Telemedicine and eHealth in Finland On the Way to Digitalization – from Individual TeleHealth Applications to Connected Health

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Introduction

Finland is a relatively sparsely populated country (5.5 million inhabitants) with a highly advanced technological infrastructure. Like in other Nordic countries, the health care system in Finland is mainly based on public health care providers. Municipalities, through taxes, finance most of the health care and the government is providing additional support. There are additional private services based on insurances and service fees. All the primary health care centres, secondary and tertiary hospitals as well as private service providers obey the same general health care and medical treatment guidelines and patient documentation policies, which has contributed positively to the opportunities offered by Telemedicine and eHealth [1].

In this article the authors share the Finnish history of telehealth development with strategical and national guidance, the Finnish as 'first-timers' in the change and modernizing health care into eHealth, our national FSTeH (Finish Society of Telemedicine and eHealth) association, evaluative research, development and education, example of private eHealth provider, and current situation in Finland with the experimental development attitude, and future.

National Guidance Over Two Decades – Health Care as Part of Public Administration

The first Finnish national strategy for applying information technology to health care and social welfare in 1996 focused on developing and implementing technologies that would help answer the needs for efficient, accessible, affordable and high-quality health care [2]. The latest Information Strategy for Social and Health Care 2020 was published at the end of 2014 [3]. The objective of the newest strategy is to support the renewal of the social welfare and health care sector and the active role of citizens in maintaining their own well-being by improving information management and increasing the provision of online services. To achieve these goals, the strategy states that it is essential to make active use of information related to social welfare and health care services and to refine it into knowledge that will support both the service system and individual citizens [3].

The strategy consists of six thematic areas. The strategic objectives and measures to meet the objectives are described. The thematic areas are:

1. Citizens as service users – Doing it yourself,
2. Professionals – Smart systems for capable users,
3. Service System – Effective utilization of limited resources,
4. Refinement of information and knowledge management – Knowledge-based management,
5. Steering and cooperation in information management – From soloists to harmony, and
6. Info Structure – Ensuring a solid foundation [3].

The national development of healthcare information systems and its continuous scientific evaluation is reflected against this new overall strategy.

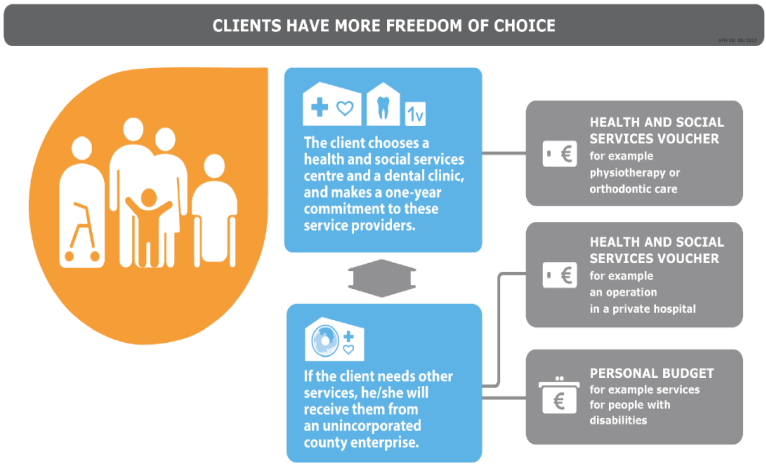
When comparing the development of the strategies over the past 20 years, one can notice that now all stakeholders are covered. Information technology and eHealth have a strategic role in health care service delivery. Integration of health and social care as well as citizens' active role are clearly written within the strategy. Furthermore, the future social and health care reform will continue supporting the 'client's choice-principle' (Figure 1) [4].

New eHealth Service Structure, National Kanta Services and Virtual Services for Citizens - Realisation of Government's National Digitalisation Programme

In order to facilitate modern health and social care, a comprehensive restructuring of care towards eCare is needed. Finland has taken bold initiatives to build a comprehensive and standardized eService architecture, which then enables various and individual eServices to citizens and to

professional use. The accumulated digital data is at the same time valuable resource for research and innovation [5]. The last ten years period has been a success story, involving both national and local authorities, as well as public and private service providers.

Figure 1. Finnish national reform enhances client participation [4]



In 2016, the Finnish Government has launched nine principles, leading to national digitalisation reform, relating all fields of administration. The principles guide information sharing and interfaces, operating models, rapid service development and preparedness, for example [6] (Figure 2).

Figure 2. Finnish principles of national digitalisation guidelines [6]

These nine principles are the jointly agreed rules for digitalisation in all public administration, including health care. The overall aim is to enhance productivity, user-orientation and the primarily digital role of all public services [6].

Today in Finnish health care, the documentation of patient data is carried out by electronic means at all levels of care. This means that the government has to launch new legislation and revise new strategies to respond to the future development needs. The Ministry of Social Affairs and Health produced in 2015 the National Finnish eHealth and eSocial Strategy 2020, which aims to support and guide the social and health care reform and promote the active citizenship in maintaining one's own wellbeing by improving data management and boosting electronic services [3].

Finland has done a lot of national development as how to make the best of the new technologies in the health care. Since 1996, Finland has acknowledged the need for information society policy development, and it has built a national strategy how to develop information and communication technology (ICT) in the field of health care. For nurses, main emphasis of the policy was the possibility to gain education related to ICT [2].

For the time being, numerous new strategies have been devised to manage the digital change. Both the Ministry of Finance and the Ministry of Social and Health have published strategies [6, 3] and a Europe 2020 strategy [7], which envisage smart, sustainable and inclusive growth in Finland as well as well functioning services for citizens. In addition to the digitalisation, European Union member countries signed a new roadmap, which says that the digital transformation of the public administration is EU-countries' collective endeavour at national, regional and local levels within EU-countries as well as by the EU institutions, respecting the division of competences. The joint collaboration aims to facilitate international collaboration, interoperable solutions and sharing of good practices throughout public administrations and across country borders [8].

Brief History of Finnish TeleHealth Presenting Some Success Stories

Pioneering Telemedicine Activities

Tele-Radiology was the first known form of traditional telemedicine in Finland.

In 1969, the television network of the Finnish broadcasting corporation was utilized to send x-ray images between university towns of Oulu and Helsinki, at a distance of 600 kilometers [9]. Because of the high costs, the system was however not applicable for routine clinical use, though the technical quality of the transmitted images was considered adequate for basic diagnosis.

At the same time, one channel electrocardiograms (ECG) sent over a telephone line were tested in remote health care centres in Northern Lapland (unpublished).

It has also been customary for a long time to have telephone consultations, discussing difficult cases in secondary care [10]. Similarly, primary care physicians (general practitioners) have also been in contact with their patients by telephone [11].

The Beginning of Modern Telemedicine

Modern digital telemedicine networks in Finland started to emerge in the beginning of 1990s. This was enabled by digital telephone and ISDN (Integrated Services Digital Network) connections even to remote locations and followed by fast network backbone connections. Early adaptation of ATM (Asyncronous Transfer Mode) technology made rapid transfer of huge datasets like medical images possible. An excellent example, digital Tele-Radiology networks were initiated quite simultaneously in the university hospitals of Turku, Tampere and Oulu [12, 13, 14, 15]. The first widespread Tele-Radiology network connecting various hospitals and primary health

care centres for consultation purposes was established by the Oulu University Hospital in Northern Finland by 1996 [16].

Taking care of different health care areas was important in our sparsely populated country. Mielonen et al at Oulu University Hospital [17] first developed videoconsultations for Tele-Psychiatry. Tele-Orthopedic consultation services were pioneered simultaneously in Pori central hospital [18] as well as between Pyhäjärvi primary health centre and Oulu University Hospital [19]. In South Western Finland, the Pori Central Hospital established a virtual Telemedicine development centre with various services [20] and in the northernmost part of the country, the Lapland County built a comprehensive Telemedicine consultation network between the central hospital in Rovaniemi and all the primary health centres in the region [21].

First International Telemedicine Network Using Internet

International Nordic collaboration in telemedicine started already in 1992, when research teams from university hospitals of Oulu (Finland), Reykjavik (Iceland) and Tromsö (Norway) joined their forces in order to build a Tele-Rradiology consultation network via NORDUnet (Nordic University network) that was a subset of the forthcoming Internet [22]. Regular consultations of magnetic resonance images (MRI) were successfully performed. To our knowledge, this is the first published international Tele-Radiology network that utilized Internet technology even before Internet was made widely commercially available [23].

From Wireless to Mobile Telemedicine, From Distant Consultations to Tsunami Disaster

Some medical specialities, such as neurosurgery, are depending on image information before they can give their consultation. The development of mobile Tele-Radiology in Oulu started in 1993 and already in 1995 a system based on a laptop computer and portable digital GSM phone was taken into clinical feasibility studies [24]. The overall weight and bulk of the system did not yet permit its widespread use. Then in 1997, the new Nokia 9000 smartphone made the dreams possible and Reponen et al. [25] managed to communicate Tele-Radiology images for consultation purposes into a pocket-size smartphone. The development for the first in the world medical application for smartphones was then started [25].

During the years 1998-2000, the European Union provided financial support for the Mobile Medical Data (MOMEDA) project, which, according to our knowledge, provided the first pocket-size multimedia electronic patient record (EPR) terminal and mobile app for physicians. This system made a revolution to the concept of having patient information at the point

of care, even outside the hospital. When a request for a consultation came, the system sent patient images with relevant referral text from the hospital EPR to the smartphone terminal. All the diagnostic image manipulation could be made using the smartphone and additional data requests could be performed through a secure web browser to the cloud based hospital EPR system. Finally, the consultation answers and further advice for patient care could be communicated back to the hospital information systems. The communication channel was separated from the hospital systems with secure host computers and the mobile terminal safety was carefully considered [26]. The MOMEDA smartphone terminals were taken into clinical use at the department of neurosurgery of the Oulu University Hospital [27]. They were also used successfully for helping the victim recognition by forensic dental image transmission after the Thailand tsunami disaster in 2004 [28].

During the years 2002-2004, the European Union supported the Professional Mobile Data Systems (PROMODAS) project, which further developed the ideas of medical mobile smartphone terminals and applications to new platforms. The new applications enabled to see more of the patient information and displayed it faster at the point of care with a user-friendly graphical interface [29, 30].

From Telemedicine to eHealth – EPR as a Backbone

By the end of the millennium, the main emphasis had changed from separate Telemedicine solutions to more comprehensive eHealth entities. EPRs were built as a backbone of services, together with picture archiving and communication systems (PACS) and laboratory systems [31]. Public healthcare providers developed and purchased EPR systems with integrated laboratory and imaging components. Oulu University Hospital was the first tertiary care institution in Finland to develop a modern, private cloud based and portal type EPR with seamless integration of images and laboratory data [32]. Other hospital districts followed with their digital solutions and at the same time primary care centres turned digital very quickly. By 2007 all the medical records as well as images and laboratory data in public secondary care sector were in digital format and this was also the case for the public primary care facilities with only a few exceptions [33]. Finally, by 2010 all major private sector service providers had comprehensive EPR systems, too [34].

The digital backbone made new type of services possible: the regional usage of image archives started since the new law in 2011 has made separate Tele-Radiology connections unnecessary. This meant that remote reading and image interpretation was using existing archives. Laboratory data were also regionally available, making treatment consultations easier than before

[34]. When primary care and private sector had their own EPRs ready, they could start sending electronic referrals to specialist secondary hospitals [35, 36]. Many of these electronic referrals could be answered by an electronic consultation advice, without transferring the patient. Thus, Telemedicine in Finland was structurally built into the eHealth infrastructure.

In addition, health services for pregnant women were developed, i.e. services, which could utilise internet-based platform. In the Beginning of Life project, one health care service chain (maternity service path) was being used as a model, and the pattern was renewed with the help of the most advanced and recent information and communication technologies (ICT) in 2000. The project developed a new service, Maternity and Infant Clinic on the Net (Net Clinic), which was piloted in authentic environment via Internet to users. The project gathered and studied all the participants' experiences on the new practice including the pilot families, public health nurses, midwives and doctors. There is a presentation of the Net Clinic [37], how it works, what the benefits or hindrances are and how it influences on one's health. The project was a development start to many today's online service e.g. Hyvis-services in the middle-east of Finland [38].

Assessment and Benchmarking of Telemedicine and eHealth

The Finnish Office for Health Technology Assessment (FinOHTA) initiated projects for assessment of Telemedicine services already in the 1990s. Ohinmaa et al [39] published the Finnish assessment guidelines for the cost-benefit analysis of telemedicine services. A national Telemedicine evaluation network, including university hospitals in Oulu, Turku and Helsinki, was established and Tele-Radiology, Tele-Orthopedics, Tele-Psychiatry and electronic referrals resulted most from the research data [39, 41]. After the year 2000, many academic thesis have discussed various aspects of Telemedicine, e.g. remote video-consultations of a primary care physician [42], Tele-Rehabilitation [43], and reorganizing neurological consultation services with remote consultations [44].

The University of Oulu founded the FinnTelemedicum research unit for the evaluation of eHealth services in 2003. Together with the National Institute of Health and Welfare (THL), the FinnTelemedicum has performed a longitudinal study in order to follow the availability and intensity of use of EPR systems and eHealth services since 2003 [45].

Every three years all public health care institutions are contacted as well as the most important private health services providers. This series of surveys gives a precise portrait of eHealth development in Finland, using the whole country as a living lab [46].

The Finnish Medical Association together with the University of Oulu, the Aalto University and the National Institute of Health and Welfare has since 2010 made a research of the usability and the user experience of EPRs from a physician´s perspective. This series of surveys has reached the largest base of respondents in the world for its kind of studies (approx. 4000 respondents in each of its three editions). The results have been published both in national and international publication series and they have been used for the development eHealth tools [47, 48].

These above-mentioned studies of the eHealth availability, intensity of use and usability have grown to a large joint research program called STEPS 2.0 [49], which also includes nowadays surveys of citizen´s experiences and usability issues from the perspective of nursing staff. The eWelfare aspects of the electronic social care are included in the study program, too. This research program is supervised by the National Institute of Health and Welfare and financed by the Ministry of Social Affairs and Health. This Finnish eHealth and eWelfare research program gives now a comprehensive image of the national development.

The Nordic eHealth Research Network (NeRN) was established in 2012 as a joint forum for the policy makers and researchers in the eHealth domain [50]. The network has performed eHealth policy analysis and developed common eHealth performance indicators for the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden). The indicators have been used for benchmarking eHealth development in participating countries. Most recently, common eHealth indicators from a citizen´s point of view have been suggested. The work has been done in close collaboration with similar activities of WHO (World Health Organisation) and OECD (Organisation for Economic Co-operation and Development) [51].

Society and Publication Activities in Telemedicine and eHealth

The Finnish Society for Telemedicine and e-Health (FSTeH) was founded on the 11th of January 1995 and it is the second national Telemedicine society formed after the American Telemedicine Association. The aims of the society are according to its statutes twofold: 1) to promote population health through telecommunications and 2) to disperse expert knowledge within health care. The society is multi-professional and its membership is open to individual persons, corporations, other organizations and supporting members. Discussion within the organization benefits from the different backgrounds of the members, e.g. physicians, nurses, engineers, business people, researchers, educational staff, and health administrators. The FSTeH is a founding member of the Nordic Telemedicine Association (NTA) and the new International Society for Telemedicine and eHealth (ISfTeH) [52].

The main activity of the FSTeH is the Finnish National Conference on Telemedicine and eHealth, which had its 23rd edition in 2018, in conjunction with the 23rd ISfTeH International Conference (#eHealth2018). Since 1995, the Finnish National conference has brought together the newest innovations and hottest discussions in Telemedicine and eHealth. Every other year the conference has an international focus, when it is programmed as a cruising conference on a ferry between the capitals of Finland and Sweden. The conference has visited even Estonia and it has been organized in its turn together with the NTA as the official Nordic eHealth conference. The results of the previous conferences have been published with English texts or abstracts in proceedings books and on the society website [53].

The Finnish Journal of eHealth and eWelfare (FinJeHeW) is a scientific journal established by the Finnish Social and Health Informatics Association (FinnSHIA) and the Finnish Society of Telemedicine and eHealth (FSTeH). It was established in 2009 according to the vision of late adjunct professor Ilkka Winblad, who also served as the first editor-in-chief of the journal [54]. The journal publishes high quality peer reviewed research articles on information and communication technology of social and health care, Telemedicine, eHealth, and eWellbeing. It includes also a news section and a discussion forum. FinJeHeW is mainly a Finnish language journal, but it also publishes articles in English and includes English abstracts of most Finnish language articles. It presents a most convenient tool to keep updated about what is taking place in Finnish eHealth and eWelfare research and education. There are four issues annually, they are all published online (available by way of passwords issued by the related associations or author passwords, free access three months after publication date) with special printed issues for conferences [55].

eHealth Education for Health Care Personnel

Medical doctors have long been missing a formal education in eHealth and Telemedicine. As both disciplines are becoming more and more important part of daily medical practice, a reform was needed. In Finland, the target was approached from two viewpoints: a special competence program for already qualified physicians and basic eHealth education package for medical students.

Special Competence of Healthcare Information Technology for Medical Doctors and Dentists

Finland was, to our knowledge, the first country in Europe to establish a professional special competence for healthcare information technology (eHealth) since 2012 to physicians [56] and since 2015 to dentists [57]. The special competence requires two years full time service in healthcare

information technology related positions and approved theoretical studies after a qualified medical specialist consultant status or a relevant experience as a dentist. There is a national coordinating committee and the fulfilment of the competence is testified with a peer-reviewed portfolio. Those who have earned the title are thus already experienced doctors and dentists. The new competence gives them an ability to utilize their knowledge about health care processes for the benefit of the new eHealth and mHealth services. By the end of 2016 a total of 87 professionals have been enrolled to the program and 58 physicians and three dentists have already graduated. Those who have graduated with the special competence have found positions as leading healthcare information technology experts in enterprises or in administrative tasks in regional or national healthcare information technology projects. This professional eHealth special competence program is a joint effort of the Finnish Society of Telemedicine and eHealth, the Finnish Medical Association and the Finnish Dental Association [58].

Oulu as a Pioneer: eHealth for Medical Students

The Faculty of Medicine at the University of Oulu was the first in Finland to offer medical students a special training package of eHealth since 2016 [59]. The regular springtime two days training is targeted to the fifth year medical students, who are eligible to work in primary health care centres during the following summer. The education starts with a half day of lectures including up-to-date process sets and future possibilities in eHealth from video consultations to artificial intelligence. Then during the second part of the thematic day, all the 130 medical students meander between the stands of thirty digital companies at Oulu University Hospital's Testlab. They can try the work of a virtual doctor over a chat application, use the electronic stethoscopes or wellness applications. The secrets of electronic patient record and various sensors, connected to decision support tools, are explained to them. Finally, the students write a short course essay and evaluate the products from a perspective of a primary care physician. According to a student´s comment this type of education is a real eye-opener, e.g. about the possibilities of artificial intelligence for processing the ever increasing amount of medical data. Finally, the eHealth theme is completed during the second day with a hands-on training in a real electronic patient record environment [60].

The New Strategy Guiding Nurse's Education and eHealth Competences

Furthermore, information systems important role is to support nurses' daily work via better informed decision making. The user-friendly digital tools will be part of every nurse's work and enhance nurses' operation

models, which are agreed in organisational level. Simultaneously as the technology develops, new competences and working ways are necessary to fulfil the nursing mission. Information Society reflects to all health care field. As nurses are the biggest group of health care professionals, they should be actively involved in planning and creating eHealth services in conjunction with other professions and the public. According to Staggers et al [61] and TIGER initiative [62] nurses need technical skills and knowledge with respect to the basic computer competency, information literacy and information management. All nurses must have possibility to get enough education and training related to digitalized tools, including updated privacy and data security issues.

To attain these objectives, it is crucial to benefit health care information, which can be used to forecast and prepare for the future working life.

In 2015, FNA (Finnish Nurses Association) wanted to create a National eHealth Strategy for Finnish nurses. FNA published its eHealth Strategy 2015-2020 [63].

The development of the Strategy was as follows: ten experts' group from various fields of nursing, e.g. nursing practice, higher education, nursing research and administration, were invited to write the national strategy. Along with experts' knowledge, also the strategical papers from the ministerial and as well as all-international, e.g. European Union, publications, guided the strategic work right from the beginning. The experts operated closely with the FNA and the change of information and opinions was essential during the process of Strategy building. The main goal of the expert group was to describe nurses' contribution to the national strategy concerning digitalization of health care development and implementation in national level. The group searched for answers, discussed strategic issues, wrote drafts, and sent texts for open commentary circles. One leading issue was that the technology is and will be growingly support patient/client participation. This supports the today's situation because in all Nordic countries the health care becomes more and more patient-centred (Figure 3).

The chosen themes of the eHealth strategy deal with the role of the client, nursing practice, ethical aspects, education and eHealth competences, nursing leadership, knowledge management, research and development.

Figure 3. eHealth supporting nurse and patient towards multi-professional collaboration [64]

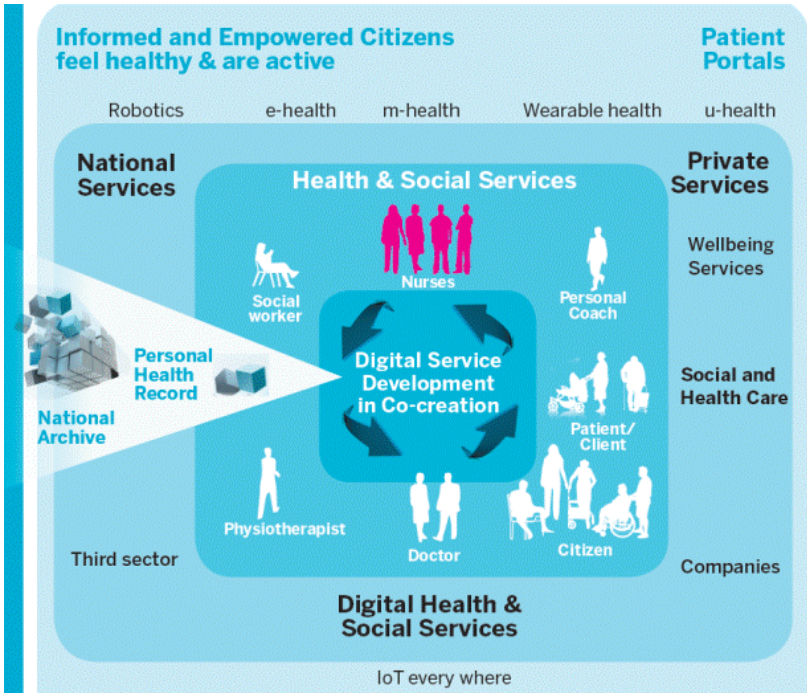


Figure 4. Six components of eHealth Strategy [63]

In FNA´s strategy nurses eHealth Competences are one main themes (Figure 4). There are two main objectives for nurses competencies as first: "Nurses know how to use information and communications technology in

nursing effectively and responsibly." and as second: "Nurses have basic skills in using technology as well as data literacy and information/knowledge management skills for functioning in eHealth services." The FNA´s strategic target is that nurses would have the opportunity to deepen their knowledge of eHealth services in specialised studies, master's degrees at universities of applied sciences and universities, so that they can operate in specialist duties in informatics, both in clinical work and teaching and research in the field of informatics. The second target is that nurses are able to demonstrate their expertise by applying for the title of specialist from the FNA. The third one is that nurses actively participate in the multi-profession discussion of eHealth service expertise with the aim of broadening it nationally and internationally. Employed nurses have the opportunity to deepen their expertise in this field [63].

Nurse Education in Digitalised Health Care

In Finland, we have versatile offers for the advanced nurse education. According to Staggers [61] there are four levels of eHealth competency that are based on experience and training.

Level 1: New nurses, have basic competence and skills in informatics and health literacy, as well as in the use of various types of technology. The main mean is that students taking upper secondary qualifications in nursing at all universities of applied sciences acquire competence and skills to use eHealth service procedures in informatics in patient care planning and care. They must be equipped to participate in the development of work processes and tools in their work community and to use of eHealth service tools as intended.

Nurses can also take optional study module about eHealth and health informatics content. There are many variations, and one example is Developer of Digital Health and Welfare Services Studies, with 15 European Credit Transfer System (ECTS) credits in multidisciplinary group [65].

Level 2: Experienced nurses are proficient in their own area of specialisation and will be highly skilled in informatics. They will use information technology to support their work and in cooperation with nurses specialised in for improving various procedures.

Universities of Applied Sciences (UAS´s) in Finland are having specialisation training e.g. Developer of social and health services, 30 ECTS credits.

There the core contents are developing services and leading process as example: Renewal of social and health services, Customer-oriented social and health services, Digitalisation and eServices, Quality of service and

impact assessment and Social and Health Economics. These studies are in European Qualifications Framework (EQF) level 6.

Level 3: Nurses specialised in informatics are experts in this field, trained in both nursing and informatics. They are involved in the development of the information systems used by their organisation, drawing on their own specialist knowledge. There are two way to have level 3 and 4 competence. The one is master degree in UAS, where the student´s need to have three years working period after bachelor level of studies. In health informatics, there are different variations in different UAS´s to develop competence in this area. In Laurea UAS there is a master degree program where the main focus is in change leadership in social and health care of future management. In particular, it appears as a proactive transformation management in the development of public and private social and healthcare environments. In addition, different forms of leadership are studied through courses, for example: process management, information management, and the development and management of digital services. During the studies, the capacity for investigative development will also be improved [66].

In September 2017 Savonia university of Applied Sciences launched a new master education, Master's Degree Programme in Digital Health (90 ECTS credits) which offered online. The programme provides the graduates with skills needed for innovative development of advanced social and health care services, service production, expert organisation management and for the development of digital service quality and management. The studies also prepare the participants for planning, implementing and evaluating the social welfare and health care reform in different operational environments. The programme is available to health care staff, engineers and business and administration personnel working near eHealth field [67].

Level 4: Informatics innovators are information management developers, who research and develop theories and superintend information management practices and research. All nurses have the resources and will to use currently existing electronic information management equipment, to further the good care of clients, and the health and wellbeing of citizens.

Nurses have a possibility to have doctoral studies in eHealth at the University of Eastern Finland. The Master Program of Health and Human Services Informatics started in 2000 and it´s the only one in our country. The aim of the education based on the expertise of the content of social and health care services is to provide experts and researchers in social and health care information management by creating the skills needed to design, manage, implement and evaluate the exploitation of information resources in social and health care organizations. Health and Human Services Informatics studies lead to a degree in Health Sciences (MNSc) or Social Science (M.Sc.,

Social Management Science/Health and Human Services Informatics). There is also a possibility to complete a doctoral degree from this programme [68].

The Finnish Nurses Association has launched the standards for special competences of nursing informatics (NI) specialty Certificate. The Certification may be admitted to a registered nurse working in Nursing Informatics (including eHealth) and demonstrating the required merits via electronic portfolio in following in following areas: Working experience, Formal education Cooperation and developmental work. The requirements of the certification are all together worth 200 ECTS credits. The Certification has to be updated ievery five years [69].

One of them is COPE - Competent workforce for the future project. There is a research area "how digitalisation requires a shift in professional identity, attitudes, roles and work processes". The project collecting feedback on the use of electronic services to identify factors supporting efficient use. Willingness to use a service is enhanced by how useful it is perceived to be, how easy it is to use, how suitable it is for existing work processes and how the service is implemented in the organisation [70].

In Finland social and health care needs to have reform and division of labour and requirement for the reassignment of the labour. One of the reasons is the growing field of digitisation, but the main reason is to achieve customer oriented processes. This means new kind of agreements on the professions competence. It means also new combined professions [71].

Multi-professionality in eHealth

Advanced health care and engineering have found each other. In Turku University of Applied Sciences, a Bachelor's degree in Engineering in a university of applied science requires 4 years of full-time studies (240 ECTS credits). The studies are divided between basic and vocational studies, industrial work placement and a thesis project. The overall goals of a degree program are defined as a set of competence requirements that a graduate of the program shall meet. These competencies are divided in general competence requirements common to all Bachelor's programs in the Finnish universities of applied science and in subject specific competencies common to specific degree programs. Moreover, an additional set of competencies are usually defined for each specialization, too. The subject specific competencies of the degree program in Information Technology are mathematical and scientific skills, hardware expertise, and software expertise, proficiency in ICT business and proficiency in ICT engineering [72]. The subject-specific competence requirements set for the specialization

in Health Informatics are proficiency in healthcare and well-being and information system expertise, for example.

National eHealth Backbone – The Kanta Services

Over the decades, the health care field has actively followed national and EU strategies. According to a government act in 2007 [73] it has been mandatory for health care service providers to join into the national eHealth infrastructure. Finland has built a common national health information exchange (HIE), the Kanta services. The main components are Patient data repository services, Patient data management services, ePrescription services and other national infrastructure services like National code server, Certification services and Health care professionals register. The infrastructure is based on international standards like e.g. Health Level 7 Clinical Document Architecture release 2 for medical records, (Digital Communication in Medicine) DICOM for medical images and Integrated Healthcare Enterprise (IHE) profiles for information exchange. The access to the services exists through secure communications for public hospitals and primary care centres, for private health care organisations and pharmacies as well as for individual health care professionals [74]. In addition, connections to other European countries take place though the Kanta infrastructure. This has been piloted in European epSOS project between Finland and Sweden [75].

For the citizens of Finland there is a special interface to the service, called the My Kanta pages. Every citizen has a secured digital access to his or her own medical information, can read his/her own visit summaries, diagnoses, test results and medication lists. Citizens even have an access to the log data, so they can follow which health professionals have accessed their prescribed medication lists or other health data. The patients can manage their own consent and decide if other than their original service providers can see their health history [76]. Today, My Kanta pages are among the most valued and trusted Internet services in Finland [77].

The enrolment of Kanta services has been a success. Since 2017, only electronic prescriptions are used in Finland. The citizens can collect their prescriptions from any pharmacy, because all pharmacies are connected to the system. All the public health institutions and all but the smallest private health service providers have joined the Patient data repository [78, 79]. This means that the medical history follows the patient even to future service providers [80]. The next phase will be the inclusion of social care data to the same national infrastructure. The rollout is scheduled to take place in 2018 [81].

The newest addendum to the Kanta system is My Kanta Pages Personal Health Record (PHR). PHR is a national database in which citizens may enter information on their health and wellbeing. Health and wellbeing information refers to the citizens' measurement, lifestyle and activity records directly or indirectly related to their wellbeing and promoting their health. Using the service is voluntary [82].

Citizen Centred Virtual Services

Virtuaalisairaala 2.0 (The Virtual Hospital 2.0) is a project aimed at developing client-oriented digital healthcare services. It is a joint effort of all five Finnish University Hospitals (Helsinki, Turku, Tampere, Oulu and Kuopio). The different areas of the project are:

1. Production and implementation of services: the Terveyskylä.fi ('Virtual village') service offering information, advice, self-care, symptom navigators, digital treatment pathways, and tools for citizens, patients and professionals;
2. Innovation farm: innovation workshops, piloting, and research plus the required researcher's tools; and
3. Development of services and changes in operation: development model, developer network and centres of expertise [83].

The project's central outcome is the Terveyskylä.fi ('Health Village') digital health service. It provides information and support for citizens, care for patients and tools for professionals. The service comprises various themed virtual houses, some of which are already open. By the end of 2018, more than 20 houses and services will be available for more than 30 groups of patients.

The project makes digital healthcare services available to all Finns regardless of their place of residence and income level, thus improving the equality of citizens. Digital services are especially well suited for monitoring the quality of life, symptoms and lifestyle, and also for living with a long-term illness before and during treatment and in the monitoring stage of the treatment. The services thus complement the traditional treatment pathways [83].

Another project for developing intelligent digital health care services is ODA – Digital Self-care services. The ODA project aims to build a personal healthcare clinic at home in order to acquire and implement digital, device-independent service package including electronic well-being check-up and training, smart diagnosis, estimates about need for services, and electronic well-being plan. The ODA service package will be integrated with electronic patient records and other electronic services (e.g. appointment, laboratory test results). In addition, the ODA service package enables the utilization of

data collected and entered by the client himself/herself. Smart combination of data from different sources provides fluent, automated self-care service chains and guides the user to receive timely services. Primary healthcare units of major cities in Finland run the ODA project. The project is a continuation of already existing self-care and appointment services, bringing more intelligence into those services. Both ODA project and the Virtual Hospital 2.0 project collaborate in order to build a seamless service interface to citizens [84, 85].

Private Health Care

Case: Terveystalo– Contact a Doctor Online 24/7. Can You Treat Patients Chatting with Them?

Terveystalo is the largest private healthcare service provider in Finland. With its 170 units, 17 hospitals, 7000 healthcare professionals and 4 million annual visits, it provides a unique nationwide network that uses one common electronic medical record (EMR). Terveystalo operates in two major business areas – occupational health care and outpatient clinics that serve private customers [86].

Finland has uneven distribution of service availability and delivery. Today the country has 311 municipalities that provide tax-funded healthcare services for its residents either alone or in joint operations with other municipalities. The uneven division of population – and tax payers – has, over the years, led to an uneven distribution of services. This, in many places, can be seen as shortage of availability in healthcare. There has also been a tendency to reduce acute primary healthcare services outside office hours, which has led to increased demand of services in the private sector.

Finland is undergoing a major reform of social- and health services. The cost of public services in this sector has risen dramatically over the past few decades. This combined with an aging population and migration to urban areas has led to an unequal distribution of services and growing dissatisfaction of public services. The small municipalities have been seen as too small to organize social and healthcare services. The aim of the upcoming reform is to achieve better services that are not only more customer-oriented, effective and cost-efficient than before but also better coordinated. There is also a strong intent toward increasing the citizens' freedom of choice. This will be organized by opening service delivery for competition.

Today, in addition to tax-financed healthcare services for all citizens, every employee is entitled to preventive occupational health care financed and arranged by the employer. The provision of medical care is voluntary for employers, but most employers do provide medical care. Kela (The

Social Insurance Institution of Finland), national sickness insurance authority, funds parts of occupational healthcare costs [87].

The public health care services and occupational healthcare are complemented by private healthcare services funded by both private insurances and out-of-pocket of the end users. The main reason for using private healthcare services are shortage of availability in public services and the wish to directly consult a specialist – or the wish to choose one's own doctor, which is not often the case in the public sector. In public healthcare, general practitioners (GPs) function as gatekeepers e.g. when consulting specialists.

Both the public and the private sector have seen digitalization as one possibility to tackle the uneven distribution of services. Digitalization of public services is even one of five strategic priorities of the Finnish government [3]. One of the ways to achieve this strategic goal has been deregulation, which means that bureaucratic barriers have systematically been removed from preventing the implementation of new services and innovations. From the point of view of providing online healthcare services, the most visible barrier was removed in late 2015. The National Supervisory Authority for Welfare and Health (Valvira) then approved of providing healthcare services online, e.g. by means of a video call or a smartphone. Valvira assigned a set of rules that define the baseline for online healthcare services for every provider. The rules include data protection and cyber security, patient safety and the proper training of the healthcare professionals delivering online care [88].

Doctor Online

This decision made it possible for Terveystalo to launch a new service, chat with a doctor online. During the relatively short service design period, it became evident that there is both customer need and the possibility to treat certain medical conditions via a direct chat discussion with a doctor without compromising high standards of quality and patient safety [86].

The service was initially aimed at occupational healthcare customers. The service was at first provided on weekdays from 8 am to 8 pm only. Very soon, the customers expressed their need to use the service also on weekends and in the night when it is almost impossible to get attention to non-critical health issues elsewhere. Five months from the launch the service was extended to 24/7 availability and it also started to serve out-of-pocket private customers.

With over 200 general practitioners and occupational healthcare physicians in the virtual team, online chat has served tens of thousands of patients during the first year. The amount of customers first rose slowly, but

steadily, and after the first year, it served as many patients on one day as does a traditional health centre with 15 to 20 full-time physicians.

The physicians are private practitioners who have volunteered to do a novel kind of work. They are mostly not in the beginning of their careers – online consultations demand highly experienced professionals who are comfortable with their clinical skills and decision-making. It is also of essence to be able to manage different care options without the possibility to examine the patient themselves. It also requires a certain level of technical ingeniousness to be able to handle the different software programs. They are trained to use the software at online sessions or using a manual. One assistant is responsible for resourcing (nights, national holidays).

Usually the physicians also take care of traditional on-site patient visits and pick patients from a virtual queue when they have time between appointments or before and after the day at the office starts. They can also be in their own homes or even travelling themselves, as long as data security has been taken care of. The Finnish Patient Insurance Centre also demands that both the doctor and the patient should be in Finland during the online visit in order to be valid. All the online physicians form a virtual community, with the ability to consult one another, discuss various topics and create a sense of a common target – to deliver high quality medical care in a new environment.

From the customer's point of view, there are many advantages with an online session with the physician. Firstly, queueing time is very short, usually the response time is around a few seconds. The access of the service has nothing to do where in Finland the customer is, and it has helped tremendously in areas with low availability of physician resources. Around 80 % of the chat appointments last less than 12 minutes, and during the chat session it is possible to have medicines prescribed and referrals done. In Finland, there is the obligation to prescribe medication via an online system, which functions well in an all-online environment.

When designing the service, there was a preconception of the customer need for video visits. This proved to be wrong – using the video connection was not what the customers wanted – or the physicians needed in order to make treatment decisions. The customers expressed the need to discuss their problems real-time, from where they are – at home, in their offices, in meeting rooms, airport lounges etc. Physicians, too, said they seldom needed video contact when they had access to previous EMR information and could discuss with the patient further. Much more often there is a need to send pictures, e.g. of skin lesions or an inflammation of the eye.

There are several indications in which the online chat appointment works especially well. The most common reasons for consulting the online chat are and typical considerations for the physician are listed in Table 1.

Table 1. Main reasons for the Online Doctor

Common reasons for visiting online chat	Customer need for virtual appointment	Examples of considerations
Acute respiratory symptoms – cough, sore throat, fever, running nose etc.	Need for an expert opinion, is it safe to treat symptoms or is further diagnostics or antibiotics required	Sometimes requires diagnostics such as strep test, C-reactive protein (CRP) or radiology. Prescription of antibiotics not allowed at virtual clinics
"Red eye" – acute conjunctivitis and other acute symptoms of the eye	Acute symptoms, which typically are not severe. Need for prescription medicines	Differential diagnostics – possible severe conditions. Contact lenses users need to be examined
Urinary tract infections	Acute, but familiar symptoms in female patients	Male gender, pregnancy, general symptoms, allergies
Allergies and skin manifestations	Acute symptoms, need for recommendations on self-care, prescription renewal	Correct diagnosis, pictures, follow up
Prescription renewal	A chronic disease, such as high blood pressure, cholesterol or asthma. No new symptoms or side effects, no need to meet a doctor	Background information on the patient usually readily available in the EMR. Often need to check laboratory tests etc., that can be ordered online. Need to plan future care and communicate it with the patient
Family planning / birth control	Need to consult on different options. Renewal of prescriptions	Consider need for gynecology status + mammography

Sexually transmitted diseases (STDs)	Fear of STDs or need to have an expert opinion on self-testing	One STD does not rule out other STDs. Consider further testing
Erectile dysfunction	Sensitive issue, wish to discuss without face-to-face contact. Renewal of prescriptions	General health status, e.g. coronary artery disease. Underlying conditions, co-morbidities
Mental health and traumatic experiences	Sensitive issues, wish to discuss without face-to-face contact. Often first point of contact	Plan ahead, consider care options, check for suicidal symptoms. No prescriptions of central nervous system (CNS) affecting drugs online
Malaria prevention and other travelers medicine	Need for prescriptions and vaccine information prior to travelling	Check interactions, ask about other medications and possible underlying mental health issues (malaria prevention)
Headaches and migraines	Usually the diagnosis is clear, and the customer needs a prescription or a second opinion	Serious underlying reasons have to be excluded. No prescriptions of CNS affecting drugs online

The session starts with strong authentication of the patient via a patient portal. The first available physician picks the patient from the queue and starts the discussion with an open question. During the chat, the physician considers a variety of issues, such as certainty of the diagnosis, need to further diagnostics or a physical examination, availability of services if there is a worsening of the situation, the patient's readiness to follow instructions etc. When the physician has concluded his/her opinion, he/she instructs the patient on next steps: medication, follow up, sick leave, laboratory tests, imaging or consultations. Medicines are prescribed and ready for pickup at the nearest pharmacy. The patient is encouraged to contact the chat or a traditional appointment if recovering does not happen as planned.

We measure the quality of the online services with different indicators:

- Response time,
- Aborted sessions because of technical faults,
- Use on antibiotics (should never be prescribed online in upper respiratory tract infections),

- Use of medicines affecting central nervous system (should never be prescribed or renewed online),
- Feedback from customers.

There are several lessons learned from the first year of this new service. The patients are satisfied with the speed and reachability of the new service. It seems that there are several medical indications in which chatting with the physician are more than sufficient, without compromising patient safety. From the point of view of the ongoing social and healthcare reform, these kinds of service innovations would be game changers. The new allocation of resources would save face-to-face time for those most in need, e.g. in primary healthcare receptions or emergency rooms. The new way for a physician to organize the working days and being a part of the online community creates an unprecedented flexibility to working life.

The competitive advantages Terveystalo has in the field of online healthcare services are:

- The amount of physicians – sufficient to deliver service 24/7, 365 days a year;
- The network of traditional units that complement the online services, e.g. laboratory and imaging;
- One electronic medical record that helps in decision making and planning ahead [86].

Ethical and patient safety issues must be closely considered during the innovation and implementation of any new service. Several issues must be taken into account, like data privacy, cyber security, training the physicians, and pricing, marketing and resourcing the service. The triage of patients must be given thought. Collecting feedback from both the physicians and patients is of essence in continuous improvement. An ongoing discussion between the service development and the online community of physicians has proven extremely helpful. The physicians in the virtual team regard it as their working place, and it has become their go-to place with all their work-related questions. In this sense, it has increased the overall work-related wellbeing of the physicians in a way we did not take into account when implementing the service. The online chat cannot turn into a place where drug addicts seek their daily fixes or drug dealers get their stock. This is why we have, from the beginning, ruled out any prescriptions of sleeping pills, strong painkillers and tranquilizers. It has also been important to maintain high standards in the use of antibiotics in order to fight resistant bacteria and other unwanted effects, and this is why we have followed closely their use. It cannot be stressed enough how important it is to have experienced physicians delivering the service.

The digital era gives us plenty of possibilities to create meaningful, high quality services. The problem is not really technology – other industries use much more complicated and sophisticated solutions. The complexity comes from understanding the process from both the customers' and professionals' point of view and designing a service that creates value for both.

What Is Happening Today in Finland

Experimentation Culture

Promoting good health calls for new global solutions to keep people healthy and active for longer. This requires new approaches, more agile and flexible social development methods alongside with proper planning, preparation, foresight and preparedness. Experimentation culture is one method to find new solutions and is one of the Finnish Government's key projects [89]. Experimentation culture is quite typical for digitalisation and provides more agile and flexible development methods alongside with proper planning, preparation, foresight and preparedness that are more common in healthcare.

This new way of doing challenges healthcare and at the same time it provides an advantage of digitalisation in modernizing services effectively. Experimentation culture highlights the importance of decision-making, managerial and personnel commitment as well as new business in order to achieve permanent changes as well as open-minded and forward-thinking attitude.

Through its experimentation culture, Finland has a vision to become a nationwide living lab and testbed for developing future healthcare solutions in an authentic healthcare environment. For example Oulu [90] and Kuopio [91] regions have started living lab services (university hospital and primary healthcare), where companies receive information about the usability of their solutions, while healthcare providers get information about the benefits of the latest solutions and their cost-effectiveness.

Games for Health – Innovative Ways to Promote Health

An emerging field, combining Finland's long history of digitised healthcare information and the rapidly growing mainstream video gaming industry, is the 'Games for Health' [94]. These specialised games have desired health outcomes [95] and are used to encourage citizens to take responsibility for their own health and self-care.

The 'Games for Health Finland' ecosystem integrates state-of-the-art research, standardisation, safety, living labs (smart cities), user involvement and fast prototyping to promote entrepreneurship for global business [96].

Experimentation culture together with Games for Health provides very promising approach to new health innovations through game jams and hackathons with a health twist [97]. The game jams and hackathons are well-established concepts that are used globally to gather people with all kinds of backgrounds to participate to test their ideas and skills, be creative, share experiences and express themselves. In Finland, the Ministry of Social Affairs and Health is active promoting these hackathons to find ideas for enhancing future nationwide eHealth services [98]. This is an example of how cross-sectoral collaboration around new technologies such as Internet of Things (IoT) and smart cities can create innovative solutions that motivate different user groups to achieve health benefits and at the same time reduce inequalities.

mHealth Boosts Digitalization in Wellbeing and Health

The World Health Organization considers mHealth as a component of eHealth and defines mHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices" [99]. mHealth applications (mHealth apps or health apps) are application programs that offer, for example, health-related services for smartphones and tablet PCs. Such applications can be downloaded from places like Google Play and Apple AppStore.

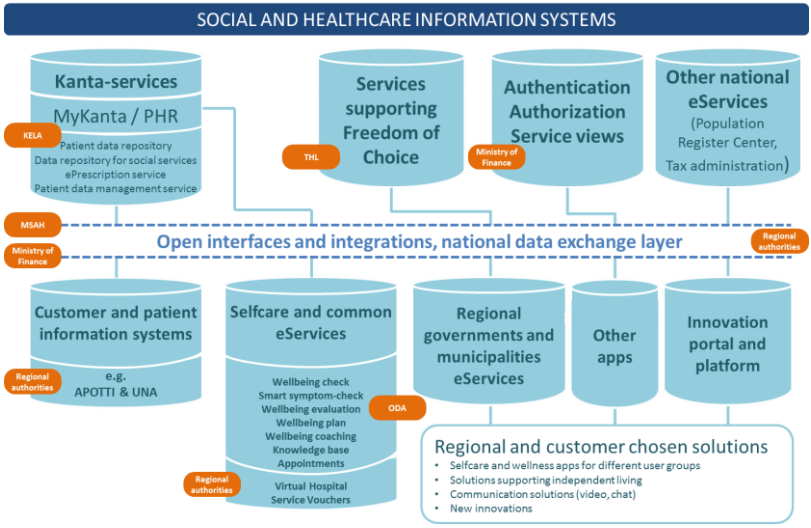
There are almost as many mobile telephone connections in the world as there are people. A vast number of mHealth apps related to health and welfare are available and can be used by mobile phones, smart phones and tablets [100]. In Finland, mHealth apps are seen as enablers of more accessible services and totally new services in future. Finland is a high user of mobile data services and has the highest mobile data usage per Subscriber Identity Module (SIM) in the world [101]. Mobile applications allow easy access to services and empowers own health management, wherever you are. The national social and healthcare information system architecture [Fig. 4, 102] builds upon open interfaces and promotes new innovative applications to be applied through innovation portal (e.g. connected to national personal health record).

Conclusions

In conclusion, Finland has developed a national backbone for eHealth services that connects currently practically all health care services providers (Figure 5). This HIE backbone makes it possible to develop further integrated, personalized and mobile services to citizens. Finland has taken patient-centric approach when developing health care services. Social care

and health care services are integrated when it is natural e.g. care of the elderly. Furthermore, the need for hybrid professionals, new jobs, is growing e.g. gamification in health is growing. IoT elements in health care are developing fast. This needs constant education and competence building for both health care staff and citizens. Multi- and interdisciplinary is shaping also eHealth education. Ethical issues, privacy and data security from hospital to home must be considered all the time in all levels. Big data is available from multiple sources. However, the huge amount of data needs new technologies and research in order to get most benefits of the collected data. The stored standardized health data will stay available even if the healthcare organizational structure will be modified in the future. The various forthcoming telemedicine services can rely on this national backbone. Finally, quality assurance and research activities can be supported by the reliable data.

Figure 5. Finnish National Social and Healthcare information system architecture



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Principal Lecturer, PhD, Savonia University of Applied Sciences.
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Acting as an eHealth expert in various groups e.g. ICN's eHealth Strategic group, Ministry of Social Affairs and Health. Over 30 years expertise in healthcare technology.
Chair of Regional Cancer Association in North-Savo. Two personal medals:
The President of the Republic of Finland, Sauli Niinistö, as the Grand Master of the Orders of the White Rose of Finland and of the Lion of Finland, has awarded the order of the Knight of the Lion of Finland to Pirkko Kouri on the 6th December 2015.
City of Kuopio awarded with Kuopio silver medal-reward Nov 18th 2016.
The award was based on international work e.g. in ISfTeH has positive effect

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The first professor of Health Information Systems in medical faculties in Finland.
The past president of the FSTeH, the former president of the European Association for Promoting Picture Archiving and Communication Systems (EuroPACS) and a former member of the board at the International Society for Telemedicine & eHealth (ISfTeH).
He has more than 27 years of experience with telemedicine and eHealth and electronic patient record systems. His team was first in Europe to develop a mobile medical app to smartphones already since 1997 and the first to perform international teleradiology consultations since 1994.

Currently, his research group at FinnTelemedicum performs assessment studies of the availability, intensity of use, usability and innovation potential of eHealth systems. In benchmarking studies, there is collaboration in national level, in Nordic eHealth Research Network and connections to WHO and OECD.

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