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Rehabilitation strategies for Patients with Cardiovascular disease

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Abstract

Acronyms and Abbreviations

Acronyms and Abbreviations	Definition
ICT	Information and Communication Technology
GP	General Practitioner
CAD	Coronary Artery Disease
CR	Cardiac Rehabilitation
CEA	Cost-Effective Analysis
ICEA	Incremental Cost-Effective Analysis
CAPEX	Capital Expenditure
OPEX	Operating Expenses

Table 1: Forkortelser & Definition

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1 | Introduction

1.1 Background

The background section will give a short introduction to the three main areas in this project; The technology that is used in vCare, the Danish Healthcare System and finally an introduction to the main target group who will be affected when introducing telemedicine in rehabilitation.

1.1.1 Technology

The technology section will be based on the new ICT based virtual coaching solution vCare.

The basic concept of vCare is carried out by a central eHealth platform that serves central infrastructure services. The platform obtains the information delivered by sensors or gained by the direct interaction between the patient and the virtual coach. The devices added to this platform consist of camera, microphones and a Kinect which makes the platform able to track movements. The information from the devices are conducted by a real-time processor. Beside the platform the infrastructure delivers supporting services to improve the quality of life of patients. The service provides physical and cognitive exercises as well as education material within nutrition and life behaviour. This service will be extended with a care pathway and a knowledge layer that enables personalized exercises and material for the given patient. Based on algorithms the virtual coach is flexible regarding the patients' needs and hereby able to make specific rehabilitation programs. The platform can be implemented on different devices, e.g., tablets, smartphones, TV screens etc. [1].

1.1.2 The Danish Healthcare System

The establishment of the Danish Healthcare System started in the eighteenth century. The first hospital was placed in Copenhagen and opened in 1757. This hospital is still running and today it is known as Rigshospitalet. Outside of the capital small hospitals were built during the late eighteenth century. At that time the hospitals were partly financed by taxes, patient payment and charity. In the late nineteenth century every thirteenth Dane was a member of a sick-benefit association which the Danish Government co-funded. The Danish Welfare State has roots in 1933 where the Social reform was founded. By this reform to all Danes with a low income it became a demand that they were members of a sick-benefit association. During the thirties taxes gradually became the dominant finance source at the Danish Healthcare System.

The sick-benefit associations were shut down in 1973 and replaced by public health insurance. The Danish public health insurance is paid by the Danes themselves by taxes. The

insurance provides free care for everyone regardless of income and residence. This public health insurance includes hospital stays, surgery, visits to a GP and specialist'. Furthermore, it provides partly funding for dentist, physiotherapist, chiropractor, podiatrist and contributes to medicine.

1.1.3 Target Group and Market Segment

By introducing telemedicine, the rehabilitation process is brought directly to patients' homes and mostly targets people with chronic conditions, which includes cardiac patients. Telemedicine rehabilitation is used to prevent hospitalization, to improve patients' feeling of safety, to empower patients to manage their own chronic condition and hereby improve patients' quality of life [2].

The need for cardiac rehabilitation is evaluated for all patients with heart disease. This includes both patients who have had a balloon dilation or by-pass surgery and patients with stable ischemic heart disease. Patients with heart failure, pacemaker or patients who have had heart-valve surgery or cardiac transplantation are also being evaluated for the purpose of cardiac rehabilitation [3]. By this statement it is seen, that this invention will involve a large target group.

To teach cardiac patients about their illness and how they are able to influence the course of the disease, results in a reduced risk of dying. Furthermore, research shows that rehabilitation programs with physical exercise reduce cardiac mortality [4].

1.2 Problem Statement

More than half of the danish citizens over the age of 55 suffer from a cardiovascular disease. Furthermore, cardiovascular diseases are one of the most common causes to death in Denmark. The total cost of treating cardiovascular patients at the Danish Healthcare System was 5.5 billion DKK in 2015. Every year approximately 55.700 Danes is diagnosed with cardiovascular disease.

Nearly 107.100 Danes are hospitalized every year for cardiovascular disease and almost 73.100 Danes are yearly at one or more consultations at the hospital. Approximately 23 percent of the cardiovascular patients are readmitted into the hospital within 30 days after being discharged. It has been proven, that cardiac rehabilitation results in a reduction in deaths caused by cardiovascular diseases and the need for readmissions [4].

All this indicates that cardiovascular patients constitute a large part of the Danish states economy. This leads to our problem statement which is:

- What impact would an ICT solution for rehabilitation have on both cardiovascular patients and the Danish Healthcare System?

- How can ICT help to prevent readmission of cardiac patients?
- Which barriers/challenges can such system meet in implementation?

1.2.1 Delimitation

This project is limited only to be focusing on healthcare in Denmark and how the technology within rehabilitation will have an essential impact on the Danish Healthcare System. However, the project will be compared to related ICT solutions in EU as scientific articles based on The Danish Healthcare System is limited in this research area.

Relevant data on how the Danish Healthcare System is establish will mainly be based on literature found in books and on websides where guidelines, statistics and the historical development is being published.

2 | Methodology

This study is a combined multi-method qualitative case study divided in three fases. The study is combined between exploratory, descriptive and evaluative study. Each study type is represented in a research question. Furthermore the study is a multi-method qualitative study due to two types qualitative analyzing techniques.

2.1 Research design



Figure 2.1: Research design

figure 2.1 is an overview of the research design in this paper. Phase 1 in the study is the initial process, phase 2 is knowledge/data and phase 3 is analysis/outcome. In phase 1 the topic was selected and translated into questions and hereby the problem statement. In this process the delimitation of the project was laid out. Furthermore the methodology was chosen during this fase in the project. The methodology contains considerations in literature search, interview method and data analyzing methods. Phase 2 is the process to gain knowledge and collect the necessary data to analyze the problem. The knowledge is gathered through a literature search in the area. The method is described in section 2.2. The data is collected throughout interviews with both cardiac patients and a research nurse. To learn more about the interview and the empirical process read section 2.3 and chapter 4. In phase 3 the collected data and knowledge is analyzed and evaluated. Furthermore the newly gathered information are discussed within the literature search. The closing statement in this study will be an overall conclusion of the studies findings. The last process in the project is to reflect and look into further investigation of the problem.

2.2 Literature search method

The literature was conducted with a thorough literature research. To find the right type of literature PICO(Population/Problem, Intervention, Comparison/Control, Outcome) was used as a framework, see table 2.2. Following databases have been used for this project: PubMed, AULibrary, Embase and google scholar. The literature search started in february 2018, where the primary part of the literature was collected within two month, although literature has been collected through the hole period of writing the project. Search keywords was conducted in the problem statement and have been used for search words in the databases. Following words was chosen as key words: ICT, Healthcare, cardiovascular, rehabilitation, cost effectiveness. The papers were chosen from title and abstract. Furthermore other literature was conducted through a chained search in relevant literature. Multiple papers was deselected due to irrelevance or mismatch of the subject. The national guidelines and national history was conducted on state webpages. The keywords were combined with an "AND" - and in related areas as "OR". The PICO blocks was as well combined with the "And" and "OR".

PICO	Search headings
Population/Problem:	Patients with cardiac illness
Intervention:	Patient in telerehabilitation
Comparison/Control:	Standard cardiac rehabilitation
Outcome:	Adherence to CR, readmission, mortality

Table 2.2: Search headings in PICO principles

2.3 Research interviews

Research interview is defined as a purposeful conversation between two or more people whereas an interviewer ask concise and unambiguous questions and the interviewee will respond. To collect data for this study interviews with experts in rehabilitation of cardiac patients and cardiac patients themselves have been made. There is many types of interview but for this study Semi-structured interview has its purpose. The semi-structured interviews is exploratory, explanatory and evaluative. Furthermore this kind of interview is referred to as qualitative research interview. This type of interview makes it possible to make a frame of the interview but it also allow the interviewee to expand the knowledge area and hereby expand the frame of the interview. Besides the expansion of the frame this setup allows the interviewee to explain the opinions and reason for attitude. Semi-structured interview provides the opportunity to probe answers whereas the interviewee can explain their responses. The interview may also lead the discussion in to unforeseen areas, which can collaborate to new knowledge. The interview types gives a detailed set

of data but it can be viewed as biased due to the interviewers impact on the interviewee. In this project the questions are formed as open ended and only as a frame hence the semi-structured interview [5].

To prepare for the semi-structured interview we used the "five p's": Prior planning prevents poor performance. To withhold these p's following was taken in to count. Level of knowledge, developing the interview themes, inform interviewee before interview and finding an appropriate location. The group had gained a lot of prior knowledge of the rehabilitation of cardiac patient in Denmark before the interview which supports the capability to accurate respons in the interview and the interviewers credibility. The knowledge was secured during the literature research fase [5].

For the interview with the expert in rehabilitation of cardiac patients some interview questions were designed to make sure that the every area wanted was conducted although the nurse was able to walk outside the framework. The question ideas came from read literature and the problem statement. The prepared questions is present in app XXX. If the interview do not have some focus the interview might lack a sense of purpose. The frame made for this intervies was made like a guide in a perhaps logical order. The location of the interview should be convenient for the partipant otherwise they might feel uncomfortable which could impact the data collection. For this interview the participant chose the location to oblige convenience for the participant.

2.4 Focus group/open discussion with patients

A focus group is defined as an interview method that involves more than one but usually at least four participants. The interview takes places in a fairly unstructured setting. The person who runs the interview is the moderator or facilitator and is expected too guide the session without being intrusive. In this paper the focus group session was held with the patient who attends the CR in Herning municipality at the moment. The data collection from this focus group is qualitative and is used to collect the opinion on ICT used in rehabilitation of cardiac patients. This setup gives the researchers the possibility to understand the way people feel. The set up also gives opportunity for the attendies to probe each other [6]. The questions for the focus group was premade and pointed for the group of patients. The short focus group was held in continuation of the education and training class. This means that the participants had a knowledge of the project and project members. Through the interview both premade and new question was asked during the session. The interview was recorded and transcribed, read the transcription in APP XXXX. The session is further described in ??.

2.5 Micro ethnography

The method ethnography is used when an observer/ethnographer immerses in a group for an extended period. For this project it has not been possible to follow the CR in Herning

municipality for an extended period. However a micro ethnography has been carried out. The project group attended a training and education session for cardiac patients in Herning municipality. The participant observer role is classified in four role types: *Complete participant*, *Participant-as-observer*, *Observer-as-participant* and *Complete observer*. For the training and education session in Herning municipality the researchers attend in the role as *Participant-as-observer*. The *Participant-as-observer* is a fully functioning member in the setting and the social setting is aware of the researchers status as a researcher [7]. The purpose of the participation is to connect with the patients before the focus group and to get a sense of the social setting in the cardiac rehabilitation. During the session mental field notes were taken. The notes was taken as mental notes where as much as possible is remembering during the session and written down later. This is a method that results in a low level detail, but it makes it possible to fully participate within the session without interfering with social setting [8]. This field work was prior to the focus group/open discussion with the patients and that might make the patients feel more comfortable sharing their thoughts. The Field notes can be read in app XXXX.

2.6 Analyzing qualitative data

Qualitative research depend on social interaction, hence the analyzing qualitative data in an interactive and iterative process. Qualitative data are likely to be more varied, elastic and complex than quantitate. A analyzing method is therefor a great tool to evaluate and use the data to answer the research questions.

To analyze the interview with the research nurse an analyzing tool is necessary. The Narrative analysis method has been chosen to this. The narrative analysis consist of a collection of different approaches to analyse qualitative data. The study only have the narrative of one individual but the nurse will give another perspective into the healthcare system than state literature can. She gives the opportunity to look into a small peace of the danish healthcare system, more likely region Midtjylland and specific Herning hospital. Due to the interview only being collected on one individual coding has been deselected in this analysis.

2.7 Economy

Various approaches are possible when valuing and comparing a technology with the existing method. For this study a one approach has been chosen to look into the cost and effect of telerehabilitation in Denmark.

2.7.1 Cost-effectiveness analysis

When implementing new technology and rehabilitation processes it is important to look at the cost. Every region and municipality is on a budget provided by the state. Therefor

resource allocation is a big part of the Danish system. But in health care, cost is not the only value taken in to account, the patients health and well being is an important part of the puzzle. When allocating money for one intervention another intervention may be dismissed. This is why a decision tool is needed to evaluate interventions and pick the interventions that provides the most benefit with the available resources. Cost-effective analysis(CEA) is an analysis of cost and effectiveness of perhaps a new service or technology. The benefit if using a CEA is that it does not only look in to the cost but also takes the patient in to count. It is often used to evaluating effectiveness in healthcare. In this study the CEA is used to compare the traditional CR with a the new setup with telerehabilitation and is therefor the Incremental Cost-Effectiveness Ratio(ICER) type of CEA. In the analysis the CE ratio is calculated. The CE ratio is the cost associated divided with health outcome. The data for the analysis is collected in corporation with *Herning sygehus* and Herning municipality. Following cost are taken in to count:

Health related	Non-health related
Profession (Staff)	(Travel)
Rehospitalization	(Productivity loss)
Physical materials	(Presentism loss)
Training equipment	
Other cost	
(Medication)	
IT	

Table 2.3: Cost variables CEA

The cost in this setup can vary at lot from municipality to municipality and furthermore in between contries. Moreover the choice of the cost taken in to count. The selected cost in this project is chosen due to research in similar trials and the cost possible to be collected [9, 10].

Following cost have been left out of the analysis: Travel reimbursement, Productivity loss, Presentism loss and Medication. The mentioned cost are all a part of evaluating a health technology as this, but not possible to collect in this study. Travel reimbursement is left out because it is a cost for the patient and not the municipality. Productivity loss is left out because the average cardiac patient is above or about the pension age. Medication is a big area and would definitely be an interesting element to include but it is not possible to collect the needed data in this area.

The measure of effect can be done in various scale methods. For this project quality-adjusted life year(QALY) has been chosen. "The QALY is able to combine 'the effects of health interventions on mortality and morbidity into a single index', thereby providing a 'common currency' to enable comparisons across different disease areas" [11]. This evaluation method combines survival with health-related quality of life(HRQoL). QALY

is an index between 1 and 0 and the higher the QALY index is the better the effect of the intervention. The QALY method makes it easier to look at both the patient's personal experience and medical facts [11]. To obtain the data from the patient an EQ-5D questionnaire can be used [9]. This study will not perform any actions to obtain a QALY index, but the data will be obtained from literature if similar projects where the QALY index has been measured and calculated with the EQ-5D questionnaire.

3 | Theory

3.1 The Danish Healthcare System

Structure of the Danish Healthcare System

Every healthcare system consists of users, healthcare institutions and the financial third part. Apart from that there are three fundamental financial mechanisms; user fee, tax and budgets/rates. These three financial mechanisms links together the Danish Healthcare System. This is described with the tripartite model in figure 3.1. A, B and C is the financial mechanism and 1, 2 and 3 are the components within the healthcare system. The model shows how a third part is pushed in between users and healthcare institutions. This third part creates equality between users as much as possible. The constellation of finances differs from country to country. Denmark is mostly funded by the Government through taxes whereas US citizen needs health insurance to pay the for these services [12].

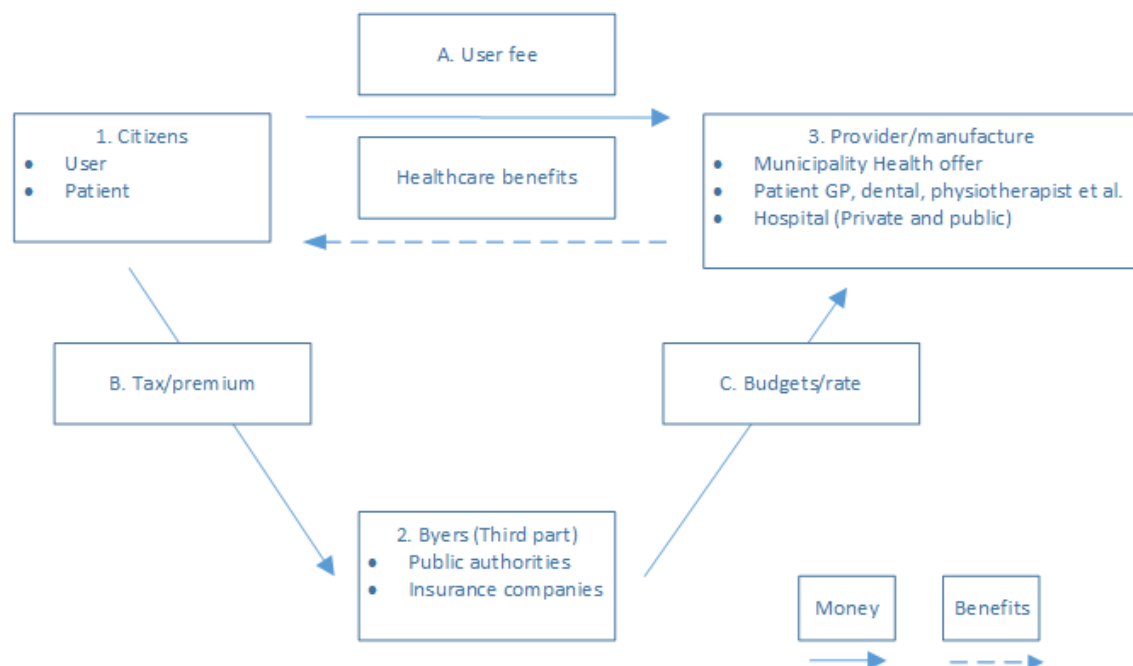


Figure 3.1: Tripartite model [12]

In 1927 there was a total of 160 somatic hospitals in Denmark. Today the Danish health authority is responsible for planning the distribution of specialized hospitals. The Danish healthcare authority made a decision to centralize hospitals to improve quality and efficient use of resources. This concerns both acute, long-term and psychiatric care sectors. The centralization leads to a structural change within the hospitals. Small hospitals got shut down and big hospitals have been modernized. Besides these alterations seven new greenfield projects is under construction. These projects are specialized hospitals. The

new hospital construction requires modernized technology and new solutions to ensure cost effective care and shorter admission time.

The average length of the admission has decreased with 40%, which makes Denmark the country with shortest length of hospital stay in Scandinavia. The decline is due to more effective treatments and outpatient treatments. The Ministry of Health is constantly seeking to improve the sector both in quality and efficiency at a minimum cost. Hereby the ministry set up some future goals and one of them is to minimize bed days. "As a result of the modernisation process, the number of bed days is expected to be reduced by 20 percent, and outpatient treatment to be expanded by 50 percent from 2007 to 2020". To manage greater distance between both hospitals and patients, ICT solutions will be a major factor in the development of communication within the new hospital construction[13, 14].

In 2007 the Danish State made big structural changes throughout the healthcare organisation. Municipalities were combined which meant a change from 275 municipalities down to 98. The 14 counties were replaced by five regions. The Danish Healthcare System was thereby organized in three levels: State (National level), region (regional level) and municipalities (local level) [14, 15].

The municipalities have multiple tasks but in the health area they administrate general practitioners, home nursing, public healthcare, school health service, child dental treatment, prevention and rehabilitation[16].

The five regions are responsible for the secondary sector which is mainly the hospital sector. Each region is able to organize their services accordingly to their regional needs. They may adjust within the national legal limits, but the region will be responsible of procurement of staff and equipment.

The states task is to initiate, coordinate, and advise. Furthermore, the job is to establish goals for the national health policy[16]. In Denmark a ministry takes care of this job. The ministry changes over time but in 2015 the name of the ministry became Ministry of health [17]. This ministry is responsible for establishing the overall framework for the provision of health and elderly care.

Finances

The region is financed by four subsidies: Block grant from the state(75%), state activity-related subsidy(5%), local contribution(10%) and local activity-related contribution(10%). The block grant from the state is distributed with the consideration of differences inside the regions which will give the regions equal prospect of providing healthcare services. The rest of the subsidies are divided in three different types of distribution, this is partly to encourage the regions and municipalities to increase activity and efficiency [16].

The municipalities are financed with a block grant from the state but also council taxes which differs in the municipalities. The regions receive activity-based subsidy from the municipality which means that the municipality pays the region money depending on the number of hospitalisations and treatments performed at the hospital. Due to this constellation the municipality has incitement to reduce demands for hospitalization and

other regional healthcare services [14]. The finance structure in the Danish Healthcare System aims to strengthen health clinical production and responsiveness with free choice of hospital in combination with the activity-based financing. Throughout the structure plan in 2007 the municipalities were given a financial incentive to keep their citizens healthy [13].

Preventive healthcare

As a part of the local government reform in 2007 preventive healthcare became an important part of the Danish Healthcare System. The vision was to improve quality of life and impact the lifestyle related diseases like cancer and cardiovascular diseases which are the dominant cause of death today in Denmark. Furthermore, it included focus on risk factors as tobacco, alcohol and lack of exercise. The municipalities were given the primary responsibility for preventive health [16].

Rehabilitation

Rehabilitation, including physical and mental training programmes are offered for all citizens by the municipalities. Training and rehabilitation of a patient may be initiated at the hospital and continued within the municipality when the patient is discharged. This means that the municipality will be responsible for the rehabilitation after discharge. Rehabilitation helps the patient to regain functional abilities and helps them to become self-sufficient. Some will receive rehabilitation free of charge whereas others may pay partly by themselves. This depends of type of illness [14, 18, 19].

Digitalization within the Danish Healthcare System

Denmark is known for extensive digitization and electronic communication in the Healthcare System and the use of health data. Denmark made standards for electronic communication years ago and the result of this is an almost digitalized communication within the healthcare sector. Health records, laboratory test results and hospital referrals are all nearly collected as electronic data. Multiple ICT and digital workflow are completely integrated, this marks Denmark as a frontrunner in deployment of e-health.

Telemedicine is a big part of the digitalization plan in Denmark where five initiatives is to be the foundation of future telemedicine infrastructure in Denmark. "The goal is to have a digital infrastructure and IT architecture in place within the foreseeable future, so that relevant information can be exchanged across the healthcare system and other sectors" [14]. In 2011 Denmark started a project for telemedicine throughout the country. The five regions in Denmark made a strategy on how to develop telemedicine in a wider scale and combine it with effective shared knowledge. For this to happen a board has been chosen and is known as the National Board of E-Health [13].

Treatment of Cardiac patients

In 2010 treatment packages for non-acute heart disease was introduced in Denmark. This package included a process consisting of investigation, diagnosis, treatment and rehabilitation. The Danish Health Authority decided to phase out the package deal in 2017. With this alteration the patient will achieve a more simple and coherent treatment with better quality. The progress for the patient is divided in five steps and will be described in the next section.

Step 1 Preliminary assessment and referral: when a patient feels ill they contact their general practitioner (GP), unless it is acute. It is the GP's job to carry out preliminary examination and to give the patient the right kind of treatment if necessary. The GP should include the patient in choice of treatment plan and decide if the patient needs to be admitted to the hospital or an outpatient treatment is necessary.

Step 2 Investigation and treatment: the investigation and treatment of cardiovascular patients differs from different diagnoses. Common is, that the knowledge of comorbidity is important due to stabilization and treatment of the concurrent disease throughout the treatment of the cardiovascular disease. The health facility will form a treatment plan in corporation with the patient.

Step 3 Planning follow-up on treatment, rehabilitation and palliation: At the end of treatment the cardiology department/specialist practice performs a systematic assessment of needs. The needs assessment is carried out in collaboration with the patient and perhaps relatives.

Step 4 Follow-up: When the patient has been discharged from the hospital the treatment will pursue as outpatient visits while others will pursue follow-up at their GP's.

Step 5 Rehabilitation and palliation: patients with heart disease should systematically perform a need assessment in order to offer rehabilitation and palliative action based on patient needs and heart disease. Rehabilitation with heart patients is mainly performed with focus on disease coping, nutrition, physical training, tobacco cessation and work retention. Furthermore, it aims to improve the individuals physical and mental state of health. The rehabilitation is primarily placed in the municipalities. The effort of rehabilitation planning should origin in the patients functioning, preferences and resources. Motivation, participation and adherence of achieved change of behaviour are important elements in the rehabilitation process. After a heart disease the patient is at great risk of developing anxiety and depression and it is therefore important that physicians related to the rehabilitation process are observant.

Patients with heart disease experience varying periods of worsening of the disease along with more calm periods. In connection with impairments and possible subsequent hospitalization, there will often be uncertainty as to whether the patient survives. This is

always a burden for both the patient and the relatives. In this regard, it is important for health professionals to pay attention to and assess the patient's and their dependents' palliative needs and problems associated with heart disease, and that the need is assessed on a regular basis to prevent efforts from initiating too late [20].

3.2 ICT in telemedicine

The first use of Telemedicine was in 1877. A group of doctors made a communication network towards the drug store by using telephones. The first video consultation between a doctor and a patient took place in 1927. In the 1950s a two way television group therapy took place in Alaska. In the 1970s NASA built *Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC)*. This system was able to communicate with a two-way radio, audio and data. It wasn't until the eighties where the technology had renewed interest, due to high cost, lack of suitable technologies and unacceptance. At this point the military picked up the idea of the usage of telemedicine in combat. The use of technology in military has extended to hospitals throughout the world.

Telemedicine is a generic term that covers different types of healthcare which is provided digitally and in distance. Telemedicine range from teleconsultations to telesurgery. Telemedicine has made it possible to give specialized care and diagnostic medicine for people in rural and remote areas. The introduction of telemedicine has changed the traditional doctor-patient relationship. ICT is a information and communication technology which allow people to interact in the digital world. Telemedicine use ICT as the digital communaction method. ICT has drastically changed the way the world in general communicates, work, learn and live. The usage of ICT in telemedicine have made cost-effective treatment options available due to reduced traveling expenses, decreasing hospital readmission rates, and maximization of consultations. Though providing medical care with the usage of telemedicine opens important medical, ethical and legal issues which must be addressed [21].

4 | Empirical data

The empirical data is collected from interviews both with a perspective from Herning Hospital, Herning Municipality and the involved patients. The outcome of the interviews is presented in the below sections.

4.1 Interview with Vibeke Lynggaard, post.doc, Cardiovascular Clinic, Herning Hospital

The interview was held as a semi structured interview and was a conversation based two-way communication. The questions was premade, but the interview was open for clarifying questions. The interview was audio-recorded and afterword the record was transcribed, see Appendix XX for the transcription.

Vibeke Lynggaard is working as a project nurse at the clinic for cardiovascular research. The interview was also held at the cardiovascular clinic. The interview was conducted in order to gain information on telemedicine rehabilitation from a healthcare professionals point of view. Through this interview it was possible to obtain information on how telemedicine rehabilitation can be used to support the already used rehabilitation process. By the interview it was also possible to obtain an opinion on which limitations and disadvantages a telemedicine solution gives. By the information based on this interview it was possible to give an idea on how telemedicine rehabilitation can be used in the Danish healthcare system.

4.1.1 Outcome of the interview

Cardiac rehabilitation has been a subject to the municipalities since the 1 of January 2017. Before that it was the regions responsibility to offer rehabilitation for cardiac patients. Only one team of 12 patients are directly connected to the hospital. These patients are severely ill and therefore in need to be in contact with the hospital throughout their rehabilitation progress. Cardiac rehabilitation consists of exercise, education and social and it is important that all three collaborates. Both at the hospital and in the municipalities the patients do cardiac rehabilitation 2 times a week in 12 weeks. Furthermore, they are being educated about their illness and healthy lifestyle habits once a week. These 12 weeks of rehabilitation is described as phase 2 rehabilitation. Afterword patients are offered phase 3 rehabilitation. At the beginning of phase 2 rehabilitation the patients makes a maximal symptom-based stress test. This gives a starting point for the rehabilitation progress. Furthermore, they measure weight, height, waistline, blood pressure and heart rate. After 12 weeks they will do the test and measurements again and hereby the healthcare professionals are able to see how the patients has developed through the progress. The physiotherapist coaches the patients through a program where both cardio stress and

muscle stretching are included. There are some national guidelines which indicates how much intensity and how many repetitions the patients are able to do. It is necessary to keep in mind that cardiac patients struggles with different illnesses, such as reduced pump function, those who have had a new heart valve and those who has got a pacemaker. Therefore, cardiac patients got different needs and have to do different exercises.

How could telemedicine be included in rehabilitation?

Phase 2 rehabilitation is mandatory to offer cardiac patients. This rehabilitation program is a class 1 recommendation from the American and European heart institutes and there is evidence that it is working. Therefore, it would be a hard process to replace phase 2 rehabilitation with telemedicine rehabilitation. All patients are being offered phase 3 rehabilitation, but most patients refuses to undergo this program. Mostly they refuse phase 3 as they want to get back to the labor market and a normal life. Unfortunately, most patients stops with common care and doesn't continue their healthy lifestyle after the rehabilitation program. Therefore, it would be highly relevant to introduce a telemedicine solution after phase 2 rehabilitation. Furthermore, phase 3 rehabilitation is about continuing and maintaining decent exercises and dietary habits and for example continue a smoking cessation.

More ever patients are being screened for depression at the beginning of their illness. They complete the questionnaire HADS – The Hospital Anxiety and Depression Scale. There is an algorithm behind the scale which indicates if the patient need to contact the doctor. It could be beneficial to perform a depression score once a month and hereby catch patients who is in risk of getting a depression. This questionnaire could also be a part of phase 3 and could easily be included in a telemedicine rehabilitation program.

Is it possible to do all measurements at home?

Waistline can be hard to do by the patients themselves. Usually healthcare professionals do this measurement to make sure there is no bias. The objectivity disappears if the patient has to do that kind of personal measurements themselves. Furthermore, Vibeke Lynggaard mentioned that it could be relevant to connect a censor to the telemedicine platform. This could for example be used as a reminder to take medicine. Hereby the patient need to interact with the platform to let the system know that they have taken the medicine, otherwise an alarm will start. Another score that is used today is a score to indicate how nicotine dependent the patient is. The score will let the patient know whether they need to use a nicotine plaster or chewing gum. This could easily take place at the patients home as well.

How could telemedicine be used in rehabilitation?

It would be beneficial to track how the patients complies with healthy lifestyle and behavior. Moreover, if the patient could interact with healthcare professional through the platform it would be very useful. By this communication platform it would be possible for the patient to ask questions about the illness and how to maintain a healthy lifestyle. For healthcare professionals it would be possible to keep an eye on the patient and keep track on their behavior.

The rehabilitation program that is used today includes former patients to communicate

experienced knowledge. This could also be included in telemedicine rehabilitation where former patients could be connected the platform and hereby it is possible for former patients and current patients to be in contact when needed.

Furthermore, at the current rehabilitation program patients are offered a program at a dietitian. Usually the program is within two days and concludes a presentation and some practical exercises. Not all patients accepts this offer and therefor it would be preferable to include meal plans, diet diaries or television chefs at the platform. By this platform the patient doesn't need to go to the dietitian, but they will be able to obtain the information through the platform. This would possible seem easier and hopefully more patients would continue a healthy lifestyle.

By introducing telemedicine in rehabilitation both the patient and healthcare professionals would experience time savings as they doesn't have to spent time on transportation. If telemedicine could be used to keep a healthy lifestyle for more patients, and hereby reduce readmission, a health economic reduce will also be a positive outcome.

At Herning municipality, it is known that only 50% of cardiac patients accepts phase 2 rehabilitation and 20% doesn't complete the program [22]. It is therefore a very large group of patients who doesn't undergo the rehabilitation program that is being offered. Hopefully by introducing telemedicine and herby a more technological and easy access rehabilitation program this large number of patients could be reduced.

Limitations and disadvantages

The social aspect with other patients can be hard to obtain by using telemedicine instead of cardiac classes. To most patients it gives motivation if the teamwork and dynamic between the patients is good. There has been made some qualitative research interviews which indicates that the social aspect is highly important. Furthermore, there are some ethical challenges that has to be taken into account. For example, patients must be offered the best-known rehabilitation program and as there is highly evidence that the rehabilitation program that is used today is the best this one must be the one that is being offered.

4.2 Interview with Hanne Voldgaard Nielsen, Professional leader, Health, Training and Assistive Technology, Herning Municipality and Eva Klose Jensen, Leader, Rehabilitation and Health, Herning Municipality

The interview was held as a semi structured interview and was conversations based between the interviewer and the two interviewees. The interview was held to give an perspective on how rehabilitation is working in Herning Municipality and to achieve information on cost-effectiveness data. The questions was premade and was based on previous and comparable cost effectiveness analysis from other similar studies [9], [10]. Notes were taken during the interview and can be seen in Appendix ??

Hanne Voldgaard Nielsen and Eva Klose Jensen are both working with cardiac

rehabilitation in Herning Municipality. The interview was held at Holing Sport Center in Herning which is normally used for rehabilitation. The main purpose for this interview was to obtain cost-effectiveness data. By the interview it was almost possible to achieve all the cost data that was sought. The only data that wasn't possible to get was the number of readmissions. Unfortunately, it was not possible to get any effectiveness information as the rehabilitation team does not use and calculate on that specific data. Furthermore, the interviewees gave a subjective opinion on how cardiac rehabilitation is working in Herning Municipality.

4.2.1 Outcome of the interview

In Herning Municipality 200 patients are being offered the rehabilitation program. Table 4.2 shows patients who did not want to participate on cardiac rehabilitation. As seen on the table the percentage of participants is very high, and only five patients turned down the offer.

Date	Ends before test	Ends after test	Reason
17.01.18	X		Fails to appear
06.02.18	X		Dementia – tried to start the program. Does wish to continue
18.04.18	X		Regretted that he said yes
30.04.18	X		Called for start test - announces cancellation. Ends via non-disclosure letter
23.04.18		X	Depression

Table 4.2: Registration cardiac rehabilitation 2018

In Herning Municipality, the rehabilitation program is offered in Sport Center Holing which is very centrally located for patients in Herning Municipality. It is known from other Municipalities that patients who lives in rural areas seem to turn down the offer as the rehabilitation program is being offered to far away from their homes.

In Herning Municipality, the rehabilitation department agreed on marking the best possible solution where the desire was to achieve the best possible result for cardiac patients. Therefore, the solution isn't the cheapest as the main focus isn't on the financial part. The primary focus is on the patient and how to get them through a rehabilitation process in the best possible way with the best possible outcome. The nurses used within the rehabilitation program is hired from the cardiac department at the hospital. It is important that the nurses have the right competences to work with cardiac patients and

therefore they are more experienced and on a higher salary step. The same applies for the physiotherapists. When the rehabilitation department became a subject to the municipalities the rehabilitation department had to find the right place to perform and offer the rehabilitation program. In Herning they didn't have access to a health center and therefore they were required to invest all equipment necessary to open up a rehabilitation center. Therefore, it is important to keep in mind that the prices seen in Table 5.4 and Table 5.6 are implementation rates and hereby a lump sum payment.

Beside nurses and physiotherapists, a dietitian is available through the rehabilitation process. The dietitian participates four times a year for three hours. Furthermore, cardiac patients are being offered smoking cessation during and after the rehabilitation program. Most patients do not have the time and energy to undergo a smoking cessation while they participate in the rehabilitation program. Therefore, it is possible to do a smoking cessation after the 12 weeks of rehabilitation and it will still be paid by the municipality.

An important part in the rehabilitation program is that a previous patient participates in the program. By this concept patients are able to share experiences and to get knowledge on how to deal with a chronic disease. This is a very important factor to many of the patients as it is very trustworthy to hear personal disease and health experiences.

By the interview it was mentioned that patients are being pressed hard physically to obtain the best result. A few times it has been experienced that some patients feel ill and are in need for personal help and assistance. As this patient group suffer from heart diseases it's important to keep in mind that they are in risk of getting a heart attack while they are doing their exercises. This is an important information to be aware of if telemedicine is introduced in rehabilitation. If patients are doing their exercise via telemedicine at home instead of participating at a team at the rehabilitation center, they are not able to receive the same urgent help if a heart attack or another emergency health situation appears.

4.3 Economy and effect

The economics aspects of this paper is conducted in collaboration with Herning municipality. The primary data for the economic analysis was gathered at Herning *sportscenter* which is the location of cardiac rehabilitation in the municipality. The data was collected as an open semi-structured interview with Eva Klose Jensen, Rehabilitation and health promotion manager in Herning municipality and Hanne Volsgaard Nielsen, Professional leader at Herning municipality. The data from this interview will be used for the control group resources of the standard CR treatment. The interview is to be found in App XXXX.

This case study is not a trial so there is need of data from a former conducted trial to look into the effect of implementing a ICT solution in the rehabilitation of cardiac patient. For this a study from 2015 in Belgium was chosen (Frederix et. al 2016). The set up of the trial is comparable with the Danish setup. It is a randomized controlled trial to look in to the cost-effectiveness of telerehabilitation with the ICER method. The study uses the same methodology and set up as wanted in this paper but with focus on the Belgian

system. In this paper they measure effect in Quality adjusted life years(QALY). The result of this papers QALY is really comparable due to Belgium and Denmark follows the same guidelines for cardiac patients that is provided from the European Union. To collect the QALY the EQ-5D questionnaire was used before, after and under the trial. Therefor it was chosen to use the collected QALY of the intervention group from this paper. Herning municipality do not collect effectiveness data on their patient and due to the lack of data for the control group the QALY of the control group is used from the Belgian project [9].

4.4 Open discussion with cardiac patients, Sport Center Holing, Herning

The interview took place at Sport Center Holing and was conducted both as a micro ethnography and an open group discussion. 12 patients participated, and the interview was held as a part of the rehabilitation program that the patients are following. The interviewer participated in the physical rehabilitation program followed by the education program within knowledge on risk factors to develop heart disease. The questions was premade and were focusing on the subjective perspective to how telemedicine could be used in rehabilitation. The interview was audio-recorded, and afterword transcribed, see Appendix XX for the transcription.

The patients were mostly elderly retired citizens who suffer from heart disease, only a few were still on the labor market. One of the patients haven't had a heart disease but were in higher risk of becoming of cardiac patient. Therefore, the rehabilitation program in Herning Municipality is both offered to cardiac patients but also to citizens in high risk of getting a heart disease. By offering the rehabilitation program to citizens in high risk of getting a heart disease, these citizens could possibly get the right help and information about heart disease and hereby avoid becoming a cardiac patient. By this open group discussion, it was possible to obtain opinions on the use of telemedicine rehabilitation by the patients themselves. It was also possible to get an impression on how the rehabilitation program works in Herning Municipality and how the patients find the program.

Outcome of the interview

To this group of patients, they could not imagine home based rehabilitation as a replacement to the 12-week rehabilitation program that they follow at the sport center. They don't think they would be able to the exercise at home as they had to do it by themselves instead of doing it together on a team. To them the social aspect is very important. A patient states, "We have a great relationship to each other. It means a lot that it isn't just workout but also social. We meet in good time before we start and speak a little afterwards as well: " To do rehabilitation by themselves isn't as motivating as being on a team. It is too impersonal and to talk with other patients will be missed.

Another important factor is the safety by participating at the sport center compared to home rehabilitation. The patients feel safe at the center as there is a nurse and a physiotherapist while they are doing the exercises. That wouldn't be the same

if rehabilitation took place at the patient's home. If a patient feel ill during home rehabilitation it would take some time before they get the right help. The patients are being pushed very hard during training and sometimes patients feel a bit dizzy after an exercise.

Telemedicine rehabilitation could possibly be used after the 12 weeks of center-based rehabilitation. A patient mention: "That would definitely be a motivation to continue". The patents could see an idea in developing an app where different training programs and nutritional advices were regularly uploaded. It was also discussed how measurements, e.g. blood pressure could be measured at home and sent directly to doctors at the hospital. To these patients that was seen as a positive monitoring and would give a sense of security.

Overall this patient group would prefer to keep the 12 weeks of center-based rehabilitation. At the center they learn what exercise to do and they learn to do them the right way. An important information was mentioned by one of the nurses who pointed out that unfortunately after three years most patients are back at the same state of health as they were before they started rehabilitation. Therefore, to do some kind of rehabilitation program after the 12 weeks could possibly have an positive effect. One patient mentioned that it would be beneficial to have a progress after the 12 weeks of center-based rehabilitation. "It would be helpful if it could be tracked that the citizen followed the training program. Of course, it is beneficial to my own health, but it gives motivation that someone is looking after me". Even though, patients learn training exercises and get healthy nutrition advises it can be hard to stay motivated and continue the new healthy lifestyle. Therefore, some kind of telemedicine solution after the 12 weeks of center-based rehabilitation is seen as a possible and positive solution, both to patients and healthcare professionals.

5 | Analysis

5.0.1 Impact of ICT in homecare

Existing studies describing the use of ICT in homecare are predominated by positive responses from both chronically ill patients and healthcare professional. As an example, healthcare professional's opinion is that their work has been facilitated by introducing ICT in homecare. Most studies show that communication between patients and healthcare professional was improved by using ICT. Furthermore, the use of ICT showed cost savings. However, it is important to keep in mind that the use of ICT cannot replace face to face consultations but is an ideal complement [23]. It is important to keep in mind that telemedicine supporting already integrated care is associated with the development of new roles within the healthcare system. Ideally, new structures of care delivery at an operational level needs to be supported by corresponding changes at institutional level [24]. Therefore, by introducing telemedicine both patients and healthcare professional has to be openminded to this new technology and adaptable to change already known working methods. Hence, the development of ICT in homecare should be seen as a learning process and will constantly be evolving and improved based on the ongoing use.

Another important impact of ICT is the information flow between healthcare professionals. Effective interprofessional communication is highly important within the healthcare system but is seen to be critical when teams are not co-located. For this reason, healthcare professionals who has been in use of an ICT solution pointed out how information via ICT potentially could have and positive effect on patient care and collaboration [25].

Furthermore, exchanging information with patients, follow up and motive them to keep working out and keep having a healthy lifestyle is seen to be easier with ICT. Patients are able to log information, send documents and ask questions more frequently which increases the communication and contact between patient and healthcare professionals. Having more regular discussions with the patient will facilitate more comprehensive and effective collaboration to the patient [25].

5.0.2 Implementation of telemedicine in Denmark

By the European Society of Cardiology, it is a Class I recommendation to follow a cardiac rehabilitation program. This recommendation also includes cardiac patients in Denmark. The effects of a clinical rehabilitation program is clinical approved and there is very strong evidence that it is working. This statement was also mentioned in the interview with Vibeke Lynggaard. Although cardiac rehabilitation is strongly recommended it is seen that long term benefits are often disappointing due to low cardiac rehabilitation uptake and adherence rates. Several studies has been made to indicate the feasibility, safety and effectiveness of cardiac telemedicine rehabilitation. Looking from a cost effectiveness point of view it has been shown that telemedicine rehabilitation is more effective and efficient.

Furthermore, it has been concluded that the total cost of an ambulant telemedicine rehabilitation is lower than hospital rehabilitation. A follow up study has shown a reduced number of days lost due to rehospitalization and an increase in days alive and days out of hospital [9].

Rehabilitation offered in Herning municipality

Herning municipality offers free rehabilitation programs for all cardiac patients. The rehabilitation program is known as phase two rehabilitation and consists of a 10-week team progress with 12 patients on every team. The program includes an individual conversation, physical exercise, education and social networking. The team meets twice a week for about two hours and both physiotherapist, nurse and a professional dietary consultant are responsible for the course. At the beginning of the progress the patients are being asked to fill a questionnaire. After respectively 3 and 12 months the patients are being asked to fill the same questionnaire to follow up how the progress is going.

The purpose of this rehabilitation program is to achieve greater knowledge and understanding of the factors that affect life with a chronic disease. It is important that the patients learn to live life with a chronic disease and how to deal with everyday challenges. Furthermore, it is essential that patients improve physical health, mental fitness and well-being and hereby share experiences with other patients.

The education will be focusing on better habits within diet, smoking, alcohol and exercise. The physical exercises will consist of different types of training. Both cardio and strength will be included. In corporation with the physiotherapist the right exercise program will be matched to the specific patient in order to physical level and situation [26]. After participating in phase two rehabilitation patients are offered phase three rehabilitation. This rehabilitation program is based on follow-up and maintenance of treatment, exercise and a healthy lifestyle [3].

Outcome

It is important to keep in mind that cardiac rehabilitation is a Class I recommendation as has been approved international. Patients are entitled to be offered the best-known rehabilitation program and so far, the centered based rehabilitation is the best rehabilitation program to offer. At the interview with Vibeke Lynggaard she mentioned, that centered based rehabilitation will be hard to replace as it is the best to offer at the moment. An important note from the interview was how telemedicine could be used in phase three rehabilitation. Vibeke Lynggaard mentioned, that all patients are being offered phase three rehabilitation but most of them decides not to participate in the program. This statement indicates, that telemedicine rehabilitation could possibly have an influence and great effect in phase three rehabilitation. This of course rely on the fact that patients decide to participate in the telemedicine solution instead of not participating at all. If more patients agree to participate in phase three rehabilitation where telemedicine is being

used, this might have an positive influence on readmission and in the end an cost reducing outcome.

5.0.3 Relative's Experiences of cardiac Patient's telemedicine rehabilitation

It is known that it can be stressful to be a relative to cardiac patients. Most often relatives help with home exercises, medicine dosage and transportation to and from the hospital. They participate in discussions about the patient's illness and they do housekeeping and practical activities at home, which the patient isn't capable of doing. Research has shown that relatives are in risk of being a patient themselves as a consequence of the stressful job it is to take care of the patient [27, 28]. Therefore, telemedicine rehabilitation is being offered to reduce relative's homecare. By introducing telemedicine rehabilitation relatives feel more comfortable and secure as the patient is being monitored and healthcare staff react if the patient's measurements are to be concerned about. By an interview of 13 cardiac patients who participated in telemedicine rehabilitation the results indicated that relatives find telemedicine equipment easy to use and the use of telemedicine motivates the patient to be more active in their own treatment [29].

A research has taken place in Denmark where the patient did weekly blood pressure- and weight measurements. A heart rate monitor was used three times a week under physical conditions. Data were shown on an application via smartphone and hereby the patient, relatives and healthcare staff were able to follow the patient's state of health. For the patients it was a relief that they were able to do exercises and health measurements at home and hereby they were able to do so according to work schedule as well as motivation and mental energy. Furthermore, less hospital visits removes focus on the disease and makes the patient feel more normal and less ill. Hereby patients experience higher quality of life as they feel healthier [30].

Relatives experienced that everyday life were more normal by using telemedicine rehabilitation as they were able to continue everyday routines and spent less time taking care of the patient. They experienced more freedom as they didn't have to take the patient to rehabilitation classes, regulate diet and take care of medicine. It indicates that relatives to patients using telemedicine rehabilitation gain more freedom and less concern and responsibility [31].

5.0.4 Comparison with telemedicine solution for COPD patients

Telemedicine solutions have been tested in pilot projects in different cities in Denmark. The projects have shown that telemedicine can provide financial benefits as well as better and more consistent patients progress and more self-reliant patients [32]. In 2016 the government, *Kommunernes Landsforening* and Danish Regions did an agreement to offer telemedicine home monitoring to citizens with Chronic obstructive pulmonary disease (COPD) throughout the country by the end of 2019 [33].

In 2014 a pilot project took place in the municipality of Skanderborg where 15 COPD patients were included. After participating in the project, the patients were interviewed to give their perspective on the telemedicine solution. Overall the patients were very satisfied for the solution and especially as they had the freedom to do measurements and exercises whenever they wanted and did not depend on a specific time schedule at the hospital. The only disadvantage the patients were aware of was the connection which sometimes was a bit unstable. For the patients it was very important that picture and sound on the platform was clear and was working optimal at all time, otherwise they lost the motivation. An important observation at this interview was how the patients experience the social aspect. The patients were used to do exercises at the gym in classes with other patients. Now they had to do exercise at home where they were able to see and talk to each other through the screen. One of the patients mentioned that it was a good solution but only for a short time. To him the social aspect was very important, and he didn't experience the social interaction the same way as he did at the gym. Another important observation was one of the patients who was too ill to get to the hospital and therefore he wasn't capable of participating at the exercise classes. But by this telemedicine solution he was able to do exercise at home and in the end of the project his physical condition was so good that he was able to do his normal routines at home and also to leave home and go to the hospital. Therefore, this telemedicine solution definitely was an important help to make him feel and get better, Appendix 1.

5.0.5 Challenges within telemedicine rehabilitation

Personal aspect

The telemedicine solution collides with the GPs' individual approach, where knowledge on patients' reaction patterns and personal relationship to the patient is important when assessing the patient and deciding the right intervention. By the use of telemedicine, GPs' are not able to look at the patient's overall condition and use knowledge about the patient's normal reaction. By using telemedicine GPs' will be looking at measurements measured by the patients themselves and that won't give the same overall understanding on the patients' physical condition [2].

Furthermore, communication through ICT is seen to be more impersonal and to build up trust to the patient is much more difficult compared to face to face meetings. Visual information such as body language, person interaction and empathy are very important for the therapeutic relationship and this is seen to be a barrier to the effective collaboration between healthcare professional and the patient [25].

Funding

In several countries medical help is funded by health insurance and an ICT solution for a cardiac patient would be financed primarily of the insurance company, this limits the possibility to implement such solutions in foreign countries [21]. Denmark in the other hand

is primarily funded by the state as explained in section 3.1. This gives Denmark an unique opportunity to bring the best equipment to the patients. In Denmark the municipality takes care of the rehabilitation of cardiac patients. The municipalities receives a fixed amount of money which should be distributed in different areas. If vCare is a cheaper and more sufficient solution it would be worth investing in for the municipality. An important consideration in funding is the public tendering rules both in Denmark and EU. If a provided service expense, provided by an privat company to a public unit, is more than 1.489.820 kr the service are ordered to go in to public tendering. This process can be expensive for both the company and the public unit. The rules of public tendering is made to secure transparency, equality of treatment, non-discrimination and openness [34]. If the ICT service a municipality wants cost less than 1.489.820 kr the municipality is free to buy the service without going in to public tendering.

Technological skills

There are certain technological skills necessary for operating ICT. The majority of cardiac patients are older adults and may not be familiar or comfortable using ICT. Some patients might not be used to use technology on a daily basis and therefore the ICT solution can be a difficult solution for that specific patient group. Additionally, some patients might live in rural areas where adequate internet access is not available. This is seen to be a barrier which has to be considered when introducing ICT [25].

Ethics

During the implementation process ethical implications of telemedicine has to be considered to ensure privacy and confidentiality. It is an universal understanding that all patients have rights and healthcare professionals are obliged to respect those rights. When handling patient data, it is important that healthcare professionals keep personal information protected. An ethical concern when using telemedicine, it that confidentiality may be more difficult to ensure. To break confidentiality can be seen as breaches of security or inappropriate disclosure of patient data. This kind of inappropriate disclosure applies both videoconferences and viewing electronically medical patient journals [35].

The Danish Healthcare Authority must ensure that patients are offered the best possible treatment. This requires many and high demands to fulfill. Both prevention, diagnostics, treatment and rehabilitation must be carried out with high academic quality and effective utilization of resources. Moreover, it is a requirement that expertise, research, development and education should be continuously expanded and maintained [36]. With that said it is important to keep in mind that all patients must be offered the best known and evidence based rehabilitation program to ensure that patients are being treated in the best possible way. Therefore, if Herning Municipality decides to introduce telemedicine in rehabilitation it has to be proven that telemedicine rehabilitation is a better and more effective solution than center-based rehabilitation.

<http://knudramian.pbworks.com/w/page/45224847/Vidensbegreber>

<https://socialstyrelsen.dk/voksne/stof-og-alkoholmisbrug/stofmisbrugsbehandling/retningslinjer-for-indsatser-og-ydelser/retningslinje-for-anvendelse-af-evidensbaserede-metoder-1>

What impact would an ICT solution for rehabilitation have on both cardiovascular patients and the Danish Healthcare System?

How can ICT be used to prevent rehospitalisation for cardiovascular patients?

Which barriers/challenges can such system meet in implementation?

"Studies have shown that telemental health has proven to reduce both healthcare costs and patient costs. Break-even analysis of multiple studies, however, showed that in order to be cost-effective, a certain number of consultations must take place per year to justify the capital investment costs of implementing such programs (Hilty, et al., 2013)". [21]

5.1 Economy and effect analysis

The cost part of this analysis will be the implementation cost of standard or telerehabilitation with vCare as the ICT provider. It is important to distinguish between capital expenditure (CAPEX) and Operating expenses (OPEX). For this project the CAPEX to implement standard CR and vCare is collected and the OPEX for running the rehabilitation for the first year.

Comparable basis to randomised controlled trial conducted in Belgium

As it wasn't possible to collect data on cost-effectiveness analysis using quality adjusted life years (QALY) and rehospitalization rates, it has been chosen to use data from a previous study. The study that has been used was done in 2015 and carried out in Belgium. The study was made to investigate in the effect of cardiac telerehabilitation in patients with a personalised patient-centred web application. 140 patients suffering from a cardiac disease were randomly allocated to telemedicine rehabilitation (intervention group) or centre-based rehabilitation (control group). Belgium are following the same European CR guidelines as seen in Denmark. Therefore, the rehabilitation program used in the control group is seen to be the same as the one used in Herning Municipality. The study period for the control group was three month and the group participated in group-based training sessions at the rehabilitation centre. The group size varied from 8-12 patients per session and they were under supervision of physical therapist and exercise specialist, both specialised in CR. The rehabilitation program started with an individual physical test on an electromagnetically braked cycle ergometer. In the end of the program the patient's physical health were evaluated by a nurse. Furthermore, the CR programme consisted of an information / education module, smoking cessation and dietician guidelines [9].

As seen in the below section the study conducted in Belgium can be compared to the 12-weeks rehabilitation program used in Herning. Therefore, QALY and rehospitalization rates are evaluated as useful data to be used in this project.

5.1.1 Phase 1

The Economic analysis in this paper does not include a detailed analyse of phase 1 which is the period of hospitalization of the patient. This is dismissed because the cost of the control group and intervention group is the same in this phase of rehabilitation. Furthermore, the introduction of telerehabilitation will not effect this phase of rehabilitation.

5.1.2 Phase 2

Phase 2 is the phase after the patient has been discharged.

Control group

The control group in this cost-effectiveness analysis is as before mentioned the standard CR in Herning Municipality. 200 patients are on average in the program yearly.

Economics

Almost all cost for the control group was collected during the semi-structured interview with Eva Klose Jensen and Hanne Voldgaard Nielsen described in Section 4.2. If a cost has been collected elsewhere it will be described throughout this section.

The cost of profession is the first cost that is taken into account. The salary and working hours of the professions needed in the control group is based on the cost in Herning Municipality this means it will differ from municipality too municipality. The collected data will be described further in this section where cost per patient will be the outcome of the calculations.

The salary of the nurses needed in the standard CR is 308DKK per hour and they have two nurses who works 21 hours, 48 weeks a year. The cost per patient will there for be as follows:

Total hours of working nurses a year:

$$42hours \cdot 48weeks = 2016hours$$

Total cost per year:

$$2016hours \cdot 308DKK = 620.928DKK$$

Cost per patient:

$$\frac{620.928DKK}{200patients} = 3104,64DKK$$

The cost per year for the physiotherapist is 600.000DKK hence the calculations for the physiotherapist is backwards. The physiotherapist works 54 hours a week in 48 weeks a year. The cost of the physiotherapist is therefore as follows:

Total hours of working physiotherapist a year:

$$54\text{hours} \cdot 48\text{weeks} = 2592\text{hours}$$

Physiotherapist hourly cost:

$$\frac{600.000DKK}{2592\text{hours}} = 231,50DKK$$

Cost per patient:

$$\frac{600.000DKK}{200\text{patients}} = 3000DKK$$

The salary of the dietician needed in the standard CR is 225DKK per hour. The dietician is schedule to participate four times a year for three hours. Furthermore, the dietician get paid for two hours of preparation per class. Therefore, the cost of the dietician is as follows:

Total hours of working dietician a year:

$$5\text{hours} \cdot 4 = 20\text{hours}$$

Total cost per year:

$$20\text{hours} \cdot 225DKK = 4500DKK$$

Cost per patient:

$$\frac{4500DKK}{200\text{patients}} = 22,5DKK$$

Profession	Average hourly Cost	Total cost a year	Cost per patient
Nurse	308 DKK	620.928DKK	3104,64DKK
Physiotherapist	231,50DKK	600.000DKK	3000DKK
Dietician	225DKK	4500 DKK	22.5DKK
Total		1.225.428DKK	6127,14DKK

Table 5.2: Profession control group cost

The next cost that is considered is the implementation cost of materials as training equipment and office environment at the training facility. It is important to notice that these cost is a one time cost and in the future it will be a significant minor cost. The data is collected from a spreadsheet handed out from Herning Municipality. To see the exact prices on all materials please see Appendix XXXX.

Materials implementation	Unit	Total Cost	Cost per patient
Training equipment	97	29.711DKK	149DKK
Training bikes	12	118.200DKK	591DKK
Test bike	1	76.750DKK	382.75DKK
Office environment	39	34.545DKK	173DKK
Other material	8	18.161DKK	91DKK
Total	157	277.367DKK	1386,75DKK

Table 5.4: Materials control group cost

To provide the right care for the patient and follow up on their condition some medical equipment is needed. These are described in Table 5.6. This data is based on the spreadsheet as before mentioned and is to be seen in Appendix XXX.

Medical equipment	Unit	Total Cost	Cost per patient
Model of heart	1	350DKK	1,75DKK
Sphygmomanometer	1	1599DKK	8DKK
Pulse Oximeter	1	599DKK	3DKK
Cuff	2	498DKK	2,5DKK
Ventilation mask	1	1637DKK	8DKK
Total	6	4683DKK	23,25DKK

Table 5.6: Medical equipment control group cost

The rest of Herning Municipality cost is collected in Table 5.8. The cost of renting the facility is not given in the table. This is due to a non disclosure agreement with Herning Municipality. The group know the value of the cost and is able to say that this is a big cost for the municipality, but it is not possible to publish the number in this paper.

The number of rehospitalized patients in Region Midtjylland was 4658 in 2015 out of 20289 admissions, hence the percentage of rehospitalization per patient is 23% in the Region. Keep in mind that some patients are rehospitalized twice and therefore the total number of readmissions is 6339, wich means a total percentage of 31% readmissions [37]. It is not possible to collect the exact data from Herning Municipality. The total cost is calculated

as it is expected that 23% of all patients in CR treatment in Herning Municipality i rehospitalized. The average cost of rehospitalisation was 100.875DKK in 2004 [38]. This is the newest number that has been collected, but the cost is higher today, but unknown. The calculation of cost in Herning Municipality is as followed.

Estimated amount of readmissions to Herning Hospital:

$$31\%200 = 62readmission$$

Total cost:

$$62 \cdot 100.875DKK = 6.254.250DKK$$

Total cost spread out as a cost on all patients:

$$\frac{6.254.250DKK}{200} = 31.271,25DKK$$

Other Cost	Total Cost a year	Cost per patient
Location	(NDA)	(NDA)
Employee education	10.000DKK	50DKK
HjerteKomMidt (database)	?DKK	?DKK
Brochure	0DKK	0DKK
Rehospitalization	6.254.250DKK	31.271,25DKK
Total	?	?DKK

Table 5.8: Other cost control group

From these collected cost from Herning it is possible to calculate the total cost per patient after the first year of implementation. This indicates that the CAPEX cost is included in this analysis.

$$Profession+Materialimplementation+Medicalequipment+othercost = Costperpatient$$

Effectiveness

The QALY baseline in the control group is 0.77 and this is the number that will be used in the cost-effectiveness analysis in this paper[9].

Intervention group

Profession	Average hourly Cost	Total cost a year	Cost per patient
Nurse	308 DKK	620.928DKK	3104,64DKK
Physiotherapist	231,50DKK	600.000DKK	3000DKK
Dietician	225DKK	4500 DKK	22.5DKK
Total		1.225.428DKK	6127,14DKK

Table 5.10: Profession Intervention group cost

Materials implementation	Unit	Total Cost	Cost per patient
Training equipment	97	29.711DKK	149DKK
Training bikes	12	118.200DKK	591DKK
Test bike	1	76.750DKK	382.75DKK
Office environment	39	34.545DKK	173DKK
Other material	8	18.161DKK	91DKK
Total	157	277.367DKK	1386,75DKK

Table 5.12: Materials intervention group cost

Medical equipment	Unit	Total Cost	Cost per patient
Model of heart	1	350DKK	1,75DKK
Sphygmomanometer	1	1599DKK	8DKK
Pulse Oximeter	1	599DKK	3DKK
Cuff	2	498DKK	2,5DKK
Ventilation mask	1	1637DKK	8DKK
Total	6	4683DKK	23,25DKK

Table 5.14: Medical equipment Intervention group cost

Other Cost	Total Cost	Cost per patient
Location	(NDA)	(NDA)
Employee education	10.000DKK	50DKK
HjerteKomMidt (database)	?DKK	?DKK
Brochure	0DKK	0DKK
Rehospitalization	?	?
Total	?	?DKK

Table 5.16: Other cost Intervention group

Effectiveness

The QALY baseline in the intervention group is 0.74 and this is the number that will be used in the cost-effectiveness analysis in this paper[9].

5.1.3 Phase 3

5.1.4 calculations

ICER(Cost I – Cost C)/(Effectiveness I – Effectiveness C) (DKK/QALY):

6 | Discussion

Rehabilitation solution with respect to the patient

Cardiac rehabilitation has proven beneficial effects on morbidity and mortality and is highly recommended by international guidelines within the European Society of Cardiology [39]. These guidelines contain evidence exists for selected items to be offered in cardiac rehabilitation and therefore it can be a difficult task to replace the centre-based rehabilitation program which is used internationally today. Unfortunately, CR is underutilised due to patient related factors such as traveling distance, social aspects and/or work schedule. As reported in a randomized controlled trial in Herning Municipality [22], only 50% of the patients who are being offered to follow a rehabilitation program accepts the offer. Furthermore, it is seen that improvements on lifestyle behaviour, such as physical condition and nutrition, are often not maintained over time [40]. This statement was also concluded in the patient interview, Section 4.4, where a nurse mentioned that three years after participating in the rehabilitation program most patients are back to the same state of health as they were before participating in the rehabilitation program. With these aspects in mind telemedicine rehabilitation can possible be a beneficial solution to be offered as part of the centre-based rehabilitation program. To accommodate the patients' needs a telemedicine solution would be beneficial after the 12-weeks of centre-based rehabilitation. By this solution patients could possible continue on both exercises and nutrition programs made by physiotherapist and dietitian. This solution could possibly be implemented as an application that can be downloaded to both smartphones and tablets. The application could consist of exercise programs with different levels to accommodate patients with different physical shape. Also, nutrition programs made with regard to cardiac patients could be included. Furthermore, information and knowledge within heart disease, risk factors, medicine, etc. could be a part of the application. This solution would not be used to reduce exact cost on the rehabilitation program that is being used today. It could possible help patients after the rehabilitation program and hereby is could possibly be cost effective due to readmission as hopefully patients would stay in good physical shape.

7 | Recommendation

8 | Perspectivation

8.0.1 Ongoing project in Netherlands

A project in Netherlands is looking into the impact of ICT solution for a group of cardiac patients. The patient group has been diagnosed with coronary artery disease (CAD). The result of the trial is not yet submitted as the trial is ongoing. The study is looking into 300 patients whereas 150 are restricted as a control group. The control group will receive normal Cardiac Rehabilitation (CR) treatment and the intervention group will receive home-based telemedicine rehabilitation[40]. The result of this study could have a great impact on this project.

9 | Conclusion

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A | Appendix

Appendix Number

1. Interview - Borgere fra Skanderborg Kommune

B | aap1

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