is important to realize that information about the existing context should guide the design and specification of an intended context and related changes.

The traditional user-centred approach to information system development seems to be highly applicable in the context of "Healthcare Professionals as ICT Users". The earlier presented ISO 13407 standard (1999) and ISO 9241-11 standard (1996) provide instructions for interactive system development targeted at working environmental use. A participatory design approach (Schuler & Namioka, 1993) emphasizes the need for user involvement and cooperative actions during various phases of the design process. UCD methods, such as interviews, observations, focus groups, work analysis, and usability evaluations can be applied in studying healthcare workers' working practices and redesigning various aspects of ICT-supported work

However, there are several domain-specific challenges which raise challenges for UCD methods and user involvement when designing ICT applications for healthcare professionals. Firstly, while working in a hectic and critical environment, healthcare workers are extremely busy with customary tasks and unexpected emergences. The challenge of finding motivated users and involving them in design seems to be true in healthcare ICT development (Shah & Robinson, 2007), but also in other areas of information technology development (Wagner & Piccoli, 2007). Secondly, representative participants of multiple potential user groups are difficult to reach, and it is even more demanding to set up times for observations, interviews, and other appointments. Thirdly, the challenges arising out of the earlier discussed characteristics of healthcare ICT development (e.g., several user groups and use contexts, as well as asafety-critical and hectic environment) need to be carefully considered.

5.1.2. Context 2: New eHealth Services for Citizens' Use

The healthcare sector is currently undergoing major challenges and changes. The ageing population is said to require more healthcare services than ever before (The Joint Commission, 2008; Gupta, 2006). Also, citizens are becoming more demanding (Wilson et al., 2004; Raghupathi, 1997), and expect the services and processes to be of high quality. The amount of required services is increasing at the same time as the expectations for quality. However, resources for providing these services are limited and not increasing at the same pace. Therefore, new solutions are required to solve the contradiction.

Empowering and activating citizens is considered as a key competence for healthcare delivery in the future (Adams et al., 2008). One of the prerequisites for innovative care-process change and preventive healthcare is engaging the citizens in behavior that mitigates diseases and improves lifelong care and wellbeing. The use of emerging ICT technology to improve or enable health and healthcare is the central focus of eHealth. The area has already gained wide acceptance, and the adaption of new services to support preventive healthcare and wellbeing is strongly recommended. However, at the same time researchers have pointed out that several issues of citizen involvement require conceptual and empirical attention (Boote et al., 2002). One of these is: What factors are associated with successful citizen involvement in health research?

The standing points for eHealth service design for citizens' use are unquestionably challenging. Compared to the traditional health services, new eHealth and wellbeing services should emphasize the following aspects: collaborative actions, peer-support, ICT adaptation in welfare, flexibility of service provision, easy accessibility, and innovative new concepts for services. Technology intended to be used for health-related purposes should be usable by all types of individuals, including the elderly, people with low literacy, and those with permanent or temporary disability (Patrick et al., 2008; Hyppönen & Niska, 2008). Therefore, information about numerous aspects including citizens' environment, abilities, capabilities, knowledge, and motivation is needed (Hyppönen & Niska, 2008). As the citizens have more possibilities to influence their own healthcare and wellbeing, they will assume greater responsibility for their healthcare. Thus, the relationship and responsibilities between healthcare workers, citizens, and other supporting parties need to be reconsidered.

As discussed earlier, examples and experiences in diabetes care indicate interesting and valuable findings. These findings about healthcare ICT services targeted for patients in their everyday use can be used as starting points for designing and developing eHealth applications for a wide variety of users and uses. Also, the previously launched free patient health records (GoogleHealth and HealthValue) have revealed interesting and positive experiences. Evaluation studies have indicated that the majority of the participants found PHRs to be useful and stated that they had an interest in building their own (Peters et al., 2009). However, these applications represent only a small sample of future eHealth services.

The main challenge underlying the service design seems to be the adoption of an innovative approach in development. Parker and Heapy (2008) have argued that two problems lie at the heart of an attempt to close the gap between what people want and need, and what service organizations do. These are: 1) people are changing faster than organizations are, and 2) service is still seen as a commodity rather than as something deeper.

How do we know what the users want if they do not know it themselves? There might be several possible ways to approach this challenge. Users could take the role of innovators together with designers. For example, in most high income countries, young people are the keenest and earliest adopters of new technologies. Therefore, young people can take a leading role in improving communication throughout the health system (Jaded & Delamonte, 2004). Innovative communication tools and applications could be used to enable them to preserve or improve their own health, as well as help members of older generations who are less familiar with the Internet.

One possible approach for these challenges might be effective adoption of more flexible internet-based techniques in user involvement. Within the HCI research the idea of utilizing on-line communities, an open innovation ideology (Chesbrough, 2003), and active user involvement is new. This kind of methodology could be used to support other research methods and thereby provide advantages that traditional HCI research methods, characterized with face-to-face communication and intensive data capturing sessions, do not allow. The papers IIIa: *Avoin vuorovaikutusfoorumi käyttäjäkeskeisen kehittämisen tukena – tapaus Tervesysteemi.info* (in English: Open Interaction: Describing a New Methodology Approach for User-centred Design) and IIIb: *Open Interaction*: *A User-centred Approach for Healthcare Information System Development* introduce this novel idea and describe an exploratory research case which aimed at: 1) conceptualizing an open interaction forum to enable various healthcare-related parties to contribute to the discussion of innovation, design, and development of healthcare ICT, and 2) gathering experiences of an innovative research approach.

Taken together, it seems that the potential benefits of eHealth services are evident. However, an important question underlying the successful design is: Under which conditions and for whom are eHealth services effective and how can effectiveness in delivering medical and social care and support electronically be maximized? The main challenges for design are the broad user population, divergent contexts of uses, and a user-informed design approach.

5.1.3. Context 3: ICT Support for Cooperative Care

Interaction and collaboration between healthcare professionals and patients play an important role in the care process as well as during single face-to-face appointments. The currently used healthcare information systems are targeted mainly for healthcare professionals' use. Therefore, these systems provide only limited support for collaborative actions between the patient and the healthcare professionals.

Healthcare is heading towards patient-centred actions in care delivery. The visions of patient-centred healthcare (Davis et al., 2004; Delbanco et al., 2001; Haux et al., 2002) share the idea of cooperative care, and information delivery and communication between healthcare workers, patients, and other involved parties. Today, the involvement of patients and other citizens in healthcare is a policy in many countries (Boote et al., 2002; Health Committee, 2007). Thereby, the adaptation of new healthcare information and communication technologies and applications are strongly supported.

Several findings have indicated that patients and other citizens are willing to take an active role in their own health maintenance. Liederman and Morefield (2002) have found a high demand by patients to communicate electronically with their doctor. Patients have also expressed a clear need for more information about their personal health (Lähteenmäki et al., 2008). Several studies have investigated patient-physician communication and indicated positive findings: the experiences showed that both the patients and physicians found enhanced communication beneficial (Ilvonen et al., 2006; Lähteenmäki et al., 2008; Wiesenthal, 2009).

Cutting-edge modern technology provides enormous possibilities for healthcare ICT development. Healthcare information systems are already reaching the new potential users: patients. Patient health records (PHRs) are to provide the citizens a great access to a wide array of credible health information, data, and knowledge, and to improve communication between different parties. Also, the healthcare workers could benefit from these actions. For example, if the patients could be given the rights to do part of the documentation themselves, self-documentation could reduce the workload of the healthcare professionals (Häyrinen et al., 2008) and provide them with rich information about the patients' way of life and health-related habits. Because of their high rate of ownership and use, mobile phones show promise as a tool in healthcare communication technologies (Giménez-Pérez et al., 2002). Several aspects of the impact of mobile phones on personal health are self-evident: healthcare professionals and patients can reach each other more easily, discuss sensitive medical issues in privacy, and leave messages for one another (Patrick et al., 2008). In short, the technology seems to be mature enough to support the new ways of communication and cooperation in healthcare. Hence, the question is: How do we get the full advantage of the most modern technologies in healthcare?

Patients are already familiar with numerous ways of communicating and cooperating with each other. However, they prefer different ways of doing things and discussing about their personal lives. The skills, expectations, and routines the patients have need to be considered, and therefore various healthcare services need to be offered using different modalities.

In the same way, patients' access to their own health information requires careful planning. Research about patients' contribution to electronic medical summaries found the summaries in general practice inaccurate to a worrying extent (Ward & Innes, 2003). Consequently, the researchers suggested that negotiation with patients can result in a more accurate summary that includes the patient's perspective. Other challenges have also been identified. Patient-related interface, technology, and access issues specific to PHRs may not yet be well understood (Tang et al., 2006). Before development it is important to understand how the PHRs can fit into the flow of what individuals do on a day-to-day basis (Tang et al., 2006). These claims have been supported by Downs and Brennan (2008):

> *It's simply not enough to create a personal health record and then assume patients will use it. We need to know if they will live with it if it fits into their routines and helps satisfy their health-related need amidst everything else they juggle – work, school, family, etc.*

To be successful, the design of healthcare ICT applications, aimed at supporting cooperative actions between patients and healthcare workers, needs to be multidisciplinary. There are several reasons to support this argument. Firstly, the designers of new communicative and cooperative applications need to consider the regulations and legal aspects of information transfer in healthcare. Secondly, the goal of design is more or less ambitious: the solutions should serve both patients and healthcare workers in an optimal way. The designers are in between the two main groups of users, patients, and healthcare workers. In order to understand both individuals' mental models of healthcare process and means of communication, these groups need to be carefully studied. Thirdly, from the healthcare professionals' viewpoint, system integration is one of the most important prerequisites for a successful and efficient use of ICT in healthcare. If healthcare ICT applications cannot communicate with each other, and the compatibility of these systems is not clear, the effectiveness of healthcare work and the benefits gained by using new applications won't be achieved.

The design context of "ICT support for cooperative care" incorporates several challenges that are new for the traditional healthcare ICT development approach. First of all, the context in which these applications are used is hard to define. The general objectives for design include integrating new applications and enabling patient-centred activities. However, there are probably other objectives also which are not yet identified. Compared to other contexts, this context emphasizes the need for designing applications to support communication and collaboration between diverse user groups. This aspect of design can be considered as somewhat new for user-centred design, although the area is to some extent similar to the fundamentals of computer supported cooperative work (CSCW) research.

5.2. An Initial Conceptual Framework for Design

An initial conceptual framework, presented in Table 1, encompasses the previously described three perspectives on healthcare ICT design, and thereby introduces several important starting points for application development. In addition to the starting points that are already known and established, the framework includes themes that are not yet well understood or discussed in research literature (these questions are marked with italic font). Most of the questions are related to the third design context "ICT support for cooperative care". These viewpoints are expressed as questions in the following table (Table 1) and are to be researched further in the near future.

The starting points are to ground fundamentals for user-centred design of healthcare information and communication technologies. It seems that the third context of healthcare ICT design appears to be the most challenging of all the introduced design contexts: the currently applied UCD methods and research approaches may not be applicable or sufficient for the purposes of designing in this context. With the following aspects in mind, the healthcare ICT development could head towards a user-centred approach in an effort to improve the quality of care, support cooperative care, and provide pleasant eHealth services for citizens.

Table 1. User-centred framework for healthcare ICT design.

	Context 1: Healthcare professionals as ICT users in healthcare environment	**Context 2: New eHealth services for citizens' use**	**Context 3: ICT support for cooperative care between patients and healthcare professionals**
Users	Various healthcare professionals with medical experience and knowledge	"Anyone", broad population: citizens and their supportive stakeholders, (healthcare workers)	Healthcare professionals, patients, and other citizens as collaborators
Context of use	Healthcare working environment	"Anywhere & anytime" in leisure time, probably in collaboration with other users	Multiple contexts: healthcare working environment, "anywhere & anytime"
Relationship between designers and users	Users as experts (medical knowledge and current working procedures) and cooperators	Citizens as informants, innovators, and designers	Designers in between two main user groups: healthcare professionals and patients
Overall design goals in context	Support communication, and improve quality of care and clinical documentation provided by healthcare workers	Empower the citizens by means of eHealth services	Support cooperative care and patient–healthcare provider communication

Questions underlying the problem-state definition	Which are the aspects of current work procedures and technologies that need to be redesigned?	What are the future eHealth services like? *How can we motivate the citizens to actively participate in their own health and wellbeing?*	How to use the most modern technology to support cooperation and communication between healthcare professionals and patients?
General objectives of design	Redesign work processes and supportive ICT applications Support for communication between healthcare workers	Redesign responsibilities between citizens, healthcare professionals, and other stakeholders Design new eHealth services to fulfill the citizens' need Design multichannel services for patients	Integrate new applications and ways of action into the healthcare working context Enable patient and citizen-centred activities. *What are these activities in healthcare about?*
UCD fundamentals	The new information system typically requires changes in working processes. → These changes should be designed alongside with the technology.	Variety of users and characteristics. → Need for identifying the potential user groups and defining target groups. New services need to mesh with the currently used technologies.	New solutions should support both user groups in an optimal way. Patients and other citizens should be able to communicate in a way they are familiar with. → Need for multichannel services.
General design issues	The technology environment should be seen as a whole. New applications should be flexible and adapt to various use contexts and purposes of use.	eHealth services should motivate the citizens to take an active role in wellbeing, and provide them satisfactory ways of conducting health related actions. Some examples of eServices already exist (e.g., services provided by banks and posts) → What can we learn from those?	Domain-specific issues, such as privacy and ethical aspects, regulations, and legal aspects of information transfer. New solutions should be flexible and simple, in order to be easily adapted and accepted both by patients and healthcare professionals.
Applicable UCD methodology	Participatory design approach Traditional UCD methods, e.g., observation, interview, focus groups, work analysis, usability evaluation.	User-informed design approach, open innovation via Internet Quick and dirty prototypes may be used to provide feedback about services.	*What are the applicable UCD methods to be used to support the design?*
Challenges for UCD methods and user involvement	Busy healthcare workers: • How to find motivated users? • What are the appropriate methods to be used in a hectic environment?	Broad user base: • What are the appropriate methods for innovative and cooperative design? • Huge versatility in use cases	*In addition to other contexts and related challenges, what are the context specific challenges for healthcare ICT design?*

5.3. Case Study: An Early Framework Analysis

The described design framework is preliminary and therefore is to be evaluated and developed further in the near future. This section briefly describes a "digital dictation" case study example and related experiences, which are used for the purposes of an early framework analysis. The case study is described in more detail in Paper II: *Redesigning Digital Dictation for Physicians – A User-centred Approach.*

The dictation study focused on researching the evaluation and redesign of healthcare technologies from the healthcare professionals' viewpoint in healthcare surroundings. Therefore, the experiences and identified challenges for a user-centred design approach are valuable especially when considering the first context of the framework "Healthcare professionals as ICT users in healthcare" and the related aspects of design.

The dictation study employed a contextual inquiry (Beyer & Holzblatt, 1998) method for exploring the currently used dictation methods in their context of use. Semi-structured interviews were conducted with seven physicians experienced in using a variety of dictation methods. Each of the inquiries lasted about one and a half hours and was conducted in the physicians' real working environment in the target hospital. Thereafter the researchers arranged a team sharing session with the hospital project members and analyzed all the gathered data following an affinity diagram method procedure (Beyer & Holzblatt, 1998).

In the dictation study the contextual inquiry method was found to be suitable for the intended purposes. The used method provided the researchers an opportunity to increase their understanding of the healthcare technology domain while observing and inquiring about the users' actions. As was expected, from time to time, communication between the interviewer and the physician became more complicated because of the medical terminology. Researchers, previously unfamiliar with the domain-specific terminology, had difficulties in understanding the reasoning and terminology integrated in the user interfaces. For these reasons the master-apprentice model of learning, which is integrated in the contextual inquiry method, was found easy to apply.

Experiences in applying the contextual inquiry method were promising, yet thought-provoking. The contextual inquiry method enabled the researchers to gather large amounts of qualitative data and revealed needs that the users could not articulate. However, the method was challenging to apply due to time constrains and limited resources. While working in a hectic and critical environment, physicians are extremely busy with customary tasks and unexpected emergencies. The physicians were also suspicious about the interview requests for the reason that they doubted whether while on duty they had enough time for

interviewing. The researchers' experiences from the inquiries partially supported these previous assumptions. During the inquiry sessions, interruptions, caused by urgent questions and phone calls, were a rule rather than an exception. In addition, one inquiry had to be postponed due to an unexpected emergency.

In general, the physicians' attitudes reflected their doubts towards technology redesign and their opportunities to influence these decisions. The physicians appreciated the idea of adapting new technology in an effort to support their work. Nevertheless, they were not able to analyze their daily work by themselves nor did the physicians seem to appreciate the attempts to involve them in development activities.

Unexpectedly, the findings of the dictation study reached far beyond the original objectives. The qualitative research approach put the stress more on questions and flaws than ideas of enhancements or solutions. The findings revealed the need for extensive improvements both at the technology and procedure-wide levels, and indicated that the dictation procedures and solutions should be closely integrated to the surrounding technology environment and therefore cannot be evaluated separately.

In conclusion, the previously described findings and experiences supported those research and design issues already established in an initial framework. In the study, physicians as medical work experts provided the researchers valuable information about the practices, procedures and context-sensitive characteristics of work and healthcare technology usage. The dictation study indicated that in order to design healthcare ICT for healthcare professionals, it is important to understand the current working context and define the aspects that need to be redesigned.

However, the case example had its' limitations. The dictation study focused on a single user group perspective, evaluating the current dictation procedures and methods from the physician's viewpoint, whereupon other user groups were intentionally left out of the research scope. Nonetheless, in order to design hospital-wide ICT applications other viewpoints and stakeholders ought to be considered as well.

6. Conclusions

This thesis aimed at researching how the user-centred research approach has been applied in the development of healthcare ICT applications and how the research approach could be included in healthcare ICT development. The literature reviews conducted in this thesis revealed that the need for a user-oriented approach has been widely recognized in the field of health informatics; however, no research has been conducted to systematically and extensively support the user-centred design of healthcare ICT applications. Therefore, the research conducted in this thesis is valuable and stands for a novel approach to healthcare ICT development.

The main contributions of this thesis are:

- *An increased understanding of a) the main challenges underlying the healthcare ICT development and b) the current state of user-oriented research in healthcare technology domain.* The conducted literature reviews indicated that many of the current challenges in development are related to the changing role of ICT in healthcare and its delivery. The reviews also revealed that the current user-oriented research in health informatics field is characterized with certain aspects that represent a rather narrow approach on user-centred ICT development.
- *The descriptions of the three distinctive contexts of healthcare ICT design*: 1) Healthcare professionals as ICT users in the healthcare environment, 2) New eHealth services for citizens' use, and 3) ICT support for cooperative care between patients and healthcare professionals. These contexts encompass the characteristics of various healthcare contexts: the users, their tasks and equipments, and environments of use.
- *The DeHus framework for user-centred healthcare ICT design*. The presented framework includes the three healthcare contexts and describes the fundamentals and challenges for design in each context.
- *Directions for further scientific contribution*. The research findings and the described design framework indicated several directions for further research. Especially the third context of healthcare ICT design "ICT support for collaborative care" seems to be the interesting and important with regards to the future of healthcare delivery and UCD research contribution.

7. Discussion

What is the current state of a user-oriented approach in healthcare ICT development?

In general, the development of healthcare ICT applications seems to follow the traditions of system-centred design. In the healthcare domain, information technology has been adapted in an effort to increase the effectiveness of care and processes. In many cases this has yielded to a situation where information systems are designed to serve patient safety by efficient information delivery and management, and administrative perspective of care by increased clinical documentation. Indeed, wouldn't it be important to consider how these systems could be used to support healthcare professionals' operative work with patients? The described findings of user-oriented research raise the concern of which goals the adaptation of information technology in healthcare is striving for; is the most modern technology developed to serve their users or to determine how the healthcare work is to be performed?

Marc Berg (2002), in his article about the healthcare information society in the year 2013, has stated that:

> *We can make systems that help professionals do their work better: providing reminders, allowing free and fast communication, allowing fast access to patient information and so forth. ... On the other hand, we can also make systems that require meticulous data entry for the sake of "completeness", or that help managers' overview and control the work of professionals.*

Based on the literature review findings and experiences on case studies, it is easy to conclude that for the meanwhile, unfortunately, we seem to be closer to Berg's latter scenario.

Limitations of the research

There are some limitations that need to be acknowledged and addressed regarding the described literature review research. First, the literature review was not conducted in a systematic manner. Second, a relatively small group of user-oriented studies, published in various research forums, were included in the analysis. These decisions were reached for reasons of expediency.

In a non-systematic manner, I searched through several relevant research forums. Since there are no special forums for publications about user-oriented healthcare ICT development, the articles were searched from both health informatics and usability research related forums. As a result, I found an unexpectedly small group of studies.

The relatively small group of recently conducted studies indicates that the area of user-centred healthcare ICT research is beginning to gain importance in both healthcare ICT development and in the usability research field. The selected articles illustrated a variety of qualitative and quantitative research approaches on healthcare ICT use and development, and hence I did find the selected group representative enough for the purposes of the descriptive review.

The relevance of the presented research

In conclusion, I found my work about a user-centred design approach on healthcare ICT development valuable for several reasons. First, the need for considering user perspectives in healthcare ICT development has been established both in academic research forums and in public discussions. Therefore, the research area seems to have a high practical relevance.

Second, the academic research on the health informatics field is lacking commonly established models, theoretical approaches, and practical procedures for user-oriented research. For example, several essential concepts such as *usability of healthcare information system* and contexts of healthcare ICT use have not been defined or described. In general it seems that usability is a widely used, but poorly understood, concept in the health informatics field. Additionally, divergent terms are used to describe the user issues and user-oriented research approaches. The concept *user-centred design* appears only in very few research papers. User-oriented research in the healthcare ICT field seems to have its focus on usability evaluation research. Alongside with usability evaluation, other methods should be used to support user-centred design activities during the design and development phases. I believe that the user-centred analysis described in this thesis provides guidance for analyzing and structuring the research area conceptually, thematically, and methodologically.

Third, the area of user-oriented research in the health informatics field seems to be in the process of establishing an identity based upon demonstrated results and findings. Additionally, health-related research is gaining importance in the field of human-computer interaction (HCI) research. Both the analysis and the initial framework described in this thesis enable me as a researcher to present the work under progress to other researchers and thereby contribute to the academic discussions of user-oriented healthcare ICT design.

8. Thesis Summary and Further Research

From the beginning, healthcare information applications were developed to deliver relevant information to the healthcare professional and support the healthcare process by enabling a seamless information flow between different participants and different locations. Today, the range of electronic healthcare technologies already in place is huge. The evolving ICT has already influenced the way healthcare is delivered, and, in the future, is seen as a core actor in the shaping of healthcare systems and ways of action. The benefits of technology adaptation seem to be obvious in theory; however, they are not clearly associated in operating situations in healthcare environments.

This thesis reported a literature review which aimed at analyzing the current state of user-oriented research in the health informatics domain (Chapter 3 – Review of User-oriented Research in the Healthcare ICT Domain). Surprisingly few studies were found to describe healthcare ICT use and development from the user's perspective. The review findings indicated that the main reasons for conducting user-oriented studies in health informatics domain are: a) to explore user acceptance and experiences, b) to develop healthcare information systems and tools for healthcare professionals, and c) to research the usability of new technologies. As expected, most of the studies were conducted from healthcare workers' viewpoint. Only some of the studies had researched both healthcare workers and patients' experiences. The findings suggested that some research had already been conducted in the field of consumer health informatics; however, in general this branch of health informatics that strives for analyzing the consumers' needs for information and integrating the consumers' preferences into medical information systems seems to be rather young.

Many of the reviewed studies pointed out the increasing demand for incorporating user perspectives in design and development. However, the academic researchers have not proposed concrete suggestions of actions or approaches, let alone how to systematically analyze the research area and established challenges. The described review and analysis suggested that in general, user-oriented research in the field of health informatics is characterized with certain aspects, such as short-period research projects, narrow focus on user issues, and isolated system development. These findings indicate that the importance of user considerations are widely recognized and there is a growing need for more systematic and extensive adoption of a user-oriented approach both in research and development.

To address the established issues this thesis described a user-centred analysis of the healthcare ICT development domain (Chapter 4 – Analyzing the Healthcare ICT Development from the UCD Perspective). The analysis aimed at increasing the understanding of how a user-centred design approach could be applied in the health informatics domain. The descriptive analysis covered several user perspective-related themes, such as the context of use and usability issues, and also discussed how the principles of design could be applied in a healthcare context. The analysis made it possible to intertwine the two discrete research perspectives, health informatics and user-centred design, closer together, and thereby provided an enhanced understanding of the characteristics and fundamentals of user-centred healthcare ICT design.

Based on this understanding, three distinctive contexts of healthcare ICT design were identified and described (Chapter 5 – DeHus – A User-centred Framework for Healthcare ICT Design):

- Context 1: Healthcare professionals as ICT users in the healthcare environment.
- Context 2: eHealth services for citizens' use.
- Context 3: ICT support for cooperative care between patients and healthcare professionals.

The initial conceptual framework for user-centred design of healthcare ICT summons up the author's knowledge and understanding of user-centred design theories and practices, and the analysis and findings of user-oriented research in the health informatics domain. The user-centred framework for healthcare ICT development aims at increasing the understanding of how a user-centred design approach can be applied to address the current challenges of ICT development. The framework describes the three distinct contexts of healthcare ICT design and discusses the design fundamentals, and thereby is to provide background and starting points for user-centred healthcare ICT design.

It seems that the available user-centred design (UCD) methods and earlier experiences in system development in other industries can be utilized to support the design in the first and in the second context (Healthcare professionals as ICT users in healthcare environment and eHealth services for citizens' use). However, the third one (ICT support for cooperative care) challenges the currently applied UCD methods and research approaches.

The presented framework preliminary and therefore needs to be evaluated and developed further. In the near future the framework will be applied in case studies that will be conducted in the field of healthcare ICT development. The practical studies are expected to provide us with a better understanding of the special characteristics of the development domain. The intent is to gather experiences and findings of the UCD approach and with the

help of those evaluate and develop the described framework further. The following tasks are to serve as a guide through the further framework analysis and the planning of practical research cases.

Task 1: To conduct practical research about user issues concerning healthcare ICT design.

In general, more practical research is needed regarding the different contexts of healthcare ICT design. As the described literature review indicated, user-oriented studies have emphasized the healthcare professionals' viewpoint on healthcare ICT development and use; however, relatively few references were found to support healthcare ICT design for patients' or citizens' use. This task addresses the need for conducting research at least within the following thematic areas:

- Explore healthcare ICT use in healthcare surroundings from multiple user groups' perspectives.
- Evaluate and redesign healthcare ICT applications together with healthcare workers and developers.
- Explore possibilities to apply currently used communication technologies to enhance the interaction and collaborative care between healthcare workers and patients in the following ways: a) study how these new ways of action could be integrated into the healthcare professionals' working practices and daily routine actions, and in addition, b) study the patients' and their supportive parties' experiences on collaborative healthcare services.
- Design new innovative healthcare services targeted to citizens' use together with various end-user group members.

The performance of practical research requires knowledge of UCD methods and practices, and understanding of the healthcare ICT development domain. The studies should be conducted in close cooperation with potential users and developers in order to learn more about: a) the prevailing practices of ICT design, b) the suitability of user-centred research methodology, and c) the possibilities and challenges of multidisciplinary design in the health informatics field.

Task 2: To adapt the user-centred design methodology to suit the characteristics and objectives of healthcare ICT design contexts.

The UCD approach and applied methods have proven their success broadly in software and product development, but have been applied less widely in the health informatics domain.

However, within the health informatics domain, conventional UCD methods have been criticized as being insufficient for safety-critical system design (Thimbleby, 2007). Along with this argument, earlier studies have established the need for cost-effective research methods, as well as investigation of the benefits and obstacles associated with user involvement (e.g., Shah & Robinson, 2006).

It seems that the traditional methods of UCD, characterized with face-to-face communication and intensive data capturing sessions, might as such be challenging to apply in the healthcare research field. The dictation case study and open interaction methodology approach have already provided some important experiences on applying UCD methods in the health informatics field. However, the task is to more widely explore the use of UCD methods and practices in various healthcare contexts and provide a systematic comparison and suggestions for applying UCD methods in different design contexts.

Task 3: To further develop the initial conceptual framework for a user-centred design for healthcare ICT development.

Within this thesis, the experiences of a dictation case study were used for the purposes of evaluating the framework. The dictation study focused on a single user group perspective and examined the practices of clinical documentation in a hospital context. The study revealed interesting findings related to user-centred research methodology and the practical settings of healthcare ICT research. Although the early framework analysis had its limitations, all in all, it indicated supportive findings. In the future, all of the findings from the dictation case study are to be carefully considered, further studied, and integrated into the conceptual framework. Within this thesis, however, the two other design contexts (context 2: eHealth services for citizens' use and context 3: ICT support for cooperative care) were neither analyzed further nor evaluated. Especially, information about research and design methods as well as experiences from long-term projects are needed to supplement the presented framework.

To support the further analysis, tasks 1 and 2 will provide valuable information about several aspects of design in various contexts. The conceptual framework should be supplemented based on both practical findings and methodology considerations. Furthermore, the conceptual framework could be used to provide a roadmap for user-centred healthcare ICT design. The fourth task could be described as putting the framework to work: identifying fundamentals for user-centred healthcare ICT design and providing a theoretical basis for empirical studies.

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Papers

Paper I:

Viitanen, J., & Nieminen, M. (2009) Terveydenhuollon tietojärjestelmien käytettävyys (in English: Usability of Healthcare Information Systems). SoTeTiTe[1] research seminar, 2009 (submitted and accepted.)

Paper II:

Viitanen, J. (2009) Redesigning Digital Dictation for Physicians: A User-Centred Approach. Health Informatics Journal (submitted and accepted).

Paper IIIa:

Viitanen J., & Nieminen, M. (2008) Avoin vuorovaikutusfoorumi käyttäjäkeskeisen kehittämisen tukena – tapaus Tervesysteemi.info (in English: Open Interaction: Describing a New Methodology Approach for User-centred Design). SoTeTiTe[1] research seminar 2008. Stakes, Työpapereita 19/2008, pp. 90-96.

Paper IIIb:

Viitanen, J. (2008) Open Interaction: A User-Centred Approach for Healthcare Information System Development (poster abstract). Proceedings of the 13th International Symposium of Health Information Management Research conference (ISHIMR'08), Auckland, New Zealand.

[1] *Sosiaali- ja terveydenhuollon tietojenkäsittelyn tutkimuspäivät (SoTeTiTe)* is a yearly seminar on health informatics research in Finland organized by Sosiaali- ja terveydenhuollon tietotekniikkayhdistys ry.